



FinTech and Financial Inclusion: Unpacking the Links to Inequality

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Abstract

This investigation analyses how financial inclusion, dimensions of inequality and financial technology (FinTech), are related across 113 countries using data from the 2011–2021 Global Findex survey. The study finds both direct and indirect associations between the different constructs employing structural equation modelling methodologies. The primary findings reveal that FinTech simultaneously worsens income inequality while narrowing gender gaps through enhanced financial inclusion. Additionally, these technologies promote broader financial participation among excluded sections of the population. Greater financial inclusion lowers both economic and gender-based inequalities. The research also explains that effective regulation, educational opportunities, and availability of credit can contribute to more equitable outcomes through financial inclusion. These findings add to emerging scholarships on how financial technological innovation and robust financial inclusion initiatives can improve resource allocation and promote more inclusive economic development globally. This represents the first comprehensive examination of multiple inequality types and their complex relationships within this framework. The study provides preliminary evidence of the varying distributional implications of technology-based finance and financial inclusion on several types of inequalities.

Keywords: FinTech, Financial inclusion, Income Inequality, Gender Inequality Structural Equation Modelling

1. Introduction

There has been considerable attention on the dynamic between different facets of finance and various dimensions of inequality (Altunbaş & Thornton, 2019; Nguyen & Nasir, 2021; Demir et al., 2022). These studies accentuate the essentiality of financial establishments, markets, and other stakeholders in resource allocation, which drives economic growth (Murinde, 2012). Gaining access to finance enables low-income individuals to pursue income-generating opportunities, contributing to investment, employment, and economic development (Basu, 2008). Studies also show a strong connection between expanding financial access and narrowing inequality. Enhancing access to commercial banks for low-income individuals improves their wellness (Danladi et al., 2023; Ali, 2022). The UN 2030 Agenda highlights holistic financial access as a driver in the realization of the Goals for Sustainable Development (Azmeah, 2025; Carè et al., 2025)

There is increasing optimism about financial technology (FinTech) and its prospects to strengthen financial inclusion by promoting inclusive finance at lower costs (Philippon, 2019; Berg et al., 2025; Edigbonya & Tioluwani, 2022; Ferilli et al., 2024; Jena, 2025). Mobile financial services may help integrate underbanked populations into the regulated financial network, promoting growth and development which is equitable and balanced (Demirgüç-Kunt et al., 2020). FinTech can also transform business engagement with suppliers and other stakeholders (Cumming et al., 2021)

Under this backdrop, this paper explores the relationships linking financial technology, financial inclusion, and inequality dimensions across 113 nations using 2011–2021 Global Findex survey database. Our objectives are threefold: first, to assess how FinTech influences inequality; second, study the manner in which financial inclusion is influenced by FinTech and contributes to inequality; and third, to analyze how enabling factors, like regulatory quality, education, and financial deepening, affect these dynamics. Unlike prior research that primarily relied on supply-side data (e.g., Beck et al., 2008; Hannig & Jansen, 2010), this study employs the Global Findex database (demand-side), an overarching source on individual financial practices and decisions.

The structure of the paper is as follows: The pertinent literature is examined in Section 2, the methodology is outlined in Section 3, the results and findings are put forward in Section 4, and the policy impacts are addressed in Section 5.

2. Literature review

Key literature examining the interconnectedness of FinTech, financial inclusion, inequality, and factors influencing resource mobilization inform the current study.

Inequality and FinTech

Increased internet and mobile penetration in African nations have demonstrated improved access to FinTech and decreased inequality (Tchamyu, 2019; Kouladoum et al., 2022). Positive effects of this include escaping the poverty trap, building savings, promoting rural entrepreneurship, and influencing financial decisions made by households (Yang & Zhang, 2022; Ge et al., 2022; Dzator et al., 2023; Chen & Liu, 2023; Zheng & Ma, 2023; Sampat et al., 2024; Kumar & Ahuja, 2025). Automating public disbursements reduces administrative expenses and minimizes corruption, thereby freeing up resources for public welfare initiatives and reducing wealth inequality (Muralidharan et al., 2014; Munyegera & Matsumoto, 2016; Muralidharan et al., 2017). Fintech offers greater incentives to bridge the rural-urban divide and gender-based inequities stimulating female labour market participation (Cheng et al., 2021; Loko & Yang, 2022; Morgan, 2021). FinTech could render financial services readily available, especially to smaller firms. (Lahreche et al., 2020)

But studies propose the cautious and planned implementation of FinTech, as in certain contexts it can exacerbate income inequality (Li & Li, 2021). Also, Asongu & Odhiambo, (2019) and Kolovich & Newiak, (2024) emphasize that expanding information technology beyond basic levels is essential to alleviate inequality to increase female involvement in the economy. Some studies highlight the challenges of rising gender divide perpetuated by FinTech (Anandhita & Ariansyah, 2018). Therefore, from the foregoing discussion on FinTech and inequality, the resulting hypothesis is derived:

- H1: There is a significant link involving FinTech and inequality.

Financial inclusion and inequality

Mounting research findings suggest that a higher level of financial inclusion is connected with lower national inequality in income (Ozturk & Ullah, 2022; Das & Chatterjee, 2023). However, this dynamic is not uniform across the regions suggesting that while access and affordable financial offerings can mitigate income disparity, factors like type, nature and quality of institutions, maturity of markets, instruments, and policies could have different impact on this

relationship (Dabla-Norris et al., 2015; Markkanen & Anger-Kraavi, 2019; Banna et al., 2021; Choudhary & Thenmozhi, 2024; Park & Mercado, 2018; Le et al., 2019; Ozili, 2020).

Financial inclusion may be hindered by an ongoing gender inequality in adoption of technology in finance, as per Cheng et al. (2021). Studies reveal that women ownership of bank accounts is less than male ownership (Demirgüç-Kunt et al., 2020), women manage fewer household finances (Guiso & Zaccaria, 2023; Chen et al., 2023), or partake less in the equity market (Ke, 2017; Bucher-Koenen et al., 2024; McMahon & Reiche, 2024). There are gender variations in attitudes and preferences towards emerging financial technologies. However, as these emerging technologies become more widely adopted and governed by frameworks over time, the gender gap could potentially narrow (Cheng et al., 2021). Based off the foregoing discussion, the following hypotheses are derived.

- H2a. There is a significant link involving financial inclusion and inequality.
- H2b. There is a mediation effect of financial inclusion in the FinTech-inequality association.

FinTech and financial inclusion

Different fintech instruments for remittance, lending, payment, and credit risk evaluations have bolstered financial inclusion across various parts of the world (Ghosh, 2016; Okello Candiya Bongomin et al., 2018; Tchamyou et al., 2019; Lahreche et al., 2020; Click or tap here to enter text. Myovella et al., 2020; Asongu & Odhiambo, 2020; Hendricks & Mwapwele, 2024). This has presented an impetus meant for the expansion of digital access to banking and other financial offerings in a number of nations as per the latest Global Findex Survey results. There is strong evidence to suggest that households using mobile banking accounts are more inclined to possess formal bank accounts, remit funds, and save for the future (Morawczynski, 2009; Mbiti et al., 2011; Ghosh, 2016; Ouma et al., 2017; Lyons & Kass-Hanna, 2021; Cheng et al., 2021; Shaikh et al., 2023;). Additionally, it has been observed that mobile money benefits SMEs and entrepreneurial financial inclusion, enhancing resource mobilization by increasing availability of bank credit (Gosavi, 2018) Fintech frequently enhances traditional banking services rather than replacing them, as evidenced by (Fuster et al., 2019) Contrarily, it was proposed that Fintech and BigTech firms extend credit and financial support to borrowers who are often overlooked by traditional banks (Agarwal et al., 2019; (Berg et al., 2022; Hodula, 2022). Based on the above, the following hypothesis is framed.

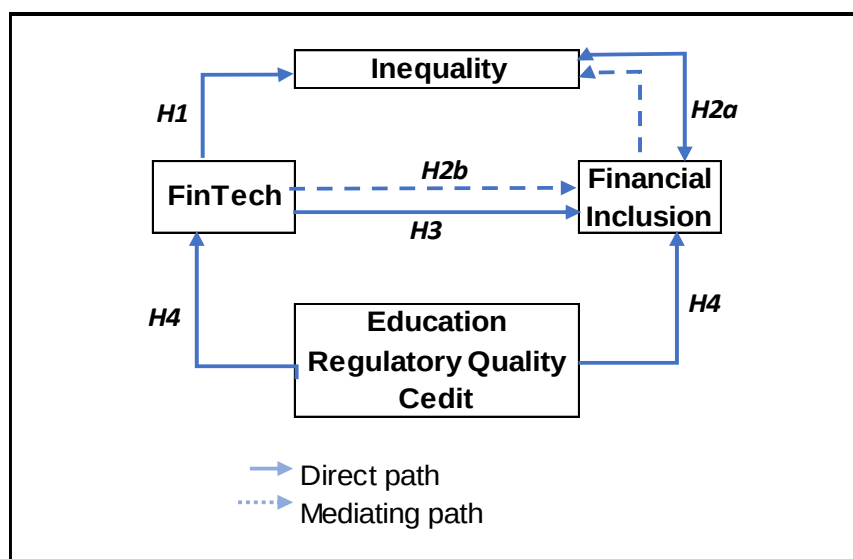
- H3: There is a significant link between FinTech and financial inclusion.

Key enablers for resource mobilizations

Digital financial inclusion can result in higher resource mobilization through efficiencies and innovation (Sharma, 2016; Becker, 2017; Chen et al., 2019). It aids in better distribution of resources through disintermediation and lower transaction costs. To sustain such benefits, regulations must evolve fostering education, invention, and consumer welfare (Arner et al., 2015; Anagnostopoulos, 2018) Buckley et al., 2020; Thakor, 2020; Hodson, 2021). An increasing number of studies indicate that education is crucial in promoting financial inclusion and overall well-being. Variation in financial awareness and knowledge influences heterogeneity in asset accumulation, susceptibility, and financial resilience (Lusardi & Mitchell, 2014; Goyal & Kumar, 2021; Lusardi et al., 2017) Increased pecuniary and technological literacy enables individuals to engage with FinTech more effectively (Aoun, 2017) Finally, financial deepening (captured by credit) combined with more equitable financial systems can reduce inequality while enhancing resource allocation (Dabla-Norris et al., 2015) To reduce inequality, expansion of financial services must be accompanied by greater financial inclusion. Consequently, in accordance with this discussion, the following hypothesis can be formulated.

- H4: Regulatory quality, education, and financial deepening significantly influence the FinTech-financial inclusion-inequality relationship.

Figure 1 illustrates the conceptual framework of the research.



3. Methodology

In this paper, we construct the digital and traditional financial inclusion index. The various indicators as presented in Appendix A. The following model specification was used to understand how FinTech impacts financial inclusion.

$$FI_{it} = c + \beta_1 X_{it} + \beta_2 Fintech_{it} + \alpha_i + \epsilon_{it} \dots \dots \dots (1)$$

where FI represents financial inclusion index (digital or traditional); ‘Xs’ are the controls and details are presented in Appendix A. The control variables were chosen following the literature in the preceding section.

Traditional and digital financial inclusion is estimated using the Principal Component Analysis (PCA), a popular method employed in several studies (Jolliffe & Cadima, 2016). The detailed methodology is discussed in Appendix B.

To assess how FinTech and financial inclusion affect dimensions of inequality, we propose the following model:

$$Inequality_{it} = c + \beta_1 X_{it} + \beta_2 Fintech_{it} + \beta_3 FI + \alpha_i + \epsilon_{it} \dots \dots (2)$$

In this context, where inequality refers to gender inequality and income inequality, FinTech serves as proxy for technological advancement, FI represents financial inclusion, and X denotes the control variables. To mitigate potential endogeneity concerns, lagged values of these control variables are used.

However, regression analysis does not accommodate multiple dependent variables in a relationship. Therefore, to accurately model causative dynamics of the key variables, Structuring Equation Modelling (SEM) is applied. Appendix C contains an explanation of the rationale.

4. Results and findings

We conducted multiple regression analyses to establish the influence of financial technology on financial inclusion and on inequality as shown in Table 1 and 2 of Appendix D. In the next stage, we enhanced the model by combining financial inclusion indices as additional regressors, as presented in Table 1.

Digital financial inclusion substantially lowers the different inequality forms. Further, digital financial inclusion has decreased the coefficient value of FinTech (7.88 to 7.50) indicating that

the income inequality-inducing influence of FinTech reduces marginally when directed through digitally supported inclusion initiatives. It has raised the coefficient value of FinTech (-0.046 to -0.433) indicating that the gender inequality-reducing influence of FinTech increases when directed through digitally supported inclusion initiatives. Traditional financial inclusion significantly reduces income inequality. These results provide preliminary evidence that financial inclusion acts as a mediator between FinTech and inequality (income and gender). This suggests that financial inclusion is a principal mechanism as a primary pathway whereby FinTech affects inequality.

While we find preliminary evidence suggesting that financial technology and financial inclusion influence dimensions of inequality, the results do not accurately model causal mechanisms. Therefore, to better capture inter-relationships, we apply SEM. For ease of analysis in the SEM modelling, a composite index of financial inclusion (digital and traditional) is constructed by applying PCA.

Table 1: The impact of FinTech and financial inclusion on inequality

Explanatory variable	Gender Inequality	Income Inequality
FinTech	-0.433** (0.184)	7.50*** (2.91)
Digital Financial Inclusion	-0.058** (0.03)	-0.55* (0.59)
Traditional Financial Inclusion	-0.187 (0.137)	-5.89* (2.26)
Population growth	0.003 (0.01)	0.007 (0.014)
GDP per capita growth	-0.0004 (0.0005)	-0.008 (0.0014)
Education	-0.326 (0.033)	0.769 (0.727)
Regulatory quality	-0.57*** (0.131)	-9.05*** (2.76)
Credit/GDP	-0.24** (0.147)	-5.68* (2.18)
Constant	0.824 (0.084)	19.5 (1.70)
R-square	0.43	0.2

Robust standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$)

4.1 FinTech-financial inclusion-income inequality relationship

The SEM analyses shown in Table 2 establishes a direct statically significant path from FinTech to income inequality with a positive coefficient ($\beta = 15.607$) contradicting expectations that

FinTech would lower income inequality (Altunbaş & Thornton, 2019) Additionally, a significant negative path from financial inclusion to income inequality was observed ($\beta = -23.717$) consistent with studies that suggest increased financial inclusion decreases income inequality (Park & Mercado Jr, 2018, Omar & Inaba, 2020).

The results show that a certain degree of income inequality can incentivize financial inclusion ($\beta = 0.016$) consistent with some studies (Lazear & Rosen, 1981; Barro, 2000). The SEM results show that FinTech increases financial inclusion ($\beta = 0.053$) supported by similar investigations (Tchamyoun et al., 2019; Lahreche et al., 2020; Chowdhury & Chowdhury, 2024)

Factors like regulatory quality ($\beta=0.15$) and availability of credit ($\beta=0.1$) support the proliferation of FinTech (Dabla-Norris et al., 2015; Buckley et al., 2020; Hodson, 2021) Education ($\beta = 0.184$), regulatory quality ($\beta=0.614$) and credit ($\beta=0.227$) are significant in influencing financial inclusion.

The mediation analysis establishes that financial inclusion mediates the education impact, regulatory quality and credit on income disparity showing negative coefficient ($\beta = -2.925$, -8.714 , and -2.697 respectively) signaling that efficiencies in these factors can reduce income inequality. The model fits well as justified by a $\chi^2 = 10.998$ ($df=6$, $p=0.1$), TLI = 0.954, CFI= 0.985 and RMSEA = 0.043, all meeting recommended limits (Hu & Bentler, 1999; Kyriazos, 2018; Cheung et al., 2024)

Table 2: Direct and Indirect effects of SEM model

Variable	Direct effect	Hypothesis	Indirect effect	Hypothesis
FinTech				
Education	-0.022 (-0.018)	Not supported	0 (no path)	No path
Regulatory quality	0.156*** (0.029)	H4 supported	0 (no path)	
Credit	0.100*** (-0.034)	H4 supported	0 (no path)	
Financial Inclusion				
FinTech	0.053** (0.118)	H3 supported	0.000 (-0.001)	Not supported
Income inequality	0.016*** (0.003)	H2a supported	0 (-0.001)	
Education	0.184*** (0.042)	H4 supported	0.005 (-0.006)	
Regulatory quality	0.614*** (0.079)		-0.031 (-0.025)	
Credit	0.227*** (0.081)		-0.007 (-0.012)	
Income inequality				
FinTech	15.607*** (3.895)	H1 supported	-3.296 (2.301)	Not supported
Financial Inclusion	-23.71*** (3.335)	H2a supported	6.403 (2.481)	
Population growth	0.057 (0.032)	Not supported	0.015 (0.015)	
GDP per capita growth	-0.002 (0.003)		0.001 (0.001)	
Education	0 (no path)	No path	-2.925 *** (0.791)	H4 supported Mediation through Financial Inclusion
Regulatory quality	0 (no path)		-8.714*** (1.584)	
Credit	0 (no path)		-2.697** (1.481)	

Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

The FinTech-financial inclusion-income inequality nexus based on the SEM modelling is presented in Figure 2.

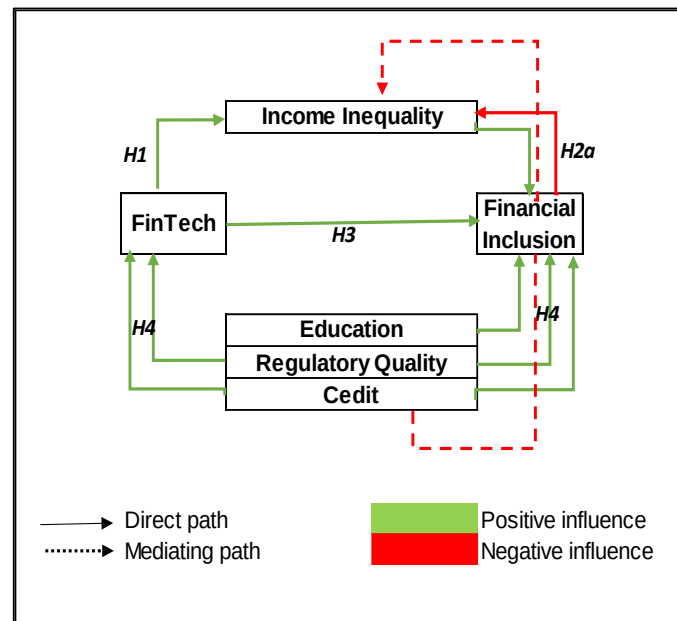


Figure 2: Conceptual model (FinTech-financial inclusion-income inequality)

4.2 FinTech-financial inclusion-gender inequality relationship

The SEM analysis shown in Table 3 found no meaningful statistical between FinTech and gender inequality. A significant negative path from financial inclusion to gender inequality was observed ($\beta = -1.036$) consistent with studies that suggest increased financial inclusion decreases gender inequality (Philippon, 2019; Carlin et al., 2019; Olafsson & Pagel, 2024; Agarwal et al., 2020; Bao & Huang, 2021; Boot et al., 2020; Gopal & Schnabl, 2020; Breza et al., 2020; Chen et al., 2023; Duan, 2025; Cumming et al., 2023).

The results show that certain degree of gender inequality can incentivize financial inclusion ($\beta = 3.045$) consistent with studies advocating for more financial access for women (Forge & Vu, 2020; Ndoya & Tsala, 2021). The SEM results show that FinTech increases financial inclusion ($\beta = 2.536$), and regulatory quality ($\beta = 0.159$) supports the proliferation of FinTech as seen in the previous case. Education ($\beta = 0.426$) and regulatory quality ($\beta = 2.817$) are significant in influencing financial inclusion (Bazarbash & Beaton, 2020).

The mediation analysis establishes that FinTech reduces gender inequality through financial inclusion ($\beta = -0.218$). The mediation analysis establish that financial inclusion mediates the influence of education and regulatory quality on gender disparity showing negative coefficient ($\beta = -0.823$ and $\beta = -0.138$ respectively) signaling that efficiencies in these factors can reduce gender inequality. The model

fits well as justified by a $\chi^2 = 13.5$ (df=6, p= p= 0.107), TLI = 0.969, CFI= 0.940 and RMSEA = 0.049, all meeting recommended limits (Hu & Bentler, 1999; Kyriazos, 2018; Cheung et al., 2024)

Table 3: Direct and Indirect effects of SEM model

Variable	Direct effect	Hypothesis	Indirect effect	Hypothesis	
FinTech					
Education	0.042 (0.035)	Not supported	0 (no path)	No path	
Regulatory quality	0.159** (0.075)	H4 supported	0 (no path)		
Credit	-0.114 (0.127)	Not supported	0 (no path)		
Financial Inclusion					
FinTech	2.536** (1.209)	H3 supported	2.326 (1.138)	Not supported	
Gender inequality	3.045** (1.392)	H2a supported	2.312 (1.352)		
Education	0.426** (0.220)	H4 supported	0.315 (0.199)		
Regulatory quality	2.817*** (1.155)		2.105 (1.139)		
Credit	-0.511 (0.692)	Not supported	0.364 (0.558)		
Gender inequality					
FinTech	-0.546 (0.336)	Not Supported	-0.218* (0.303)		H2b supported mediation through Financial Inclusion
Financial Inclusion	-1.036 *** (0.159)	H2a supported	0.786 (0.204)	Not supported	
Population growth	0.018 (0.006)	Not supported	0.015 (0.015)		
GDP per capita growth	0.001 (0.003)		0.001 (0.001)		
Education	0 (no path)	No path	-0.138 ** (0.046)	H4 supported Mediation through Financial Inclusion	
Regulatory quality	0 (no path)		-0.823 ** (0.108)		
Credit	0 (no path)		0.214 (0.177)		Not supported

Robust standard errors in parentheses (***) $p < 0.01$, ** $p < 0.05$, * $p < 0.1$)

Based on the SEM modelling, the FinTech-financial inclusion-gender inequality nexus is presented in Figure 3.

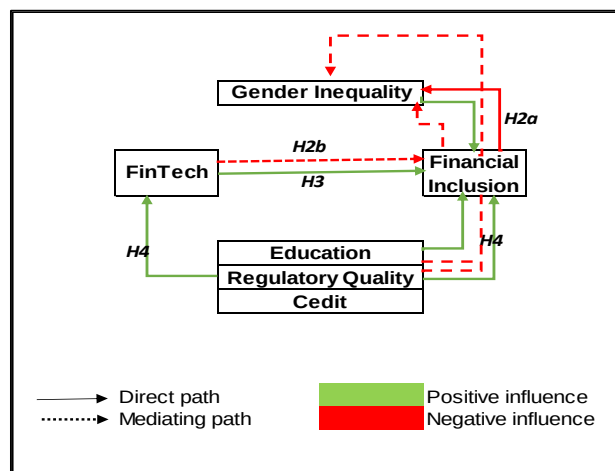


Figure 3: Conceptual Model (FinTech-financial inclusion-gender inequality)

5. Conclusion

This research developed a novel conceptual model and employed the SEM approach to investigate the interaction between inequality, financial technology, and financial inclusion across a panel of 113 national utilizing 2011-2021 Global Findex survey data. Our research offers a distinctive perspective by looking at the joint dynamics of these constructs to provide a comprehensive understanding of what factors reduce or exacerbate different dimensions of inequality.

We find that FinTech increases income inequality while decreasing gender inequality through financial inclusion. Although FinTech reduces search costs and improves advice for households and businesses, it does not diminish inequality across all categories. Financial inclusion is essential in reducing various forms of inequality. In fact, some income and gender disparities can incentivize the development and implementation of inclusive financial policies by providing safe and efficient financial options to disadvantaged individuals and communities. Regulatory quality, education, and access to credit contribute to reducing different forms of inequality by enhancing financial inclusion. These empirical results further underscore the role of key enabling factors in shaping the interplay of various facets.

The findings of our study have significant policy ramifications. First, to promote inclusive growth, policymakers must consider strategies to address different types of inequality. Our empirical findings show how FinTech, and financial inclusion may influence inequality through many channels and therefore, context-specific policies are needed. Second, access to appropriate financial offerings that benefit resource-constrained individuals and communities through targeted interventions should be a priority to reduce inequality. Third, our findings point to financial inclusion enabled by FinTech as a viable policy for lowering inequality. However, the same inequalities may expand in the future due to a lack of necessary infrastructure, geo-political tensions, lower awareness and trust, etc. Therefore, effective policymaking must balance the goals of ensuring stable growth and expanding inclusive policies, while fostering innovation and competition.

Appendix A: *Summary of variables*

Index / Variable	Indicators / Measures	Population Group
Digital Financial Inclusion Index	- Mobile cellular subscriptions - Internet access - Percentage of people with a mobile money account - Individuals who have made or received a digital payment - Individuals using a mobile phone or the internet to pay bills - Individuals checking account balances through a mobile phone or the internet	Individuals aged 15 and older
Traditional Financial Inclusion Index	- Number of commercial bank branches per 100,000 adults - Number of automated teller machines (ATMs) per 100,000 adults - Proportion of people with financial institution accounts - Ownership of credit/debit cards - Proportion of individuals with savings at a financial institution - Borrowing from a formal financial institution - Savings using a savings club or a person outside the family - Borrowing from family or friends	Individuals aged 15 and older
FinTech	- Mobile phone and fixed-line subscriptions	General population
Inequality Dimensions	- Gender inequality (Gender Inequality Index) - Income inequality (Average income of the top 10 percentile / Average income of the bottom 10 percentile)	General population

- Data sources:
 - The Global Financial Inclusion Database (Findex)
 - World Inequality Database for inequality,
 - World Development Indicators Database.
- Sample: 113 countries
- Time: 2011, 2014, 2017, and 2021.

Appendix B: *Principal Component Analysis (PCA) employed for indexing strategy*

Financial inclusion is difficult to quantify in a straightforward manner. However, the interaction of several causative variables is thought to determine this variable. Financial inclusion, we believe, demonstrates a latent structure that cannot be examined directly but can be inferred from other variables. In the estimation of any latent variable, two essential concerns arise: the selection of relevant variables and the assignment of weights. To get the most information out of a data set included in an index, the weights assigned to the indicators or sub-indices are

crucial. An effective composite index should incorporate meaningful information from all the indicators without giving disproportionate weight to any single one or group of them.

As an indexing technique, the current paper uses a two-stage principal components methodology to evaluate financial inclusion. One popular method for reducing a dataset's dimensionality is PCA by data extraction for hidden features and correlations, as well as deleting data with too much information. PCA, unlike other linear transformation methods, does not rely on fixed vectors (Taghizadeh-Hesary et al., 2019). Furthermore, (Yoshino & Taghizadeh-Hesary, 2016) found that PCA can discover the interrelationship between the multiple models constructed. PCA is a popular method for analyzing explanatory data. It displays the structure of the database and explains inconsistencies as a projection approach (Jolliffe & Cadima, 2016; Huang et al., 2021). PCA has been found to be suitable in the investigation of phenomena influenced by several financial variables. For example, Celestin, (2025) applied PCA to cryptocurrency portfolios and (Sai et al., 2025) used PCA to understand digital pattern trends, and

To determine the applicability of the data the following tests were run (Hair et.al., 2006; Tabachnick & Fidell, 2007; Hair et al., 2010; Tabachnick & Fidell, 2013).

Bartlett's test of sphericity	Test determines whether the correlation matrix used in the PCA is a significant identity matrix
Kaiser-Meyer-Olkin (KMO)	Test determine the sampling adequacy. The KMO index varies from 0 to 1, with values greater than 0.5 indicating that the analysis is appropriate.

We followed the methodologies of Sarma, (2008) and Cámara & Tuesta, (2014) to create the financial inclusion index. The dimensions for each sample of our financial inclusion index are calculated as-

$$X_{i,d} = \frac{x_i - m_i}{M_i - m_i} \dots\dots\dots(1)$$

- x_i represents the actual value of indicator i
- m_i the minimum value
- M_i the maximum value of dimension i
- $X_{i,d}$ The standardized value of indicator i within dimension

PCA is employed to aggregate each indicator to a dimension index

j^{th} eigenvalue	represented by the symbol λ_j ($j = 1, \dots, p$), where the subscript j stands for the total quantity of principal components, which is equivalent to the number of harmonized indicators, p
P_k ($k = 1, \dots, p$)	the kth principal component and suppose that $\lambda_1 > \lambda_2 > \dots > \lambda_p$

Each dimension index is then derived based on a weighted average of these components:

$$D_d = \frac{\sum_{j,k=1}^p \lambda_j P_k}{\sum_{j=1}^p \lambda_j} \dots \dots \dots (2)$$

D_d	dimension d index and $P_k = X\lambda_j$
λ_j	the weights and X is the matrix of harmonized indicators

Within each dimension, the biggest percentage of variance is captured by the first principal component. Once we have the dimension indices financial inclusion index is calculated as in Equation 2,

$$FI_i = \frac{\sum_{j=1}^p \lambda_j P_{ki}}{\sum_{j=1}^p \lambda_j} \dots \dots \dots (3)$$

FI_i	composite financial inclusion index for country i.
$P_k = X\lambda_j$	λ_j represents the dimension-specific weights and X is the dimensions matrix.

Equation 3 can be rewritten as follows

$$FI_i = w_1D_{1,i} + w_2D_{2,i} + w_3D_{3,i} + \dots w_kD_{ni} \dots \dots \dots (4)$$

w_k	weights obtained from PCA
Di	represents the dimensions

Equation 4 presents that the financial inclusion index is a weighted average of individual components (Park & Mercado, 2021).

Appendix C: *Rationale for Structural Equation Modelling (SEM)*

SEM is a method that combines aspects of factor analysis and multiple regressions, allowing for concurrent assessment of interrelationships among the variables. The SEM approach is well suited to capturing the moderating effect through two effects. These comprise the indirect effect that is conveyed through a mediator as well as the direct effect that the exogenous variable has on the outcome.

According to Hair et al., (2010) full mediation is established when the direct influence of an exogenous variable on an outcome becomes non-significant upon the inclusion of the indirect path. Whereas partial mediation occurs when the direct effect remains significant but is reduced in magnitude. The model fit is evaluated using various indicators (Hankonen et al., 2010).

chi-square (χ^2) statistic and its degrees of freedom
Comparative Fit Index (CFI) or Tucker-Lewis index (TLI),
Root Mean Square Error of Approximation (RMSEA)

Mediation analysis is appropriate when no direct association is observed between two variables and a mediator mediates the inter-relationship ((Polizzi, 2025;Obagbuwa et al., 2021; Chinoda & Mashamba, 2021).

Appendix D: *Preliminary regression modelling*

We ran a panel regression with fixed effects to establish that FinTech proxy is statistically significant with traditional and digital financial inclusion aligning with emerging research as shown in Table 1 of Appendix D.

Table 1: The impact of FinTech on financial inclusion

Explanatory variables	Traditional Financial Inclusion	Digital Financial Inclusion
FinTech	0.182*** (0.06)	0.95*** (0.313)
Population growth	0.002*** (0.004)	0.003* (0.001)
GDP per capita growth	0.0003* (0.0046)	-0.002 (0.001)
Education	0.125*** (0.017)	0.295*** (0.067)
Regulatory quality	0.53*** (0.047)	0.703** (0.359)
Credit/GDP	0.184* (0.04)	-0.446* (0.241)
Constant	-0.145 (0.03)	-0.606 (0.212)

Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

Table 2 of Appendix D illustrates the regression results for gender and income inequality. The results indicate that FinTech increases income inequality and decreases gender inequality. Education significantly reduces income inequality, while robust regulatory quality in a country significantly reduces all dimensions of inequality. The results also indicate that the ratio of credit to GDP significantly reduces income inequality.

Table 2: The impact of FinTech on inequality

Explanatory variable	Gender Inequality	Income Inequality
FinTech	-0.046** (0.181)	7.88*** (2.87)
Population growth	0.0003 (0.002)	0.20 (0.28)
GDP per capita growth	-0.0004 (0.0005)	-0.001 (0.002)
Education	-0.60** (0.031)	0.03 (0.679)
Regulatory quality	-0.74*** (0.108)	-12.29*** (2.59)
Credit/GDP	0.196 (0.152)	-6.29*** (2.17)
Constant	0.56 (0.03)	20.58 (1.67)

Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

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