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REVISITING THE DETERMINANTS OF FINANCIAL INCLUSION IN THE DIGITAL ERA: EVIDENCE FROM LATIN AMERICAN COUNTRIES

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Abstract

The advent of the Internet, coupled with rapid adoption of smartphones has accelerated the use of digital banking, compelling financial institutions worldwide to integrate digital innovation into their product offerings. However, this adoption has not translated into a proportional increase in financial inclusion among Latin American countries. This study investigates the relationship between digital banking, digital infrastructure, and financial inclusion in Latin America, using data from 2017 and 2021. The study employed descriptive statistics, correlation analysis and Granger causality tests to analyze the data. Purposive sampling techniques was used to seven (7) Latin American which include Brazil, Colombia, Costa Rica, Ecuador, Paraguay, Peru, and Uruguay. The results reveal that financial inclusion is positively correlated with digital payment usage ($r = 0.838, p < 0.05$), online purchases ($r = 0.842, p < 0.05$), online bill payment ($r = 0.779, p < 0.05$), and internet usage ($r = 0.795, p < 0.05$), all statistically significant at the 5% level. However, mobile subscriptions exhibited a weak and statistically insignificant correlation ($r = 0.175, p > 0.05$). Granger causality analysis confirmed a bidirectional causality between financial inclusion and all digital indicators, showing a mutually reinforcing relationship. This study concludes that digital payment usage, online purchases, online bill payment, mobile subscriptions and internet usage can explain financial inclusion in Latin America. This study, therefore, recommends that policymakers should implement policies that aimed at reducing the cost of internet access, particularly in rural and underserved areas. These will not only bridge the digital divide but also expand access to formal financial services in Latin America.

INTRODUCTION

Globally, financial inclusion is widely acknowledged as a vital enabler of economic development, poverty alleviation, and social equity. It plays a fundamental role in advancing the economy by ensuring individuals and businesses, especially in emerging economies like the Latin America, can access affordable financial products and services tailored to their needs, in a responsible and sustainable manner (Raffaelli, et al., 2025; Demirguc-Kunt, et al., 2022; National Banking and Securities Commission of Mexico, 2020). Financial institutions contribute meaningfully to financial inclusion by leveraging digital platforms such as mobile banking and Internet banking, thereby delivering financial services to individuals in rural or underserved areas. These technologies help overcome challenges related to geographical distance, limited infrastructure, and time constraints, making financial services more accessible to underserved populations (Rivera, et al., 2025; Modiba, et al., 2024; Hassouba, 2023).

In recent years, digital banking has gained scholarly attention as influential drivers of financial inclusion in the banking sector (Sangwan, et al., 2024). The advent of the Internet, coupled with rapid adoption of smartphones has accelerated the use of digital banking, compelling large,

medium, and small financial institutions worldwide to progressively integrate digital innovation into their product offerings (Santander Private Banking, 2024).

In Latin America and the Caribbean, traditional banks, which are reliant on physical locations and face-to-face transactions, have been mandated to transform themselves to improve financial inclusion across the region, particularly in historically underserved or marginalized areas. As a result, traditional banking practices are rapidly transitioning to digital platforms. Digital banking has become a key solution to address these challenges. The rise of digital banking offers direct-to-consumer solutions as well as services for other financial institutions, reflects the sector's adaptability to individual and institutional needs. These providers demonstrate notable flexibility and the ability to reach various market segments (Navarro, et al., 2025).

For instance, data from the International Telecommunication Union (ITU) indicate that mobile cellular subscriptions in several Latin American countries exceed 90 per 100 people, and internet penetration is steadily rising. At the same time, digital banking innovations, such as mobile payment systems, app-based banking, and online savings platforms, are gaining traction, especially among younger and tech-savvy demographics (Rivera, et al., 2025; Bawuah, 2024; Hordofa, 2024; GSMA, 2021). Liu et al. (2021) add that digital banking also mitigates risks tied to cash handling, such as theft and loss. Additionally, digital transformation reduces barriers such as poor infrastructure and long travel distances for rural residents (Seadira & Heuva, 2021). As such, banks are increasingly adopting digital technologies to stay competitive and meet the changing demands of customers, in alignment with the broader goals of the United Nations 2030 Agenda for Sustainable Development (Babu et al., 2024; Chinoda & Kapingura, 2023).

Several Latin American countries have experienced rapid growth in mobile phone subscriptions and internet usage, yet this growth has not always translated into a proportional increase in financial inclusion. For example, although mobile phones are nearly ubiquitous, many users still rely on cash-based transactions and informal financial systems due to limited trust, financial literacy, or inadequate digital infrastructure (Gallegos, et al. 2025; Andriamahery & Qamruzzaman, 2022; Motta and Gonzalez Farias, 2022). Similarly, while internet banking services are expanding, their adoption is often skewed toward urban, educated, and wealthier populations, thereby reinforcing existing disparities rather than eliminating them. These problems raise critical questions about the effectiveness of digital banking technologies in promoting inclusive finance in Latin America.

Extensive work has been done across the globe on the role of digital banking in promoting financial inclusion. For instance, studies by Qwader and AlSboul (2025), Al Rifai and AlBaker (2025), Asma (2024), Telukdarie and Mungar (2023) mainly focused on the link between digital banking and financial inclusion. Similarly, Saeed and Donkoh (2024) concentrated on mobile banking's contribution to financial inclusion. However, these studies largely overlooked the critical enabler which is the foundational infrastructure for accessing digital financial services such as internet usage and mobile phone subscription. This omission formed a major limitation for these studies and undermined the understanding of the infrastructural barriers to digital financial inclusion, especially in regions with uneven digital infrastructure like the Latin America.

This oversight is significant, as the effective use of digital banking and financial services inherently depends on access to the internet and mobile devices. Without adequate internet access and mobile

phone penetration, digital banking and other fintech innovations cannot effectively reach the financially excluded in emerging economies like Latin America. Therefore, there is a critical need for studies that assess how digital banking, internet usage and mobile phone subscriptions explain financial inclusion in Latin America, where digital divides remain a major barrier to inclusive economic participation. The strength of this study lies in its focus on digital infrastructure, as distinct drivers of financial inclusion in Latin America. Thus, this study offers a more grounded and realistic understanding of the digital prerequisites for inclusive finance.

LITERATURE REVIEW

Financial inclusion refers to the situation in which individuals and businesses, particularly those traditionally excluded from formal financial systems, have access to reliable, safe, and affordable financial services. These services, often provided through digital channels, include savings, credit, insurance, and payment platforms. The objective of financial inclusion is to enhance the flow of capital, reduce poverty, and bridge the gap between underserved communities, especially in rural areas, and modern financial infrastructure (Gupta & Kiran, 2024). While there has been global progress in expanding financial access, approximately 24% of adults worldwide still do not have a bank account, with significant portions of this figure located in developing regions such as Latin America (Olaoye, et al., 2024; Ansar et al., 2023).

Achieving financial inclusion in Latin America requires both access to basic banking infrastructure and the expansion of digital financial services. Households with diverse financial needs, ranging from savings and loan services to insurance and payment solutions, stand to benefit significantly from improved financial access (Khémiri et al., 2024). For example, savings accounts offer a secure place to store funds, insurance protects against unexpected events, and digital payment platforms empower users to transact independently of traditional bank visits (Shaikh et al., 2023; Shrier, 2022).

In this study, financial inclusion was measured using financial inclusion index created from widely recognized indicators such as the number of adults with official bank accounts, the number of ATMs per 100,000 adults, bank branches per 100,000 adults, deposit accounts with commercial banks per 1,000 adults and borrowers from commercial banks per 1,000 adults (Abiona & Koppensteiner, 2022; Kim, 2022; Aboagye & Anong, 2020; GSMA, 2018). These indicators reflect the depth of financial infrastructure in the Latin American region. While developed countries have shown strong performance on these metrics, many Latin American countries still face major gaps in financial access, especially in rural and low-income communities. This underscores the need for policies that strengthen digital infrastructure, expand mobile and internet penetration, and ensure that financial services are accessible, affordable, and relevant to the region's diverse populations.

Digital Banking

Digital banking, as defined by various scholars, are financial solutions delivered through digital technologies, including mobile applications, online banking platforms, and biometric devices (Ozili, 2022; Shipalana, 2019). Mishar and Kumar (2018) describe digital banking as services that rely entirely on digital tools for both delivery and use. These include mobile money, electronic payments, digital credit, and online investment or insurance products. Digital platforms in Latin America increasingly consist of mobile banking apps, internet banking, e-wallets, point-of-sale

(POS) terminals, and contactless cards, reflecting the region's growing digital ecosystem. As noted by Demirgüç-Kunt et al. (2018), digital financial services reduce transaction costs and offer a scalable means to provide financial access, especially in remote regions.

Similarly, Internet banking allows users to manage their finances online via web portals offered by banks and other financial institutions. Through internet banking, customers can perform essential tasks such as viewing account balances, transferring funds, paying bills, applying for loans, and accessing investment services without visiting a physical bank branch. This mode of banking is especially impactful in semi-urban and urban areas of Latin America, where internet penetration is growing rapidly. According to Fernandes et al. (2023), the increasing uptake of internet banking has improved banking efficiency, supported transparent financial transactions, and enhanced customer satisfaction by providing 24/7 access to financial services.

Digital Infrastructure: Internet Usage and Mobile Phone Subscriptions

In recent years, internet usage and mobile phone subscriptions have emerged as pivotal drivers of digital transformation and financial inclusion across Latin America. The region has experienced a significant surge in digital connectivity, with mobile phones and internet technologies acting as foundational enablers of communication, commerce, education, and financial services, especially among unbanked and underbanked populations. According to the International Telecommunication Union (ITU) and World Bank data, Latin America has witnessed steady growth in both internet usage and mobile phone subscriptions, a trend that reflects the increasing digitization of the region's economy and society (Asma, 2024; Kouladoum, et al., 2022).

The integration of mobile and internet technologies has enabled innovations in several sectors, including digital banking, e-commerce, healthcare, education, and government services. Mobile broadband networks (3G, 4G, and increasingly 5G) have allowed financial institutions and fintech companies to reach previously unbanked populations through mobile applications and USSD-based platforms. This is particularly relevant in countries such as Brazil, Mexico, Colombia, and Peru, where financial inclusion is expanding rapidly through mobile-based channels. The increasing availability of affordable smartphones, combined with declining data costs and regulatory support for digital transformation, has further accelerated this trend. Mobile network operators and fintech companies recognize the opportunity to extend financial inclusion to the over three billion people globally who lack access to conventional financial services (Asma, 2024; Bayar, et al., 2021; Lenka & Barik, 2018).

Theoretical Framework

This study is anchored on Everett Rogers' Diffusion of Innovations Theory (1962), which provides a robust lens for understanding the adoption of digital banking technologies and their potential to promote financial inclusion in Latin America. The theory explains how new technologies and practices spread through societies, focusing on the roles of communication channels, social systems, time, and the perceived characteristics of the innovation itself. Rogers posits that the adoption of digital banking, such as mobile banking and internet banking, depends on the relative advantage, compatibility, complexity (ease of use), trialability, and observability. These factors help determine how quickly and widely an innovation is embraced by a population. In the context of digital banking in Latin America, these technological innovations must be perceived as

advantageous, compatible with users' financial habits and needs, and easy to use in order to encourage adoption among various social segments.

The theory further categorizes adopters into five groups: innovators, early adopters, early majority, late majority, and laggards. These categories help explain differences in the pace and extent of digital banking adoption among individuals across Latin America. For example, urban residents with greater exposure to technology and financial services are more likely to be early adopters of mobile and internet banking. In contrast, rural populations, often characterized by lower digital literacy and limited access to internet infrastructure, may fall into the late majority or laggard categories. Recognizing these differences allows for the design of tailored digital banking solutions that respond to the unique barriers and incentives facing each group.

Therefore, this theory offers a strong theoretical basis for examining how digital banking innovations, enabled by mobile and internet technologies, diffuse across populations in Latin America and influence financial inclusion. Studies such as Saeed and Donkoh (2024), Voptia and Stukalina (2024) provide strong support for the relevance of this theory for the study.

Empirical Review

Saeed and Donkoh (2024) investigated the factors influencing mobile banking services and assess how they impact financial inclusion among customers of commercial banks in an emerging economy. The study through the use of a structured questionnaire gathered 65 primary data from managers and supervisors within 13 commercial banks in Ghana. The study employed a purposive sampling technique to select the 13 commercial banks whilst using convenience sampling to gather data from managers and supervisors within these banks. The results show that mobile banking transfer has a significant negative relationship with financial inclusion, but mobile account management has a significant positive relationship with financial inclusion. Furthermore, the results depict that Mobile banking payment and financial inclusion have no significant relationship.

Asma (2024) examined the critical role of digital finance in promoting financial inclusion in Algeria, using a descriptive methodology. The results show that Digital finance helps to boost the GDP of digital economies by facilitating access to a wide range of fundamental products and services, resulting in financial inclusion. Digital finance enables residents of rural and isolated locations to gain access to financial services via smart phones connected to the Internet, increasing the level of financial inclusion. Digital finance enables funds to be tracked, counterfeit currencies and money laundering reduced, and transactions completed more quickly. Digital finance facilitates and simplifies financial transactions, including electronic payment platforms for utilities and money transfers, promoting financial inclusion.

Voptia and Stukalina (2024) assessed how mobile money can improve financial inclusion in Sub-Saharan Africa from 2010 to 2021, using the system generalized method of moments (Sys-GMM). The results confirm the central hypothesis, according to which the use of mobile money improves financial inclusion in Sub-Saharan Africa. It is therefore up to States and mobile network operators to intensify the use of mobile money. This intensification would be possible thanks to the development of mobile money, the regulation and security of mobile money services.

Abdulumumin, B. A. (2025). Revisiting the Determinants of Financial Inclusion in the Digital Era: Evidence from Latin American Countries. *Malete Journal of Accounting and Finance*, 5 (2), 340 – 355

Chaudhary, Nimkar and Minz (2024) investigates the impact of financial innovation on financial inclusion across 50 countries with diverse economic backgrounds from 2000 to 2023, particularly mobile banking and digital payment systems, using panel data analysis. The study utilizes a comprehensive dataset. The findings indicate that financial innovations significantly improve financial inclusion indicators. Digital payment systems are particularly effective in increasing transaction efficiency and accessibility. Higher internet penetration rates correlate with better financial inclusion outcomes.

Quadri, Malik-Abdulmajeed, Akinwumi and Omotosho (2024) investigated the impact of agent banking and mobile money operation on financial inclusion in Nigeria from 2013 to 2021, using Ordinary least squares regression. Findings revealed that at 5% significance level, point-of-sale and mobile money operations have a positive impact on financial inclusion while web/internet banking plays a limited role in achieving financial inclusion.

Nwome, Ele and Ikoh (2024) sought to determine the roles financial innovations played in championing the visions of the inclusion policies of Nigerian government from 2005 to 2021, using pooled ordinary least square. The results show that agency banking has positive significant effects on financial inclusion in Nigeria, that point of sales has positive and significant effect on the financial inclusion in Nigeria. The study further found a significant positive effect of internet/mobile banking on financial inclusion in Nigeria.

Rivera, Balanzategui, Dávalos, Juelas and Miño (2025) analyze the impact of financial technology on financial inclusion in Latin American countries by employing a balanced panel data model. The analysis uses cross-sectional data from the years 2011, 2014, 2017, and 2021. Fintech is proxied by fixed broadband subscriptions (per 100 people), while financial inclusion is captured through the use of digital payments, along with other variables related to access and usage of financial services and selected macroeconomic control variables. The main findings highlight the importance of digital infrastructure in facilitating formal access to the financial system, particularly through account ownership and savings capacity, though not through access to credit.

Qwader and AlSboul (2025) explored the impact of digital transformation on enhancing financial inclusion in Jordanian commercial banks, focusing on the role of performance efficiency as a mediator in this relationship. The study employed a descriptive-analytical approach and analyzed the data using SmartPLS software. The results showed a positive relationship between the dimensions of digital transformation (digital strategy, digital technologies, and digital skills) and both financial inclusion and performance efficiency. This can be attributed to digital transformation enhancing performance efficiency by reducing human errors, speeding up processing and auditing, improving collaboration, and enhancing communication between employees and clients, thereby contributing to increased financial inclusion. Additionally, the results indicated that performance efficiency plays a partial mediating role in the relationship between digital transformation and financial inclusion, as digital transformation enhances performance efficiency by minimizing human errors and accelerating procedures, which contributes to greater financial inclusion.

METHODOLOGY

To investigate the relationship between digital banking, digital infrastructure and financial inclusion in Latin America, this study created financial inclusion index from four indicators to proxy financial inclusion which are: ATMs per 100,000 adults; number of bank branches per 100,000 adults; borrowers from commercial banks per 1,000 adults and deposit accounts with commercial banks per 1,000 adults. Digital banking was measured by the number of individuals who own made or received digital payment; used internet banking to buy something, pay bills and send money, while digital infrastructure was measure by the mobile cellular subscriptions and internet usage.

The data related to financial inclusion were sourced from the World Development Indicators (WDI). The data related to digital banking and digital infrastructure were sourced from World Bank Global Findex Database, International Telecommunication Union (ITU), and GSMA Mobile Money Metrics. These data were used on annual basis from 2010 to 2023 as the 2024 data were not available for some countries. Worthy of note is the fact that only 2017 and 2021 data were available from World Bank Global Findex Database which constrained the study to that timeframe. The study's sample consists of seven (7) countries in the Latin American region including Brazil, Colombia, Costa Rica, Ecuador, Paraguay, Peru, and Uruguay.

The functional model for this study is specified as:

$$FINANCIAL\ INCLUSION_{it} = f(DIGITAL\ BANKING, DIGITAL\ INTRASTRUCTURE) \quad (1)$$

This model posits that financial inclusion is determined by digital banking and digital infrastructure.

The functional model was further expressed as:

$$IFI = f(MOR, BUY, PAY, IUS, MPS) \quad (2)$$

where; MOR = made or received digital payment; BUY = used internet banking to buy something; PAY = used internet banking to pay for something; IUS = internet usage; and MPS = mobile cellular subscriptions

Then, the functional model can be expressed in panel Granger causality model as:

$$IFI_{i,t} = \sum_{k=1}^p \beta_{1k} IFI_{i,t-k} + \sum_{k=1}^p \gamma_{1k} X_{i,t-k} + \varepsilon_{i,t} \quad (3)$$

In this model, IFI_{it} represents financial inclusion index for country i at time t , X_{it} represents the lagged values of each independent variable (digital banking, digital infrastructure), p is the lag length (usually determined by AIC, BIC, or Schwarz criteria), α is the country-specific fixed effect and ε is the error term.

To test if mobile subscription (MPS) Granger-causes IFI, the panel Granger causality model can be expressed as:

$$IFI_{i,t} = \sum_{k=1}^p \beta_{1k} IFI_{i,t-k} + \sum_{k=1}^p \gamma_{1k} MPS_{i,t-k} + \varepsilon_{i,t} \quad (4)$$

The null hypothesis is stated as:

$$H_0: \gamma_1 = \gamma_2 = \dots = \gamma_p = 0$$

If the p-value is less than 0.05, reject the null hypothesis.

The panel Granger causality model can be repeated for other variables.

RESULTS AND DISCUSSION

Digital indicators across Latin American countries (2017 and 2021)

Table 1: Summary Statistics Table

Variables	Mean	Standard Deviation	Minimum	Maximum
Financial Inclusion Index	0.011	1.42	2.74	-1.41
Internet Usage (% of population)	70.02	10.28	50.50	87.60
Mobile Cellular Subscriptions (per 100 people)	126.24	24.60	87.75	177.02
Digital Payment (Age 25+)	54.21	11.90	36.00	77.00
Online Purchase (Age 15+)	15.57	10.01	3.00	35.00
Online Bill Payment (Age 15+)	17.64	11.74	4.00	43.00

Source: Author

The summary statistics for the dataset offer valuable insights into the state of financial inclusion and digital adoption across seven Latin American countries from 2017 to 2021. The Financial Inclusion Index has an average of 0.011, indicating that financial inclusion levels are generally low but balanced across the sample. The high standard deviation (1.42) and a wide range from 1.41 to 2.74 suggest substantial disparities between countries, with nations like Uruguay demonstrating high financial inclusion and countries such as Ecuador lagging behind.

Internet usage, a key enabler of digital finance, averages 70.02% of the population. This is a strong indication that most countries in the sample have achieved relatively widespread internet access. However, the minimum value of 50.5% shows that certain countries still face challenges in digital connectivity. Similarly, mobile cellular subscriptions average 126.24 per 100 people, indicating that mobile phone penetration exceeds the population in many countries, possibly due to individuals owning multiple SIM cards. Still, the variation (ranging from 87.75 to 177.02) highlights that mobile access is not evenly distributed.

In terms of usage, 54.21% of adults aged 25 and above reported making or receiving digital payments, with the proportion reaching as high as 77% in countries like Brazil. This suggests that digital financial services are becoming increasingly mainstream in some parts of the region. Regarding e-commerce behaviour, online purchases using mobile phones or the internet have a modest mean of 15.57%, and online bill payments show a similar pattern with a mean of 17.64%. The wide standard deviations in both cases indicate uneven digital engagement across countries. Countries such as Brazil and Uruguay report higher usage, while others remain far behind, pointing to gaps in digital literacy, infrastructure, or trust in digital platforms.

Overall, the data reveal that Latin America is progressing in digital and financial inclusion, driven by high internet and mobile penetration. However, actual adoption of digital financial tools and services still varies significantly by country, suggesting the need for targeted policies to address infrastructural gaps, build trust in digital systems, and promote inclusive digital finance ecosystems.

Digital indicators by Country (2017 and 2021)

Table 2: Country-Level Summary Statistics Table

Country	Variable	Mean	Std. Dev.	Maximum	Minimum
Brazil	Financial Inclusion Index	1.86	0.24	2.04	1.69
	Internet Usage (%)	74.1	9.1	80.7	67.5
	Mobile cellular subscriptions (per 100)	104.3	2.85	106.1	102.5
	Made or received a digital payment (%)	70	9.2	77	63
	Used mobile/internet to buy online (%)	24.5	14.85	35	14
	Used mobile/internet to pay bills (%)	27	22.0	43	11

Paraguay	Financial Inclusion Index	-0.70	0.15	-0.60	-0.81
	Internet Usage (%)	69.05	11.2	77	61.1
	Mobile cellular subscriptions (per 100)	118.2	0.76	119.0	117.5
	Made or received a digital payment (%)	52	2.8	54	50
	Used mobile/internet to buy online (%)	5	2.8	7	3
	Used mobile/internet to pay bills (%)	7.5	4.95	11	4
Peru	Financial Inclusion Index	-0.89	0.09	-0.82	-0.95
	Internet Usage (%)	60.8	14.36	71.1	50.5
	Mobile cellular subscriptions (per 100)	125.5	3.84	127.8	123.1
	Made or received a digital payment (%)	44	9.9	51	37
	Used mobile/internet to buy online (%)	10	8.49	16	4
	Used mobile/internet to pay bills (%)	12	11.31	20	4
Colombia	Financial Inclusion Index	-0.65	0.13	-0.56	-0.75
	Internet Usage (%)	67.65	7.25	73	62.3
	Mobile cellular subscriptions (per 100)	137.2	12.37	145.7	128.7
	Made or received a digital payment (%)	47.5	9.2	54	41
	Used mobile/internet to buy online (%)	11.5	4.95	15	8
	Used mobile/internet to pay bills (%)	13.5	5.5	19	8
Costa Rica	Financial Inclusion Index	-0.14	0.29	0.07	-0.35
	Internet Usage (%)	77.15	7.95	82.7	71.6
	Mobile cellular subscriptions (per 100)	164.5	17.88	177.0	152.0
	Made or received a digital payment (%)	56	1.4	57	55
	Used mobile/internet to buy online (%)	20.5	3.54	23	18
	Used mobile/internet to pay bills (%)	27	8.49	33	21
Ecuador	Financial Inclusion Index	-1.26	0.20	-1.12	-1.41
	Internet Usage (%)	62.45	9.4	69.1	55.8
	Mobile cellular subscriptions (per 100)	91.04	4.13	94.3	87.7
	Made or received a digital payment (%)	42.5	9.2	49	36
	Used mobile/internet to buy online (%)	9.5	4.95	13	6
	Used mobile/internet to pay bills (%)	11.5	7.78	17	6
Uruguay	Financial Inclusion Index	1.79	1.36	2.74	0.84
	Internet Usage (%)	79.0	12.32	87.6	70.3
	Mobile cellular subscriptions (per 100)	142.9	8.19	149.0	136.9
	Made or received a digital payment (%)	67.5	4.95	71	64
	Used mobile/internet to buy online (%)	28	6.36	32	24
	Used mobile/internet to pay bills (%)	25	9.9	32	18

Source: Author

The country-level summary statistics for the years 2017 and 2021 reveal significant heterogeneity in financial inclusion and digital financial service usage across the seven Latin American countries studied.

Brazil ranks highest in financial inclusion with an average Financial Inclusion Index (FII) of 1.86. It also boasts strong digital behaviour: 74.1% internet usage and 104.3 mobile subscriptions per 100 people. A high percentage (70%) of the population made or received digital payments, and a relatively large share of users engaged in online purchases (24.5%) and bill payments (27%). This suggests that Brazil is a regional leader in both access to and usage of digital financial services.

Paraguay has a low FII of -0.70, reflecting limited financial inclusion. Internet usage is moderate at 69.05%, but mobile penetration is strong (118.2 subscriptions per 100 people). Despite this, only 52% of the population engaged in digital payments, and e-commerce activity is notably weak, just 5% bought online, and 7.5% used digital channels to pay bills. This indicates a disconnect between mobile access and actual usage of financial technology, possibly due to trust or literacy barriers.

With an FII of -0.89, Peru also shows low financial inclusion. Internet penetration is relatively low (60.8%), though mobile subscriptions are high (125.5). Only 44% of people made or received digital payments, and fewer used digital tools for buying online (10%) or paying bills (12%). These figures suggest infrastructural and socioeconomic barriers to digital finance adoption.

Colombia's FII of -0.65 places it in the lower-middle tier of inclusion. It has decent internet usage (67.65%) and high mobile penetration (137.2). Digital payment usage (47.5%) and online financial activity (11.5% buying online; 13.5% bill payments) are modest, indicating some digital engagement but plenty of room for growth, especially given the strong mobile infrastructure. Costa Rica has a moderately negative FII (-0.14) but very high digital readiness: 77.15% internet usage and 164.5 mobile subscriptions per 100 people. Digital payment engagement is strong (56%), and a good portion of the population engages in online purchases (20.5%) and bill payments (27%). This suggests high digital potential that is not yet fully reflected in formal financial inclusion metrics.

Ecuador is one of the least financially inclusive countries in the set, with an FII of -1.26. Internet usage (62.45%) and mobile penetration (91.04) are relatively low. Only 42.5% of people made or received a digital payment, and just 9.5% and 11.5% used mobile/internet for buying and paying bills, respectively. Ecuador appears to lag in both access and adoption of digital finance. Uruguay is a strong performer, with an FII of 1.79, second only to Brazil. It also leads in internet usage (79%) and has high mobile subscription levels (142.9). Digital payment usage is high (67.5%), and online financial engagement is also substantial, with 28% shopping online and 25% paying bills via digital means. Uruguay's profile reflects a digitally mature and financially included population.

In summary, Brazil and Uruguay stand out as digital finance frontrunners in the region, combining strong digital infrastructure, financial inclusion, and high user engagement. Costa Rica shows solid digital behaviour but only moderate financial inclusion, signaling room for improvement. However, Paraguay, Peru, and Ecuador face substantial barriers, particularly in terms of financial access and usage of digital services. These disparities suggest the need for targeted interventions to enhance both digital infrastructure and financial literacy in lower-performing countries.

Correlation Coefficients

Table 3: Correlation Coefficients Table

Variables	1	2	3	4	5	6
Financial Inclusion Index (p-value)	1.000 (-)					
Internet Usage (p-value)	0.795 (0.001)	1.000 (-)				
Mobile Subscriptions (p-value)	0.175 (0.554)	0.336 (0.241)	1.000 (-)			
Digital Payment (p-value)	0.838 (0.000)	0.797 (0.001)	0.201 (0.492)	1.000 (-)		

Online Purchase (p-value)	0.842 (0.000)	0.803 (0.001)	0.275 (0.341)	0.865 (0.000)	1.000 (-)	
Online Bill Payment (p-value)	0.779 (0.001)	0.846 (0.000)	0.251 (0.386)	0.778 (0.001)	0.940 (0.000)	1.000 (-)

Source: Author

Financial inclusion shows strong positive correlations with several key indicators of digital banking and digital infrastructure.

Financial inclusion is strongly correlated with digital payment usage ($r = 0.838$, $p < 0.05$) and Online Purchase behaviour ($r = 0.842$, $p < 0.05$). This highlights that the adoption of Digital Payment Methods and Online Buying Habits are closely linked to improvements in financial inclusion, reflecting that these digital financial services play a crucial role in including more people in the financial system. Similarly, financial inclusion is also positively correlated with Online Bill Payment ($r = 0.779$, $p < 0.05$), further reinforcing the role of digital financial activities in enhancing financial inclusion. This finding is consistent with the findings of Chaudhary et al. (2024), Asma (2024), Nwome et al. (2024). Quadri et al. (2024) also found mobile banking favourably impacts financial inclusion while internet banking has negligible impact on financial inclusion.

Financial inclusion has a very strong and statistically significant correlation with Internet Usage ($r = 0.795$, $p < 0.05$), suggesting that countries with higher internet penetration tend to have better overall financial inclusion. This means that access to the internet likely facilitates financial inclusion by enabling access to financial services. This finding is consistent with the findings Chaudhary et al. (2024), Kouladoum et al. (2022). Adel (2024) also found internet penetration to significantly boosts inclusion in Latin America. However, Mobile Cellular Subscriptions per 100 people show a weak and statistically insignificant correlation with the Financial Inclusion Index ($r = 0.175$, $p = 0.554$). This suggests that mere ownership of mobile phones does not necessarily translate into increased financial inclusion or use of digital financial services. The quality of use, such as actual engagement with digital payments and online financial activities, matters more than just having a mobile phone. This finding contradicts the findings Olaoye et al. (2024), Kouladoum et al. (2022), Bayar et al. (2021).

Table 4: Cross-Section Dependence Test

To determine whether the residuals (or errors) across cross-sectional units (e.g., countries, firms) are correlated or checks if the observations from different cross-sectional units are independent of each other, the cross-section dependence (CD) test was used. If $p\text{-value} < 0.05$, reject the null hypothesis of no cross-section dependence (i.e., no correlation between the observations across countries), meaning sampled countries behave independently.

Variables	Pesaran CD
Financial Inclusion Index	0.7576
Internet Usage (% of population)	0.0000
Mobile Cellular Subscriptions (per 100 people)	0.3545
Digital Payment (Age 25+)	0.0055
Online Purchase (Age 15+)	0.0000
Online Bill Payment (Age 15+)	0.0000

Source: Author

The results of the Cross-Section Dependence Test using the Pesaran CD statistic reveal mixed evidence of cross-sectional dependence among the variables examined. Specifically, the financial inclusion and mobile cellular subscriptions have p-values of 0.7576 and 0.3545, respectively. This indicates that the study failed to reject the null hypothesis of no cross-sectional dependence for these two variables. This suggests that financial inclusion levels and mobile cellular subscription rates are relatively independent and are more likely influenced by country-specific factors such as national policies, financial regulations, or domestic economic conditions.

Conversely, the test shows strong evidence of cross-sectional dependence for internet usage, digital payment, online purchase, and online bill payment, with respective p-values of 0.0000, 0.0055, 0.0000, and 0.0000. These results imply that these digital variables are interrelated across countries, likely due to shared regional characteristics in digital transformation or internet adoption. In other words, changes in internet usage, digital payment, online purchase, and online bill payment in any Latin American country has corresponding effect on other countries with the Latin American region. In addition, this interdependence may also reflect common external factors such as international investment in digital infrastructure or cross-border digital payment systems.

Table 5: Pairwise Granger Causality Tests

Null Hypothesis	Prob.
IUS does not Granger Cause IFI	0.0000
IFI does not Granger Cause IUS	0.0000
MOR does not Granger Cause IFI	0.0000
IFI does not Granger Cause MOR	0.0000
MPS does not Granger Cause IFI	0.0000
IFI does not Granger Cause MPS	0.0000
BUY does not Granger Cause IFI	0.0000
IFI does not Granger Cause BUY	0.0000
PAY does not Granger Cause IFI	0.0000
IFI does not Granger Cause PAY	0.0000

Source: Author

The results from the Pairwise Granger Causality Tests indicate statistically significant bidirectional relationships between the Inclusive Financial Index (IFI) and all the digital financial indicators included in the analysis. In every case, the p-values are 0.0000, which are far below the conventional significance levels (1%, 5%, or 10%). This strongly suggests the rejection of all null hypotheses. Digital Payments (made or received a digital payment) both causes and is caused by financial inclusion. This suggests that not only does digital payment activity help drive financial inclusion, but increased financial inclusion, in turn, promotes more frequent digital transactions. The ability to buy online using mobile/internet is both a cause and an effect of financial inclusion. Financially included individuals are more likely to engage in e-commerce, and greater digital commerce use reflects higher financial participation. Similar to online purchases, online bill payments are both influenced by and contribute to financial inclusion. This mutual relationship underlines the role of digital financial behaviour in deepening inclusion and how inclusion efforts facilitate digital adoption.

Internet usage Granger-causes financial inclusion, and vice versa. This means past values of internet usage help predict financial inclusion levels, and historical financial inclusion data also help explain current internet usage patterns. This reflects a mutually reinforcing relationship: more internet access promotes financial inclusion, and as more people become financially included, they are more likely to engage with online platforms. The number of mobile cellular subscriptions is

bidirectionally causal with financial inclusion. Greater mobile access supports financial inclusion through mobile banking and fintech services, while a more inclusive financial system may encourage individuals to acquire mobile devices for financial services.

CONCLUSION

In conclusion, the findings of this study carry important policy implications for advancing financial inclusion in Latin America through digital channels and digital infrastructure. Thus, the study recommended that governments and financial regulators should prioritize policies that enhance access to and usage of digital payment systems. This includes supporting fintech innovation, promoting the interoperability of payment platforms, and ensuring consumer protection in digital financial transactions. Policies aimed at reducing the cost of internet access, particularly in rural and underserved areas, will not only bridge the digital divide but also expand access to formal financial services.

Policymakers should focus on digital literacy initiatives that help individuals convert mobile access into meaningful financial engagement. This could involve partnerships between government, mobile network operators, and financial institutions to deliver targeted education on how to use mobile and internet platforms for savings, payments, and credit. In summary, an integrated policy approach that combines digital infrastructure development, regulatory support for fintech, digital literacy, and incentives for digital financial behaviours will be most effective in expanding financial inclusion. These efforts should also be inclusive and equitable, ensuring that rural populations, and marginalized groups are not left behind in the digital transformation of finance.

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