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An Empirical Inquiry into the Role of Internet Connectivity on Financial Accessibility

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ABSTRACT

This paper examines the role of Information and Communication Technologies (ICT) in enhancing financial inclusion across 120 countries from 2004 to 2017. Employing a dynamic panel data (Generalized Method of Moments, GMM) methodology, it addresses two primary questions: how communication technology affects financial inclusion and whether the gains differ across developing, emerging, and developed nations. The results indicate a positive and statistically significant impact of communication technology on financial inclusion, with a relatively higher elasticity for mobile phone users in middle-income and high-income countries. Furthermore, the significance of physical bank branches diminishes once communication technology variables are included, suggesting a distinct channel through which ICT fosters financial access. The elasticity of physical bank outlets is higher for middle-income economies than for high-income counterparts, whereas the influence of communication technology is greater among high-income countries. These findings call into question potential diminishing marginal returns from communication technology. Although the model includes less developed countries in the sample, it does not adequately explain their within-group variation.

INTRODUCTION

The rapid development and extensive penetration of Information and Communication Technologies (ICT) across various economic sectors have profoundly influenced economic fundamentals worldwide. Over the past few decades, this proliferation has triggered significant research exploring the impact of ICT on productivity, political economy, environmental economics, and the shadow economy (Elgin, 2013; Sassi & Goaid, 2013). Among these areas, the financial sector, recognized as a crucial backbone of economic growth, has notably benefited from advances in ICT. This recognition is echoed by economic scholars and policymakers alike, highlighting ICT as an essential driver of economic performance. Indeed, the World Bank (2012) acknowledges the potential of ICT in reducing poverty, enhancing productivity, and fostering economic growth.

Financial sector efficiency typically involves improved financial intermediation, primarily characterized by enhanced deposit-taking and loan provisioning. Efficiency gains can be broadly categorized into two main aspects. First, ICT adoption lowers fixed or sunk costs, such as maintaining extensive branch networks, accessing borrower information, and running payment systems. Second, it reduces the variable costs of financial intermediation, specifically costs associated with credit analysis and borrower monitoring, thus decreasing the per-unit cost of financial transactions. In particular, the rise of internet banking and electronic payment systems (branchless banking) has reduced banks' reliance on physical branch networks, substantially cutting fixed costs. This paper specifically investigates the influence of

internet usage on financial accessibility, emphasizing credit market efficiency. It examines how internet access reduces information asymmetry (one party (usually the seller) in an economic transaction knows more than the other) among depositors, borrowers, and financial intermediaries compared to traditional banking infrastructures. For depositors, internet access facilitates informed decisions by allowing easy banking product comparisons and maximizing savings returns. Similarly, borrowers benefit from improved access to information on investment opportunities and optimal borrowing terms. Nsouli and Schaechter (2002) highlight how electronic banking simplifies comparative evaluations of financial services, aiding consumer decision-making. Additionally, financial intermediaries, including formal banks and informal financial entities, benefit significantly from adopting internet-based operations, leading to reduced transaction costs, greater efficiency, and minimized adverse selection risks (Kim, 2001). Further, the adoption of internet technologies facilitates effective communication and marketing strategies, further mitigating information asymmetry.

The impact of ICT on financial performance, however, may differ considerably between developed and developing countries. Developing economies typically face limitations in technological infrastructure and skilled human resources, potentially reducing the positive economic impact of ICT. Conversely, ICT can offer developing nations opportunities to bypass traditional infrastructure limitations, enabling them to enhance productivity and narrow economic gaps with developed countries (Steinmueller, 2001).

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The evolving role of ICT in improving financial sector efficiency motivates this empirical study. The paper tests the hypothesis that increased ICT connectivity leads to greater financial accessibility, enhancing borrowers' and depositors' participation in financial markets. Previous empirical literature has often relied on broad financial development indicators such as domestic credit to the private sector or monetary aggregates (M2). Distinctively, this research utilizes detailed, demographically distributed data on the number of commercial bank deposit and loan accounts, providing clearer insights into financial resource utilization. For instance, increases in loan accounts suggest broader credit accessibility, while growth in deposit accounts indicates enhanced savings mobilization for economic activities. Traditional broad measures, while informative, do not necessarily reflect inclusiveness or the equitable distribution of financial services.

Additionally, although extensive literature examines financial development's impact on economic growth, empirical research on financial inclusion determinants remains limited due to historically scarce comprehensive cross-country data. Recent availability of such data now permits rigorous empirical investigation into financial inclusion and its determinants.

The paper is organized into five sections. Section 2 reviews theoretical literature alongside recent empirical studies. Section 3 formalizes the hypotheses and details the data and empirical methodology. Section 4 presents and discusses main estimation results and robustness tests. Lastly, Section 5 concludes with policy implications and recommendations for future research.

LITERATURE REVIEW

Internet access and usage enable the creation and dissemination of information, thus improving market efficiency by reducing informational gaps. In line with modern endogenous growth theories (Romer, 1986; Barro, 1998; Aghion & Howitt, 1998), knowledge production and distribution are considered pivotal to economic progress. As argued by Huet *et al.* (2007), the development of ICT is better viewed as a catalyst for economic growth rather than merely a byproduct.

Shamim (2007) provides one of the earliest empirical investigations into how ICT diffusion and financial development jointly foster economic growth. Using liquid liabilities, the ratio of commercial bank assets to central bank assets, and domestic credit to the private sector (all expressed as percentages of GDP) to proxy financial development, Shamim's results suggest that internet and telecommunication infrastructure can positively influence long-run economic growth. A Generalized Method of Moments (GMM) estimator is employed, instrumenting financial development with ICT variables, which reinforces the existence of a long-run link between financial development and economic growth.

Yi and Choi (2009) analyze data from 1991 to 2000 for 207 countries, concluding that internet usage is a significant driver of economic growth, surpassing the

effect of investment. However, the authors do not assess financial development as an intermediary mechanism in this relationship.

Andrianaivo and Kpodar (2012) employ a system GMM framework to examine how mobile phone penetration contributes to economic growth in African nations. Their findings reveal a positive link between mobile technology and economic performance, especially when interacting mobile diffusion with financial development variables. Financial inclusion is measured through private credit to the domestic sector and the number of borrowers and depositors per capita. While Andrianaivo and Kpodar (2012) also examine the effect of mobile phone use on financial inclusion through a random effects model, they do not explicitly address endogeneity concerns. By contrast, the present study uses a dynamic panel approach (two-step system GMM) to account for potential reverse causality and omitted variables.

Sassi and Goaid (2013) jointly estimate the relationship between ICT, financial development, and economic growth for 17 Middle Eastern and North African nations spanning 1960–2009. Although private sector credit alone appears to exert a negative influence on growth, ICT indicators exhibit a direct, positive, and significant contribution. Moreover, the interaction term between communication technology and financial development proves to be positively correlated with growth.

More recently, Salahuddin *et al.* (2016) employ an autoregressive distributed lag (ARDL) model to investigate the relationship between internet diffusion, financial development, trade, and economic growth in South Africa. Their long-run estimates reveal significant positive effects of both internet usage and private sector credit on growth, whereas short-run dynamics appear less conclusive.

Finally, Niebel (2018) conducts a comparative study of ICT's effect on economic growth across three income groups of countries. While panel regression analyses confirm a positive overall effect of ICT on economic growth, subsample analyses do not yield evidence of any statistically significant difference among low-, middle-, and high-income economies. Consequently, the notion that developing countries may experience a leapfrogging effect through ICT remains unsupported.

MATERIALS AND METHODS

This study empirically evaluates the effect of internet usage on financial activity indicators, measured by the number of loan and deposit accounts at commercial banks, for a panel of 120 countries from 2004 to 2017. Additional ICT indicators such as mobile phone subscriptions, high-speed internet subscriptions, and fixed landline telephones are also included to comprehensively assess the impact of communication technologies on financial accessibility. The following three hypotheses guide this investigation:

- Hypothesis 1: Internet usage positively influences the number of borrowings and deposit accounts at

commercial banks.

- Hypothesis 2: The effect of internet usage on borrowing and lending activities is stronger in developing and emerging economies than in developed ones.

- Hypothesis 3: Conventional bank infrastructure (e.g., physical branch networks) plays a more significant role in explaining financial access in developing economies compared to developed economies.

Data & Stylized Descriptive Statistics

Financial access and usage data are taken from the International Monetary Fund’s Financial Access Survey (IMF FAS). Two key variables represent real financial usage: (i) the number of loan accounts at commercial banks per 1,000 individuals, and (ii) the number of deposit accounts at commercial banks per 1,000 individuals. These indicators capture core banking services related to credit provision and deposit-taking. Additionally, the geographical outreach of banks is measured by the number of bank branches per 1,000 square kilometers, which serves as a proxy for average physical distance to banking services. A higher number of branches per 1,000 km² implies shorter distances and thus potentially greater access.

Beck *et al.* (2008) emphasize that financial development comprises both accessibility and utilization, effectively two sides of the same coin. However, the available dataset predominantly focuses on commercial banks, thereby limiting the scope of analysis to the banking sector.

Summary statistics for the overall sample and by World Bank income classification (high-, middle-, and low-income countries) highlight substantial disparities in both financial and communication technology infrastructure. Low-income nations exhibit markedly fewer bank

branches relative to middle- and high-income peers (e.g., 6.7 times fewer branches than middle-income countries), and the gap is even wider compared to high-income countries. Similarly, the average of 162 deposit accounts per 1,000 adults in low-income countries is five times lower than in middle-income countries and approximately ten times lower than in high-income countries. Parallel trends emerge in loan accounts, where, for instance, only about 18.5 out of 1,000 people obtain commercial bank credit in low-income economies, contrasted with significantly higher ratios in middle-income countries.

It is noteworthy that the measure of banking efficiency—often approximated by the ratio of bank credit to bank deposits—does not vary extensively across income groups, suggesting a broadly consistent level of operational efficiency, even in low-income nations.

Data on communication technologies are sourced from the International Telecommunication Union (ITU), encompassing indicators such as internet usage, mobile phone subscriptions, and fixed telephone lines. On average, only about six out of 100 individuals use the internet in low-income nations, rising to 23 in middle-income countries and around 65 in high-income countries. In comparison, the disparity in mobile phone subscriptions is less pronounced: low-income countries register roughly 41 subscriptions per 100 individuals, about half the average in middle-income countries. Consequently, while substantial differences persist in access to financial services,

the gap in ICT usage appears somewhat narrower, implying that many low-income nations may be catching up faster in communication technologies than in traditional financial infrastructure.

Table 1: Descriptive Statistics

Variables	Mean				Ratios		
	LIC	MIC	HIC	All	M/L	H/L	H/M
No. of Borrowers	16.0	153.5	437.6	239.8	9.6	27.3	2.9
Bank Branches	2.1	14.2	39.8	39.8	6.7	33.6	5.0
Deposit Accounts	162.7	884.0	2268.2	1363.9	5.4	13.9	2.6
No. of Depositors	120.6	612.0	1154.1	719.1	5.1	9.6	1.9
Loan Accounts	18.5	257.6	673.6	382.2	13.9	36.3	2.6
Bank Efficiency	70.4	91.4	113.9	100.5	1.3	1.6	1.2
ICT Imports	3.9	6.3	8.3	7.2	1.6	2.1	1.3
Mobile Phones	40.7	74.6	114.9	89.1	1.8	2.8	1.5
Internet Usage	6.4	23.1	64.6	38.4	3.6	10.1	2.8
Internet Subscriptions	0.3	4.0	20.1	10.3	15.2	77.1	5.1
Fixed Telephones	1.7	12.0	37.5	17.4	7.0	21.8	3.1
GDP per Capita	590.4	4825.2	34613	15288	8.2	58.6	7.2
Education	37.4	76.4	103.9	80.3	2.0	2.8	1.4
Population Density	111.6	128.4	297.7	176.6	1.1	2.7	2.3

Notes: Author's calculations. This table provides descriptive statistics for key variables related to financial accessibility and usage (loan accounts, deposit accounts, bank branches, and banking efficiency), as well as communication technology (ICT) indicators (internet usage, mobile phone subscriptions, internet subscriptions, ICT imports, and fixed telephones). Financial access data are sourced from the IMF's Financial Access Survey (FAS), which focuses primarily on commercial banks; "Bank Branches per 1,000 km²" indicates the physical distribution of banking outlets, and banking efficiency is approximated by the ratio of bank credit to bank deposits. ICT data are taken from the International Telecommunication Union (ITU). Countries are classified as Low-Income Countries (LIC), Middle-Income Countries (MIC), and High-Income Countries (HIC), following the World Bank's categorization. The reported ratios—M/L (MIC/LIC), H/L (HIC/LIC), and H/M (HIC/MIC)—highlight relative differences across income groups.

Model Specification of the ICT–Financial Access Nexus
To empirically assess the hypothesis concerning the impact of internet usage and other ICT indicators on financial activities, this study employs the Generalized Method of Moments (GMM) estimation framework, following the methods of Arellano and Bover (1995) and refined by Roodman (2009a, 2009b). The choice of System GMM addresses several econometric challenges such as instrument proliferation, cross-sectional dependence, endogeneity, omitted variable bias, measurement errors, and latent country-specific heterogeneity (Love & Zicchino, 2006; Baltagi, 2008; Bond *et al.*, 2001). Moreover, the two-step GMM approach is preferred as it efficiently handles heteroscedasticity.

GMM application requires two critical data conditions to hold true: (i) the panel dataset should have more cross-sectional units (countries) than time periods (years); and (ii) the dependent variables (financial activity measures) must show persistence, reflected in high correlations between their current and lagged values. These conditions are satisfied by our dataset.

To evaluate robustness, fixed effects (FE) and fixed effects instrumental variable (FE-IV) estimations are also conducted. FE and FE-IV are favored over random effects based on the Hausman specification test. Income per capita and banking efficiency, among other variables, are likely endogenous due to potential bidirectional causality with financial activity variables (Andrianaivo & Kpodar, 2012). Hence, lagged explanatory variables are employed as instruments to mitigate potential biases.

The baseline dynamic panel model is specified as follows:

$$FU_{it} = \alpha_0 FU_{it-1} + \alpha_1 y_{it} + \alpha_2 ICT_{it} + \alpha_3 Eff_{it} + \alpha_5 bran_{it} + \sum_{k=1}^n (\alpha_k X_k) + \delta_t + \epsilon_{it} \tag{1}$$

where, $\epsilon_{it} = \mu_i + v_{it}$. Here, μ_i represents unobserved country-specific effects, and v_{it} is an idiosyncratic error term assumed serially uncorrelated and independent of μ_i , with $v_{it} \sim i.i.d.(0, \sigma^2)$.

The dynamic model (1) is commonly transformed into first-difference form to eliminate country-specific effects, thus allowing the use of GMM. The transformations are shown below step-by-step:

$$FU_{it} - FU_{it-1} = \alpha_0 FU_{it-1} + \alpha_1 y_{it} + \alpha_2 ICT_{it} + \alpha_3 Eff_{it} + \alpha_5 bran_{it} + \sum_{k=1}^n \alpha_k X_k + \delta_t + \epsilon_{it} \tag{2}$$

$$FU_{it} - FU_{it-1} - \alpha_0 FU_{it-1} = \alpha_1 y_{it} + \alpha_2 ICT_{it} + \alpha_3 Eff_{it} + \alpha_5 bran_{it} + \sum_{k=1}^n \alpha_k X_k + \delta_t + \epsilon_{it} \tag{3}$$

$$FU_{it} - FU_{it-1}(1 + \alpha_0) = \alpha_1 y_{it} + \alpha_2 ICT_{it} + \alpha_3 Eff_{it} + \alpha_5 bran_{it}$$

$$+ \sum_{k=1}^n \alpha_k X_k + \delta_t + \epsilon_{it} \tag{4}$$

$$FU_{it} = \alpha^* F U_{it-1} + \alpha_1 y_{it} + \alpha_2 ICT_{it} + \alpha_3 Eff_{it} + \alpha_5 bran_{it} + \sum_{k=1}^n \alpha_k X_k + \delta_t + \epsilon_{it} \tag{5}$$

where $\alpha^* = 1 + \alpha_0$. Moreover, following are the terminologies descriptions in the above model specifications:

- FU_{it} : Financial usage (e.g., number of deposit or loan accounts per 1,000 adults)
- FU_{it-1} : Lagged dependent variable measuring persistence
- y_{it} : Income per capita, potentially endogenous due to reciprocal effects with FU_{it}
- ICT_{it} : Information and Communication Technology indicators (e.g., internet usage, mobile subscriptions)
- Eff_{it} : Proxy for banking efficiency, e.g., ratio of bank deposits to bank credit
- $bran_{it}$: Branch density (branches per 1,000 square kilometers)
- X_k : Other control variables such as institutional quality, education, population density, and bank overhead costs
- δ_t : Time dummies capturing global shocks or trends
- μ_i : Unobserved, time-invariant country-specific effect
- v_{it} : Idiosyncratic error term $v_{it} \sim i.i.d.(0, \sigma^2)$

The coefficient α^* indicates how strongly current financial usage depends on its past values, reflecting inertia or stickiness in financial access. The key parameter α^2 captures the contribution of ICT indicators to financial inclusion (loan or deposit accessibility). A positive and significant α^2 supports the hypothesis that internet diffusion and other communication technologies enhance financial access, while α^5 measures the marginal contribution of physical banking infrastructure.

Rewriting Equation (1) in first-differences or incorporating instruments for potential endogenous regressors allows the two-step system GMM estimator to address measurement error and eliminate unobserved country effects (μ_i). Lags of FU_{it} and other explanatory variables can serve as valid instruments under the assumptions of no second-order serial correlation in v_{it} and strict exogeneity of instrument sets. This approach thus controls for the biases that arise from reverse causality and omitted variables, ensuring more reliable estimates.

Finally, specification (5) serves as the final model, incorporating instrumental variables to address endogeneity and omitted variable concerns by leveraging appropriate lags of the explanatory variables. Consequently, the GMM estimations yield robust and reliable parameter

estimates of the relationship between ICT diffusion and financial access. We adopt this specification as our primary (“workhorse”) model throughout the empirical analyses.

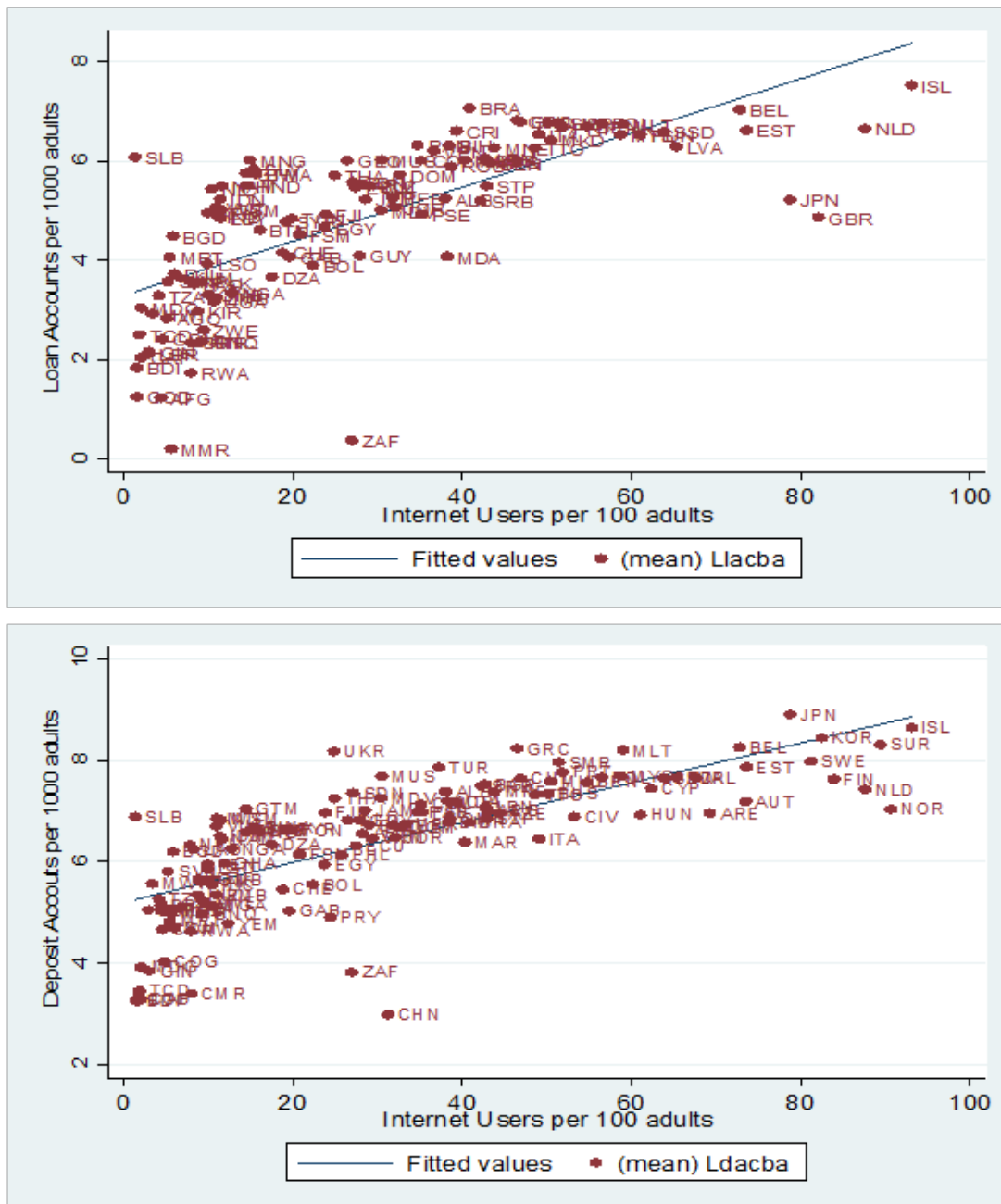


Figure 1: Values are mean values of deposit and loan accounts per 100 adults. The figure represents overall sample of 120 countries. Data is obtained from International Telecommunication Union and Financial Access Survey

RESULTS AND DISCUSSION

The estimation results from the dynamic panel Generalized Method of Moments (GMM) specification in Equation (5) are presented in the following tables. Table 4 summarizes the impact of internet usage on financial activity across 119 countries, using a two-step system robust GMM while controlling for potential instrument proliferation. Empirical estimations proceed in three stages: first, measuring the direct effect of internet usage on financial activity variables; second, controlling for time trends; and third, introducing institutional quality

and education. Specification validity is assessed via post-estimation diagnostic tests: the Arellano–Bond AR(2) test should fail to reject the null hypothesis of no second-order autocorrelation at the 10% level, and the Sargan and Hansen tests must also fail to reject the null of valid instruments. Moreover, the number of instruments is kept below the number of cross-sections to avoid proliferation.

According to Table 4, internet usage exerts a positive and significant influence on two core commercial banking services: deposit accounts per 1,000 individuals and loan

accounts per 1,000 individual10-percentage-point rise in internet usage is associated with a 0.06-percentage-point increase in deposit accounts per 1,000 people (Column 1, 1% significance). Branch density also proves crucial, as a 1-percentage-point increase in physical bank outlets corresponds to a 0.6-percentage-point rise in deposit accounts. Time trends do not materially alter the results. GDP per capita does not significantly explain deposit or loan uptake, whereas population density is consistently negative, suggesting that financial institutions may restrict lending to more geographically concentrated populations for risk-diversification reasons (Andrianaivo & Kpodar, 2012). Bank overhead costs remain mostly insignificant, though once education is introduced (Model 6), overhead costs become marginally significant, implying that higher expenditures on customer services might attract more depositors. Education itself has a positive effect on deposit accounts, while institutional quality presents a weakly significant negative sign, potentially indicating that countries with broader civil liberties and political rights offer alternative saving or investment channels beyond commercial banks.

For loan accounts, a 10-percentage-point increase in internet usage leads to roughly 0.1-percentage-point growth in borrowing at the 1% level, indicating a larger internet elasticity for loans than deposits. Branch density also fosters higher loan activity, with a 10-percentage-point rise in the number of branches driving approximately 9.6-percentage-point growth in loan uptake. Institutional quality, education, and GDP per capita do not substantially affect loan accounts in these models. Diagnostic tests (Sargan, Hansen, AR (2)) confirm the reliability of the GMM results.

Although the overall sample underscores the positive role of internet usage, distinguishing effects by income level is crucial. Table 5 examines 19 low-income countries, where internet connectivity does not significantly influence deposit or loan accounts. Branch density is the lone driver of deposits and does not significantly explain loans. These outcomes conform with descriptive findings that low-income countries lag in financial and technological infrastructure: only 6.4 out of 100 individuals use

the internet, broadband subscriptions are practically nonexistent, and average bank branch density is six times lower than in middle-income countries. In addition, low-income populations often lack sufficient collateral for formal loans and may rely on microfinance institutions. Table 6 investigates around 68 middle-income countries, revealing that internet usage positively and significantly impacts both deposit and loan accounts. A 10-percentage-point jump in internet penetration increases deposit accounts by about 0.04 percentage points; the coefficient for loans is around 0.1, highlighting a stronger effect on borrowing. Population density retains a negative correlation with financial activity, while branch expansion remains pivotal for both deposits and loans. Other variables, such as institutional quality, education, GDP per capita, and overhead costs, are not systematically related to either outcome.

Finally, Table 7 focuses on 32 high-income countries. Internet usage significantly explains only deposit accounts, where a 10-percentage-point rise in internet usage correlates with a 5-percentage-point increase in deposit accounts (Column 1). In contrast to lower-income groups, GDP per capita strongly and positively influences financial access, reflecting the prevalence of mortgages and other consumer credit instruments in higher-income settings. Bank branches also spur deposit growth, though the coefficient is smaller than in middle-income countries, implying a diminished reliance on branch networks in advanced banking systems. Population density negatively affects deposits, yet does not significantly alter loans. Banking efficiency, captured by the ratio of credit to deposits, emerges as positive and significant for deposit accounts, possibly indicating that more efficient banks attract additional savers. Across all models, Sargan, Hansen, and AR (2) tests validate the GMM specifications.

Robustness Tests with other ICT Indicators

The models for financial activity are also estimated using various other ICT indicators, including mobile phone subscriptions, fixed landline telephones, and ICT imports as a percentage of total imports. In principle, these

Table 2: Estimations for all Countries (Internet Usage and Financial Activity)

Variables	Deposit Accounts per 1000 People						Loan Accounts per 1000 People					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
L. Deposit Accounts per 1000 People	0.3059*** (0.071)	0.2936*** (0.067)	0.2434*** (0.074)	0.2399*** (0.070)	0.1837** (0.080)	0.1748** (0.072)						
L. Loan Accounts per 1000 People							0.1216	0.1363	0.0984	0.1302	0.1813**	0.1959***

cons	5.0366*** (1.711)	5.3446*** (1.841)	4.1376** (1.677)	4.6344** (1.922)	9.0166** (3.631)	8.8717*** (3.342)	7.2542* (4.164)	8.1954** (4.113)	7.9703*** (2.985)	7.8272** (3.497)	11.1086* (6.163)	12.7395* (7.591)
No. of Countries	119	119	119	119	119	119	99	99	99	85	85	85
No. of Observations	1081	1081	1081	1081	782	782	838	838	838	838	593	593
No. of Instruments	19	19	19	19	19	19	19	19	19	19	19	19
Year Dummies	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Sargan Test	0	0	0.96	0.7	0.986	0.823	0.859	0.436	1	0.971	1	0.99
Hansen Test (Prob.)	0.13	0.027	0.625	0.23	0.733	0.419	0.945	0.63	0.938	0.759	0.981	0.96
AR(1)	0	0	0.002	0.001	0.221	0.157	0.08	0.012	0.073	0.017	0.367	0.211
AR(2)	0.108	0.108	0.072	0.064	0.542	0.357	0.455	0.444	0.538	0.868	0.253	0.308

Notes: Reported in parentheses are the standard errors, whereas ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively. Log Transformations: The following variables are log-transformed: Deposit Accounts per 1000 People, Loan Accounts per 1000 People, Real GDP per Capita, Population Density, and Geographically Distributed Bank Branches.

Table 3: Estimations for Low Income Countries (Internet Usage and Financial Activity)

Variables	Deposit Accounts per 1000 People						Loan Accounts per 1000 People					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
L. Deposit Accounts per 1000 People	0.108 (0.205)	0.1432 (5.889)	0.0951 (0.131)	0.0702 (0.159)	0.007 (0.087)	0.1761 (23.581)	-	-	-	-	-	-
L. Loan Accounts per 1000 People	-	-	-	-	-	-	-0.1234 (0.194)	-0.2857 (0.276)	-0.167 (0.422)	-0.3671 (0.295)	-0.2442 (0.298)	-0.4437 (195.946)
Internet Usage	-0.0024 (0.015)	-0.0216 (0.454)	-0.038 (0.024)	-0.0602* (0.031)	-0.0263 (0.032)	-0.0113 (2.018)	0.0780** (0.032)	0.1056 (0.089)	0.0524 (0.079)	0.0834 (0.128)	0.0379 (0.048)	0.1549 (56.668)
Real GDP per Capita	-0.6082	-0.5958	1.1905	0.6382	0.8543	0.1326	0.8351	0.4945	3.0302	3.858	3.8762**	2.5011

Year Dummies	No	yes	No	yes	No	Yes	No	Yes	No	Yes	No	Yes
No. of Observations	145	145	145	145	82	82	125	125	125	125	67	67
No. of Countries	19	19	19	19	19	19	17	17	17	17	15	15
No. of Instruments	19	19	19	19	18	18	19	19	19	19	19	19
Sargan Test	0.007	0.024	0.232	0.336	0.483	0.575	0.53	0.154	0.99	0.92	0.881	0.7
Hansen Test (Prob.)	0.267	0.366	0.307	0.53	0.524	0.658	0.887	0.902	0.834	0.9	0.858	0.45
AR(1)	0.055	0.871	0.125	0.102	0.497	0.993	0.19	0.136	0.2	0.143	0.93	0.99
AR(2)	0.584	0.944	0.61	0.365	0.177	0.991	0.41	0.348	0.54	0.869	0.21	0.99

Notes: Reported in the parentheses are the standard errors, whereas ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Log Transformations: The following variables are log-transformed: Deposit Accounts per 1000 People, Loan Accounts per 1000 People, Real GDP per Capita, Population Density, and Geographically Distributed Bank Branches.

Table 4: Estimations for Middle Income Countries (Internet Usage and Financial Activity)

Variables	Deposit Accounts per 1000 People						Loan Accounts per 1000 People					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
L. Deposit accounts per 1000 People	0.3284*** (0.061)	0.3012*** (0.061)	0.3360*** (0.056)	0.3010*** (0.064)	0.3019*** (0.062)	0.2590*** (0.08)	-	-	-	-	-	-
L. Loan Accounts per 1000 People	-	-	-	-	-	-	0.2233*** (0.043)	0.2161*** (0.033)	0.2159*** (0.039)	0.2220*** (0.034)	0.2844** (0.114)	0.2519*** (0.091)
Internet Usage	0.0043*** (0.001)	0.0050** (0.002)	0.0042*** (0.002)	0.0049** (0.002)	0.0032** (0.002)	0.0044** (0.002)	0.0096*** (0.002)	0.0092*** (0.003)	0.0124*** (0.003)	0.0098** (0.005)	0.0077** (0.004)	0.0071* (0.004)
Real GDP per Capita	0.2283 (0.187)	0.3119 (0.191)	0.2357 (0.207)	0.3193 (0.222)	0.3038 (0.206)	0.4953* (0.262)	0.1031 (0.211)	0.1765 (0.207)	-0.0563 (0.268)	0.1778 (0.229)	0.2576 (0.484)	0.2649 (0.445)

Population Density	-0.8643**	(0.359)	Banks Overhead Cost	0.0014	(0.002)	Geographically Distributed Bank Branches	0.6366***	(0.173)	Banks Efficiency (Bank Credit to Bank Deposit)	-0.0007	(0.001)	Institutional Quality	-	-	Education	-	-	Constant	5.0440**	(2.162)	Year Dummies	No	No. of Observations	620	No. of Countries	68	No. of Instruments	19	Sargan Test	0.675
	-0.8171*	(0.423)		0.0019	(0.001)		0.6190***	(0.18)		-0.0008	(0.001)		-	-		-	-		4.3864*	(2.208)		Yes		620		68		19		0.405
	-0.7347**	(0.341)		0.0012	(0.002)		0.6068***	(0.169)		-0.0009	(0.001)		-0.8186	(1.038)	0.0032	(0.005)		4.7336**	(2.209)	No	620	68	19	0.975						
	-0.7550*	(0.42)		0.0017	(0.001)		0.6175***	(0.177)		-0.0008	(0.001)		-0.7736	(1.191)	-0.0004	(0.007)		4.3317*	(2.26)	yes	620	68	19	0.858						
	-0.7340**	(0.302)		0.0023	(0.002)		0.6014***	(0.135)		-0.0018*	(0.001)		-	-	-	-		4.0531**	(1.749)	No	432	68	19	0.99						
	-0.7373**	(0.322)		0.0030**	(0.001)		0.5979***	(0.134)		-0.0012	(0.001)		-	-	-	-		3.0049	(2.247)	yes	432	58	19	0.98						
	-1.4243**	(0.586)		0.002	(0.002)		0.7792**	(0.297)		0.0026	(0.002)		-	-	-	-		7.2631**	(3.165)	No	512	62	19	0.072						
	-1.4869**	(0.662)		0.0013	(0.003)		0.8310***	(0.304)		0.0034*	(0.002)		-	-	-	-		6.7590*	(3.408)	Yes	512	62	19	0.972						
	-2.1353**	(1.048)		0.0016	(0.003)		0.9055***	(0.324)		0.0034	(0.002)		-	-	-	-		9.8539*	(5.004)	No	512	62	19	0.986						
	-1.5823*	(0.909)		0.0013	(0.003)		0.8364***	(0.308)		0.0034*	(0.002)		-	-	-	-		7.1678*	(4.179)	Yes	512	62	19	0.95						
	-0.8427	(0.575)		0.0037**	(0.002)		0.5896**	(0.285)		0.0037	(0.002)		3.74	(2.964)	-0.0085	(0.012)		4.2239	(4.166)	no	359	51	19	0.83						
	-0.9871	(0.706)		0.0037*	(0.002)		0.6864*	(0.348)		0.0034*	(0.002)		-0.2692	(2.789)	-0.0071	(0.01)		4.6786	(4.219)	yes	359	51	19	0.839						

Hansen Test (Prob.)	0.603	0.465	0.665	0.511	0.9	0.93	0.755	0.428	0.471	0.23	0.48	0.275
AR(1)	0.019	0.002	0.014	0.002	0.062	0.032	0.072	0.062	0.063	0.052	0.18	0.235
AR(2)	0.138	0.14	0.134	0.16	0.2	0.094	0.443	0.584	0.409	0.56	0.4	0.366

Notes: Reported in the parentheses are the standard errors, whereas ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

Log Transformations: The following variables are log-transformed: Deposit Accounts per 1000 People, Loan Accounts per 1000 People, Real GDP per Capita, Population Density, and Geographically Distributed Bank Branches.

Table 5: Estimations for High Income Countries (Internet Usage and Financial Activity)

Variables	Deposit Accounts per 1000 People						Loan Accounts per 1000 People					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
L. Deposit Accounts per 1000 People	0.2605*	0.2314	0.209	0.1668	0.3256*	0.2313	-	-	-	-	-	-
	(0.153)	(0.15)	(0.18)	(0.322)	(0.159)	(0.138)						
L. Loan Accounts per 1000 People	-	-	-	-	-	-	0.1707	0.214	0.2499**	0.1825	0.1739	0.1966
							(0.127)	(0.149)	(0.093)	(0.117)	(0.207)	(0.154)
Internet Usage	0.0050***	0.0063***	0.0048**	0.0055**	0.0050**	0.0071***	0.0023	0.0036	0.0035	0.0032	0.0046	0.0086
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.006)	(0.006)
Real GDP per Capita	0.6410***	0.6296***	0.6744***	0.6610***	0.7143***	0.7577***	1.0050**	0.9313**	0.9907***	1.0825***	0.8545	0.7781
	(0.16)	(0.169)	(0.178)	(0.223)	(0.19)	(0.185)	(0.38)	(0.439)	(0.314)	(0.345)	(0.651)	(0.485)
Population Density	-0.5734*	-0.6074**	-0.4867	-0.5168	-0.4637	-0.5074*	0.8625	-0.2567	-0.1064	-0.0179	0.9067	-1.0262
	(0.308)	(0.278)	(0.327)	(0.401)	(0.279)	(0.287)	(1.064)	(0.617)	(0.594)	(0.611)	(4.867)	(3.265)
Banks Overhead Cost	-0.0216*	-0.0179	-0.0196	-0.0121	-0.023	-0.0231	0.03	0.016	0.0276	0.0396	0.0343	0.0372
	(0.012)	(0.012)	(0.012)	(0.015)	(0.014)	(0.014)	(0.028)	(0.03)	(0.025)	(0.038)	(0.036)	(0.028)

Geographically Distributed Bank Branches	0.1891**	0.2014**	0.1733*	0.1913**	0.1053	0.1024	0.179	0.2779**	0.1476	0.1404	0.1149	0.2072
	(0.093)	(0.085)	(0.098)	(0.082)	(0.144)	(0.123)	(0.109)	(0.12)	(0.112)	(0.244)	(0.342)	(0.287)
Banks Efficiency (Bank Credit to Bank Deposit)	0.0014*	0.0017**	0.0017*	0.002	0.0019*	0.0018**	-0.0004	-0.0009	0	0.0003	-0.0009	-0.0008
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)
Institutional Quality	-	-	-0.1905	-0.4163	-	-	-	-	-	-	0.9052	1.3851
			(0.311)	(-1.598)							(0.605)	(1.186)
Education	-	-	-0.0031	-0.0061	-	-	-	-	-	-	-0.0095	-0.0092
			(0.006)	(0.008)							(0.008)	(0.015)
Constant	0.7211	0.9547	0.5387	1.073	-0.5595	0.0543	0.039	0.037	0.053	-	-	-
	(1.602)	(1.661)	(1.706)	(1.622)	(1.488)	(1.554)	(0)	(0)	(0)			
Year Dummies	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
No. of Observations	316	316	316	316	268	268	201	201	316	316	268	268
No. of Countries	32	32	32	32	31	31	20	20	20	20	19	19
No. of Instruments	19	19	19	19	19	19	19	19	19	19	19	19
Sargan Test	0.493	0.218	0.428	0.504	0.326	0.302	0.423	0.058	0.68	0.14	0.662	0.014
Hansen Test (Prob.)	0.278	0.28	0.21	0.261	0.335	0.363	0.289	0.059	0.36	0.086	0.638	0.403
AR(1)	0.059	0.045	0.11	0.104	0.026	0.035	0.306	0.236	0.081	0.165	0.279	0.072
AR(2)	0.956	0.876	0.99	0.826	0.604	0.546	0.742	0.579	0.516	0.506	0.456	0.909

Notes: Reported in the parentheses are the standard errors, whereas ***, **, * indicate significance at 1%, 5%, and 10% levels, respectively. Log Transformations: The following variables are log-transformed: Deposit Accounts per 1000 People, Loan Accounts per 1000 People, Real GDP per Capita, Population Density, and Geographically Distributed Bank Branches.

variables can be introduced in two ways. First, because they are the primary variables of interest and exhibit relatively high correlations (often above 0.5), each can be added step by step to avoid multicollinearity. Second, principal component analysis (PCA) can be used to generate a representative ICT factor for subsequent regression. To better highlight the distinct roles of each communication technology, the step-by-step approach is adopted here. Table 8 presents robust estimation results for the overall panel of countries using the aforementioned ICT indicators, employing dynamic panel GMM. The impact of internet usage was analyzed previously, so attention now shifts to the remaining ICT variables. A 10 percentage-point increase in mobile phone penetration corresponds to a 1.6–1.96 percentage-point rise in loan accounts per 1,000 people, significant at the 1% level. This marginal effect is notably larger than that of internet usage. High-speed broadband subscriptions per 100 people likewise show a positive, significant effect on financial activity, with a greater impact observed on loans than on deposits. By contrast, neither fixed landline telephones nor ICT imports exhibit significant results for financial activity. Because landline telephones lack the portability and multifunctional capabilities of modern smartphones, they may be regarded as an outdated substitute. ICT imports, though initially linked with higher expenditures on technology equipment, may influence financial activity only later, once imported technologies are integrated into widespread use. Beyond ICT covariates, branch density remains a consistently positive predictor across most specifications, while education is positively and significantly related to financial activity in several models. Population density continues to show a negative relationship, even when additional ICT variables are introduced.

Table 9 provides results for the low-income subset. None of the ICT indicators significantly explain loan or deposit accounts in this group, and other variables are similarly insignificant. Such findings may reflect two key factors: the limited reach of formal banking (loans, deposits) in low-income countries and the incomplete penetration of modern communication technologies, where only a small fraction of the population has access to digital connectivity.

Table 10 reports estimates for middle-income countries. In line with prior results, internet usage and mobile phone subscriptions significantly and positively affect bank loans and deposits. Specifically, a 10 percentage-point increase in mobile phone penetration raises loan accounts by 1.6% and deposit accounts by 1.4% (Columns 2 and 7). Interestingly, the coefficient magnitude for mobile phone subscriptions is higher than that for internet usage. Lagged loan accounts emerge as a significant predictor, reflecting persistence in borrowing behavior. Moreover, once variables beyond internet usage are introduced, GDP per capita becomes a significant, positive determinant of deposit accounts. Branch density retains its positive, significant impact, albeit with a reduced coefficient when mobile phones are included, suggesting that part of

financial activity growth is driven by mobile technology rather than physical bank expansion. Population density remains negatively associated with formal financial activity. A similar trend applies to high-income countries, as shown by Table 9. Mobile phones have an even stronger influence in this cohort: a 10 percentage-point increase corresponds to about a 5.2% rise in loan accounts and a 2.2% rise in deposit accounts. By comparison, these figures were 1.6% and 1.3%, respectively, for middle-income countries, indicating that smart devices may enable wealthier populations to interact with banks more intensively. Higher GDP per capita also drives greater deposit account usage, consistent with the availability of products like mortgages and consumer loans. Moreover, branch density retains a positive impact on lending when internet usage is included, but becomes insignificant once mobile phone penetration is introduced, suggesting that increased connectivity can substitute for some aspects of physical branch access. As a result, further penetration of smartphones appears to be a key channel for expanding banking services in high-income countries.

Policy Implications

Based on the estimation results, several meaningful implications emerge for both the financial and communication technology sectors. First, sufficient infrastructure in finance and ICT is crucial for effectively complementing each other, especially in the banking sector. Conventional banking infrastructure (i.e., physical bank branches) remains important in both emerging and developed nations, but physical outlets alone only serve individuals who are geographically close. Consequently, there are two principal methods to broaden financial inclusion. One involves expanding the number of bank outlets to ensure convenient access for more people; the other leverages collaboration between the banking sector and telecommunications providers. Since mobile phones and the internet are often more readily available than formal banking services, embracing digital payment modes can significantly enhance financial inclusion. This approach also lowers fixed and operating costs for banks, allowing resources to be channeled toward lending and deposit services.

Pakistan offers a salient example: by 2025, the State Bank of Pakistan aims to issue digital currency—alongside robust cybersecurity measures—working toward full digitization by 2030. The establishment of Electronic Money Institutions (EMIs), non-bank entities licensed by the State Bank, aims to promote financial inclusion and efficiency through digital payments. Earlier regulations for branchless banking enabled telecom companies to expand banking services via digital platforms; these efforts facilitated a substantial increase in financial service availability. Yet promoting electronic financial access also raises cybersecurity risks. Online banking systems can become targets of cyber-attacks that erode public trust. Hence, monetary authorities must safeguard system integrity to sustain confidence in digital transactions.

Table 6: Estimations for High Income Countries (Internet Usage and Financial Activity)

Variables	Loan Accounts					Deposit Accounts				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
L. Loan accounts per 1000 People	0.2011*** (0.065)	0.1608*** (0.053)	0.2015*** (0.058)	0.1007 (0.127)	0.1771 (0.0578)	- (0.061)	- (0.070)	- (0.067)	- (0.118)	- (0.058)
L. Deposit accounts per 1000 People	- (0.061)	- (0.070)	- (0.067)	- (0.118)	- (0.058)	0.2047*** (0.061)	0.1748** (0.070)	0.2571*** (0.067)	0.0771 (0.118)	0.3139*** (0.058)
Real GDP per Capita	0.1309 (0.244)	0.2218 (0.158)	0.1998 (0.284)	-0.2368 (0.369)	0.2848 (0.267)	0.1186 (0.167)	0.1981 (0.156)	0.1295 (0.225)	0.0812 (0.375)	0.1179 (0.243)
Population Density	-2.5384** (1.177)	0 (—)	-1.8595** (0.664)	-1.5406 (1.097)	-0.3495 (0.549)	-1.4579** (0.593)	-0.4255 (0.323)	-0.9775** (0.469)	-0.6672 (0.717)	-0.4253 (0.336)
Banks Overhead Cost	0.0013 (0.002)	0.0004 (0.002)	0.0022 (0.002)	-0.0015 (0.003)	0.0018 (0.020)	0.0034** (0.001)	0.0020** (0.001)	0.0027** (0.001)	-0.0002 (0.002)	0.0020* (0.001)
No. of Bank Branches	0.7923*** (0.193)	0.3822*** (0.114)	0.7098*** (0.153)	0.4955** (0.199)	0.4589** (0.240)	0.7600*** (0.195)	0.5475*** (0.155)	0.5947*** (0.255)	0.5057* (0.286)	0.5023* (0.266)
Banks Efficiency	0.0017 (0.002)	0.0020 (0.002)	0.0020 (0.002)	0.0035 (0.002)	0.0019 (0.002)	-0.0012 (0.001)	-0.0014 (0.001)	-0.0012 (0.001)	0.0003 (0.002)	-0.0013 (0.001)
Education	0.0088* (0.005)	0.0069 (0.004)	0.0075* (0.004)	0.0358** (0.016)	0.0092** (0.0046)	0.0079** (0.003)	0.0045 (0.004)	0.0053* (0.003)	0.0281* (0.015)	0.0057* (0.003)

Internet Usage	0.0098*** (0.003)					0.0069*** (0.002)				
Mobile Phone Subscriptions		0.1581*** (0.054)								
Broadband Subscriptions per 100 people			0.0222** (0.01)					0.0085** (0.004)		
Fixed Telephone Lines				0.1933 (0.136)					0.1403 (0.116)	
ICT Imports					-0.0137 (0.008)					-0.004 (0.005)
Constant	11.6387***	-1.6242	8.4594**	6.6761	2.0485	8.4748***	1.2338	5.2882**	3.1013	4.1273
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	125	125	99	116	97	145	145	120	136	72
No. of Countries	17	17	17	17	17	19	19	19	19	19
No. of Instruments	19	19	19	19	19	19	19	19	19	19
Sargan Test (p-val)	0.15	0.44	0.37	0.4	0.81	0.024	0.31	0.38	0.85	0.26
Hansen Test (p-val)	0.9	0.9	0.36	0.97	1	0.37	0.51	0.55	0.85	0.46
AR(1) (p-val)	0.14	0.16	0.37	0.012	0.97	0.87	0.06	0.045	0.09	0.94
AR(2) (p-val)	0.35	0.43	0.63	0.94	0.97	0.94	0.45	0.77	0.11	0.98
	(5.529)	(1.586)	(3.53)	(5.454)	(2.767)	(3.058)	(1.647)	(2.992)	(4.674)	(2.738)

Notes: Reported below the coefficients are standard errors (in parentheses). Asterisks (***, **, *) denote significance at the 1%, 5%, and 10% levels, respectively. Banks Efficiency

= (Bank credit / Bank Deposit). ICT Imports refer to the share of ICT equipment imports in total imports.

Log Transformations: The following variables are log-transformed: Loan Accounts per 1000 People, Deposit Accounts per 1000 People, Real GDP per Capita, Population Density, Geographically Distributed Bank Branches, and Mobile Phones Subscriptions.

Table 7: Estimations for Low Income Countries

Variables	Loan Accounts					Deposit Accounts				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
L. Loan Accounts per 1000 People	0.214 (0.149)	-0.2329 (0.320)	-0.4565 (0.865)	-0.4617 (0.662)	0.6883 (30.366)	-	-	-	-	-
L. Deposit Accounts per 1000 People	-	-	-	-	-	0.1432 (5.889)	0.041 (0.169)	-0.0528 (0.170)	-0.0549 (0.215)	0.2696 (10.894)
Log(real Gdp per Capita)	0.9313** (0.439)	0.346 (3.369)	8 (11.49)	6.4373 (6.4373)	11.3268 (462.318)	-0.5958 (26)	-0.9572 (0.736)	0.0664 (1.657)	-0.6234 (2.994)	0.4653 (5.303)
Log(Population Density)	-0.2567 (0.617)	-0.728 (3.485)	0.2382 (1.898)	3.2909 (3.629)	-7.8188 (478.241)	-0.7197 (12.716)	-0.7006 (0.775)	-0.5327 (1.861)	-0.9049 (0.966)	0
Banks Overhead Cost	0.016 (0.030)	-0.041** (0.019)	-0.1 (0.178)	-0.068** (0.032)	-0.0787 (1.368)	0.0369 (0.310)	0.038** (0.017)	0.0305 (0.024)	0.0129 (0.008)	0.0178 (0.404)
Log (Geographically Distributed Bank Branches)	0.277** (0.120)	0.6755 (0.489)	0.7844 (0.855)	0.8736 (0.722)	1.3204 (15.301)	1.15 (14.231)	1.078** (0.380)	1.275** (0.530)	1.5347*** (0.363)	0.9159 (11.734)
Banks Efficiency (Bank Credit to Bank Deposit)	-0.009 (0.002)	0.0004 (0.010)	0.0062 (0.020)	0.0024 (0.007)	0.0331 (0.953)	-0.0008 (0.088)	-0.0024 (0.006)	-0.0049 (0.014)	0.0016 (0.008)	0.0036 (0.186)
Internet Usage	0.0036 (0.003)					-0.0216 (0.454)				
Log (Mobile Phones Subscriptions)		0.6479 (0.563)					0.0785 (0.111)			

Table 8: Estimations for Middle Income Countries

Variables	Loan Accounts					Deposit Accounts				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
L. Loan Accounts per 1000 People	0.2161*** (0.033)	0.2095*** (0.036)	0.2311*** (0.036)	0.2319*** (0.073)	0.2518*** (0.042)	-	-	-	-	-
L. Deposit Accounts per 1000 People	-	-	-	-	-	0.3012*** (0.061)	0.02873*** (0.071)	0.2875*** (0.080)	0.2508** (0.111)	0.2956*** (0.040)
(real Gdp per Capita)	0.1765 (0.207)	0.0624 (0.234)	0.2549 (0.214)	0.5558* (0.296)	0.7017** (0.266)	0.3119 (0.191)	0.4290** (0.168)	0.4822** (0.205)	0.7826** (0.297)	0.6538*** (0.243)
(Population Density)	-1.4869** (0.662)	-0.6545 (0.461)	-1.5378*** (0.500)	-0.8522* (0.438)	-1.0461** (0.497)	-0.8171* (0.423)	-0.3465 (0.303)	-0.5933 (0.426)	-0.1561 (0.340)	-0.5587** (0.272)
Banks Overhead Cost	0.0013 0.0013	0.0003 0.0003	0.0004 0.0004	-0.0006 -0.0006	0.003 0.003	0.0019 0.0019	0.0005 0.0005	0.0021 0.0021	0.0019** 0.0019**	0.0025*** 0.0025***
(Geographically Distributed Bank Branches)	0.8310*** (0.304)	0.4173*** (0.143)	0.8463*** (0.232)	0.5945** (0.250)	0.6054*** (0.198)	0.6190*** (0.180)	0.4434*** (0.119)	0.5813*** (0.213)	0.3779** (0.179)	0.5129*** (0.117)
Banks Efficiency (Bank Credit to Bank Deposit)	0.0034* (0.002)	0.0030 (0.002)	0.0028 (0.002)	0.0025 (0.002)	0.0014 (0.001)	-0.0008 (0.001)	-0.0007 (0.001)	-0.0003 (0.001)	-0.0002 (0.001)	-0.0010 (0.001)
Internet Usage	0.0092*** -	-	-	-	-	0.0050** -	-	-	-	-

Table 9: Estimations for High Income Countries

Variables	Loan Accounts					Deposit Accounts				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
L. Loan Accounts per 1000 People	0.214 (0.149)	-0.2329 (0.320)	-0.4565 (0.865)	-0.4617 (0.662)	0.6883 (30.366)	-	-	-	-	-
L. Deposit Accounts per 1000 People	-	-	-	-	-	0.1432 (5.889)	0.041 (0.169)	-0.0528 (0.170)	-0.0549 (0.215)	0.2696 (10.894)
Real GDP per Capita	0.9313** (0.439)	0.346 (3.639)	7.7881 (11.49)	6.4373 (6.99)	11.3268 (462.318)	-0.5958 (25.517)	-0.9572 (0.736)	0.0664 (1.657)	-0.6234 (2.994)	0.4653 (5.303)
Population Density	-0.2567 (0.617)	-0.728 (3.485)	0.2382 (1.898)	3.2909 (3.629)	-7.8188 (478.241)	-0.7197 (12.716)	-0.7006 (0.775)	-0.5327 (1.861)	-0.9049 (0.966)	0
Banks Overhead Cost	0.016 (0.030)	-0.0418** (0.019)	-0.1 (0.178)	-0.0684** (0.032)	-0.0787 (1.368)	0.0369 (0.310)	0.0384** (0.017)	0.0305 (0.024)	0.0129 (0.008)	0.0178 (0.404)
Geographically Distributed Bank Branches	0.2779** (0.120)	0.6755 (0.489)	0.7844 (0.855)	0.8736 (0.722)	1.3204 (15.301)	1.1548 (14.231)	1.0782** (0.380)	1.2754** (0.530)	1.5347*** (0.363)	0.9159 (11.734)
Banks Efficiency (Bank Credit to Bank Deposit)	-0.0009 (0.002)	0.0004 (0.010)	0.0062 (0.020)	0.0024 (0.007)	0.0331 (0.953)	-0.0008 (0.088)	-0.0024 (0.006)	-0.0049 (0.014)	0.0016 (0.008)	0.0036 (0.186)
Internet Usage	0.0036 (0.003)	-	-	-	-	-0.0216 (0.454)	-	-	-	-
Mobile Phones Subscriptions	-	0.6479 (0.563)	-	-	-	-	0.0785 (0.111)	-	-	-

Fixed Broadband Subscriptions	-	-	-0.7119 (4.634)	-	-	-	-	0.0069 (0.552)	-	-
Telephones per 100 People	-	-	-	-0.4488** (0.187)	-	-	-	0.1209 (0.204)	-	-
Communication Technologies Imports (% total imports)	-	-	-	-	-	-	0.1617 (9.615)	-	-	0.0037 (0.805)
Cons	-4.3167	-5.8324	-46.3331	-47.107	-38.0249	10.8541	12.1545**	6.9205	11.1664	0
	(5.231)	(29.676)	(71.789)	(53.892)	(910.952)	(124.984)	(5.628)	(8.218)	(17.101)	
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	125	125	99	116	97	145	145	120	136	72
No. of Countries	17	17	17	17	17	19	19	19	19	19
No. of Instruments	19	19	19	19	19	19	19	19	19	19
Sargan Test (p-val)	0.15	0.44	0.37	0.40	0.81	0.024	0.31	0.38	0.85	0.26
Hansen Test (p-val)	0.9	0.9	0.36	0.97	1	0.37	0.51	0.55	0.85	0.46
AR(1) (p-val)	0.14	0.16	0.37	0.012	0.97	0.87	0.06	0.045	0.09	0.94
AR(2) (p-val)	0.35	0.43	0.63	0.94	0.97	0.94	0.45	0.77	0.11	0.98

Notes: Reported below the coefficients are standard errors (in parentheses). Significance levels: *** 1%, ** 5%, * 10%.

Log Transformations: The following variables are log-transformed: Loan Accounts per 1000 People, Deposit Accounts per 1000 People, Real GDP per Capita, Population Density, Geographically Distributed Bank Branches, and Mobile Phones Subscriptions.

CONCLUSION

This empirical study investigates how ICT fosters financial inclusion by examining 120 countries worldwide and then splitting the sample into three subsamples based on income classification. Financial inclusion is measured by the number of commercial bank deposit and loan accounts per 1,000 adults, whereas ICT is proxied by internet usage, mobile phone subscriptions, high-speed internet, fixed telephone lines, and ICT imports. To address potential endogeneity, the study employs GMM dynamic panel data estimations. Two principal questions are posed. The first concerns the effect of ICT on financial inclusion, controlling for key variables such as bank branches, overhead costs, population density, and banking efficiency. The second explores

whether the effects of communication technologies differ across income groups. These questions are tested in separate regressions for low-, middle-, and high-income countries an overall global sample. Internet and mobile phone penetration significantly enhance banking accessibility—both deposits and loans—in middle- and high-income countries and the total sample. However, this relationship does not hold in low-income nations, likely owing to underdeveloped financial and technological infrastructures. Physical branch networks significantly bolster financial inclusion in middle and high-income settings, although branch coefficients are generally larger for middle-income countries. Meanwhile, ICT coefficients (particularly in high-income economies) tend to exceed those in middle-income countries,

reflecting greater technological advancement and adoption rates. Internet and mobile phone diffusion thus hold the potential to extend low-cost financial services—especially to low-income regions where formal banking services remain scarce. As seen in countries like Pakistan, Kenya, and South Africa, electronic finance can greatly expand access even amid substantial gaps in financial infrastructure. Nonetheless, limited data for low-income nations means these models do not fit perfectly in such settings. In the future, more comprehensive data on digital finance indicators (including e-money and mobile money transactions) will allow more robust analysis of how digitization influences financial inclusion and broader economic outcomes.

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