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A PANEL DATA MODELING APPROACH TO FINANCIAL INCLUSION AND INCOME INEQUALITY IN THE ANDEAN COMMUNITY

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ABSTRACT
This study examines the relationship between financial inclusion and income inequality in the Andean Community of Nations (CAN) during the period 2004–2023 using a quantitative panel data modeling approach. Income inequality is proxied by the Gini index, while financial inclusion is represented by several indicators capturing access to formal financial services, including bank branches, automated teller machines (ATMs), loans, and deposit account ownership. A fixed-effects panel model is employed to evaluate the structural association between financial inclusion and the distribution of income across member countries. The empirical results indicate that greater access to basic banking infrastructure—particularly bank branches and ATMs—is significantly associated with lower levels of income inequality. In contrast, the number of borrowers does not exhibit a statistically significant effect on income distribution. These findings provide quantitative evidence supporting the role of financial inclusion as a mechanism for reducing structural disparities in emerging economies. From a modeling perspective, the results highlight the importance of access-based financial indicators in shaping the dynamics of income inequality. The study contributes to the interdisciplinary literature linking socioeconomic systems and quantitative modeling and offers relevant insights for public policy aimed at promoting inclusive financial development in the Andean region.

Keywords: Andean Community; financial inclusion; income inequality

1. INTRODUCTION

Financial inclusion has become a central topic in the analysis of socioeconomic systems, particularly since the expansion of microfinance initiatives during the 1970s and 1980s. The development of inclusive financial systems has enabled individuals and micro and small enterprises to access financial products that facilitate savings, consumption smoothing, and business investment. Access to formal financial services is therefore considered an essential mechanism for income generation and poverty reduction when inclusive financial infrastructures are effectively developed. At the macroeconomic level, financial inclusion is a vital mechanism for financial stability, sustainable economic growth, job creation, poverty reduction, and income equality in both advanced and developing countries Omar & Inaba (2020). World Bank (2024) identifies financial inclusion as key to achieving seven Sustainable Development Goals (SDGs), reducing extreme poverty, and fostering shared prosperity by enabling long-term financial planning and response to shocks. Araque Jaramillo et al., (2019) further emphasize that access to financial services positively impacts economic development and the living conditions of disadvantaged groups. Studies by Barajas et al. (2020), Li (2018) and Kim et al. (2018) confirm that financial inclusion strengthens financial development, promotes growth, increases

productivity, facilitates capital accumulation, reduces inequality, and alleviates poverty.

According to the World Bank's Global Findex Database (2022), 76% of adults globally had financial accounts in 2021, with 71% in developing economies. Digital payments reached 95% in high-income and 83% in developing countries. In developing economies, 40% used accounts for savings or borrowing, 39% opened their first account to receive salaries or transfers, and 20% received income digitally. Demirgüç-Kunt et al. (2022) report that 67.1% of the poorest quartile had savings accounts, and 64.3% of unemployed adults held accounts. Additionally, 18.2% sent or received remittances digitally, 19.3% saved via accounts, and 30.5% borrowed formally. Despite these advances, the magnitude and direction of the impact of financial inclusion on income inequality remain subjects of debate, as the effects may vary depending on the type of financial services available, the quality of institutions, and the structural characteristics of national economies.

This study provides empirical evidence on financial inclusion and income inequality in the Andean Community of Nations (CAN), composed of Bolivia, Colombia, Ecuador, and Peru, a regional bloc with a population exceeding 114 million inhabitants. The region is characterized by limited access to basic services such as education, health, and housing for a significant share of its population, while inequality remains a structural challenge, particularly in rural areas and among vulnerable groups (United Nations, CEPAL, 2024). Income inequality in the region is a persistent concern, and the United Nations (2025) emphasizes that reducing it requires an equitable distribution of resources and investments in education and health, with one of the most direct approaches being the financial inclusion of excluded populations.

While the relationship between financial inclusion and income inequality has garnered increasing academic attention, empirical studies focusing on the Andean Community (CAN) remain limited. From a quantitative modeling perspective, analyzing this relationship through panel data techniques allows the identification of structural associations between financial access indicators and income distribution across countries and over time. By treating national economies as interconnected socioeconomic systems, panel econometric modeling provides a suitable framework for evaluating how variations in financial inclusion indicators influence inequality dynamics The analysis aims to provide empirical evidence on how improved access to financial services helps reduce income disparities within the region.

The remainder of the article is structured as follows: The next section reviews the relevant literature on financial inclusion and income inequality; the following section describes the data and the quantitative modeling strategy employed, including the specification of the panel econometric model. Finally, the empirical results are presented and discussed, and the main conclusions and implications for public policy are described.

2. LITERATURE REVIEW

Financial inclusion has become a key policy objective to boost economic growth, reduce poverty, and mitigate income inequality. It is commonly defined as the provision of accessible, affordable, and appropriate financial services—such as savings, credit, insurance, and payment systems—through formal institutions (Allen et al., 2016; Arun & Kamath, 2015; Dabla-Norris et al., 2015; Ozili, 2021). This multidimensional concept is assessed across three dimensions: access, usage, and quality of services (Cipoletta Tomassian and Matos, 2018; World Bank, 2015). Effective financial inclusion also depends on financial literacy, institutional efficiency, and technological access, which foster responsible use and broaden outreach (World Council Ecuador, 2023).

A growing body of empirical evidence supports the notion that financial inclusion reduces income inequality, particularly by enhancing access to credit, enabling entrepreneurship, and facilitating income generation for disadvantaged groups (Demir et al., 2022; Fouejieu et al., 2020). However, this relationship is influenced by various contextual factors. For example Honohan (2008) identified a positive correlation between financial inclusion and poverty reduction in over 160 countries, although causality remains unestablished. Similar effects have been observed in Sub-Saharan Africa (Ashenafi & Dong, 2022), Europe (Tsouli 2022) and Asia (Verma & Giri, 2022), where services like digital banking, microfinance, and domestic credit have supported redistribution. However, the magnitude and direction of these effects vary across contexts.

It should be noted that some studies show that financial inclusion can exacerbate inequality in certain developing economies. Tita and Aziakpono (2017) found that, in sub-Saharan Africa, access to formal financial services increased inequality due to poor infrastructure and high information asymmetries. These findings suggest that financial inclusion alone is not inherently equitable; its impact depends on institutional quality, accessibility, and the inclusiveness of delivery mechanisms.

In this context, the Kuznets hypothesis provides a useful theoretical framework. Originally proposed by Kuznets (1955), the hypothesis posits an inverted U-shaped relationship between income inequality and economic development: inequality tends to rise in the early stages of growth and decline in later stages as economic structures diversify and redistributive institutions mature. Recent empirical studies have revisited this relationship using financial inclusion variables, suggesting that financial services may initially benefit higher-income groups before broader inclusion occurs (Baiardi & Morana, 2018; Wang et al., 2024). Evidence from Chu Khanh and Chu (2018) and Gan (2023) supports this dynamic in developing regions, reinforcing the importance of analyzing where economies stand along this trajectory.

In addition to access, quality and equity in the use of financial services are essential. Seifelyazal et al. (2023) advocate for multidimensional indices that incorporate use and quality of service to better assess the impact on vulnerable groups. Additionally, a key element in improving the effectiveness of financial inclusion is human capital; Dabla-Norris et al. (2015b), Fungáčová and Weill (2015) and Kling et al. (2022), demonstrate that education improves financial participation and income, although the results are subject to conditioning factors such as gender gaps or rural origin, which is particularly relevant for regions with persistent educational inequalities, as observed in sub-Saharan Africa (Huang et al., 2023) and parts of Latin America.

Similarly, the redistributive role of public spending in developing countries remains unclear. Celikay and Gumus (2017) and Kirama (2021), emphasize the inefficiency of social expenditures, which often disproportionately benefit populations in more accessible areas, such as urban centers or primary education sectors, rather than reaching the most vulnerable groups. Dabla-Norris et al. (2015) warn that the discretionary allocation of public resources may limit redistributive outcomes if not explicitly targeted toward those in greatest need. In this context, technological infrastructure and innovation—particularly the expansion of automated teller machines (ATMs) and mobile banking—are frequently cited as mechanisms that enhance access to financial services. Ganic (2023), reports that the availability of ATMs within the European Union contributed to long-term reductions in inequality. Similarly, Williams et al. (2017) highlight the transformative role of digital financial services in Africa, despite persistent infrastructure deficiencies in rural areas. These findings suggest that access to basic financial infrastructure—such as bank accounts and ATMs—is a key factor in promoting financial inclusion, especially in regions facing significant logistical and geographic barriers.

Finally, recent studies underscore the critical role of institutional quality and the reduction of information asymmetries in fostering inclusive financial systems and mitigating income inequality, as they facilitate more efficient capital allocation and stimulate economic activity (Girma & Huseynov, 2023; Park & Mercado, 2018). These effects are significantly enhanced when supported by coordinated regional strategies, which are more effective than isolated national efforts in addressing structural disparities (Kebede et al., 2023; Salazar-Cantú et al., 2015). Within these strategies, financial institutions play a central role, as they are responsible for designing financial products that are responsive to users' needs and aligned with regulatory frameworks (Rivera et al., 2024). However, financial sector expansion alone is insufficient to reduce inequality. Targeted measures—such as the development of regulations that promote increased access to credit for small and medium-sized enterprises (SMEs)—are essential to achieving sustainable and inclusive outcomes (Turégano & Herrero, 2018).

The reviewed literature consistently highlights financial inclusion as a mechanism for reducing income inequality, particularly through improved access to credit and savings for low-income populations. However, its effectiveness varies by context, influenced by factors such as economic development, institutional quality, and the maturity of the financial system. While developed economies benefit from more equitable outcomes, less developed countries may experience initial increases in inequality. These divergences highlight the importance of conducting context-specific analyses that consider structural and socioeconomic differences.

3. METHODS

This study employs a quantitative approach based on panel data to examine the relationship between financial inclusion and income inequality in the member countries of the Andean Community (Bolivia, Colombia, Ecuador, and Peru). The analysis is grounded in economic development and financial exclusion theories, specifically drawing on the theory of asymmetric information (Stiglitz & Weiss, 1981), the capability approach (Sen, 1999), and the theory of inclusive institutions (Acemoglu & Robinson, 2012). These frameworks provide the theoretical foundation to understand how unequal access to financial services can perpetuate income disparities.

A fixed-effects panel data model was applied using annual data for the period 2004–2023. To mitigate potential reverse causality issues, lagged values for the variables number of branches, public spending, and inflation were included after performing the unit root tests. Information was obtained primarily from the Global Findex database of the Economic Commission for Latin America and the Caribbean (ECLAC), the International Monetary Fund (IMF), the United Nations Educational, Scientific and Cultural Organization (UNESCO), and macroeconomic indicators published by the World Bank. To fill in the missing values in some of the time series, linear interpolation was used. This method is recommended for estimating missing values in annual data and ensures the continuity and consistency of the variables (Little and Rubin, 2002; Schafer, 1997).

The selection of the CAN countries is justified by their common institutional framework, relatively comparable levels of economic development, and a history of regional cooperation in economic, financial, and social dimensions. Furthermore, they share similar structural characteristics—such as labor market configurations, patterns of access to financial services, and the persistence of high levels of inequality—which make them an appropriate unit of analysis for a comparative regional approach.

The study period, 2004–2023, was defined based on empirical and conceptual criteria. It encompasses a timeframe during which governments and central banks intensified their efforts to promote financial inclusion through regulatory reforms aligned with Basel standards (Bank for International Settlements (BIS, 2012), the digitalization of financial services, and the expansion of banking and payment infrastructure (Demirguc-Kunt et al., 2018; Global Partnership for Financial Inclusion, 2016). It also covers major macroeconomic events and relevant exogenous shocks, such as the 2008–2009 global financial crisis, sharp fluctuations in commodity prices, and the COVID-19 pandemic, all of which may have affected both financial access and income distribution (Claessens et al., 2010; International Monetary Fund, 2021; Lahreche et al., 2020). Analyzing this 20-year interval allows for the identification of structural trends and long-term dynamics in the region's financial and socioeconomic systems.

In the econometric model, income inequality—measured by the Gini coefficient—was set as the dependent variable. Financial inclusion is taken as the independent variable, defined as access to and use of financial services by all segments of the population, particularly disadvantaged groups. While financial inclusion is a multidimensional concept encompassing access, use, and quality, this study adopts four widely used proxy indicators due to data availability: commercial bank branches and ATMs per 100,000 adults, and commercial bank borrowers and deposit accounts per 1,000 adults. These indicators reflect both access and use and are consistent with previous empirical research (Pesqué-Cela et al., 2021; Chinoda and Mashamba, 2021; Ouechtati, 2020).

To control for other factors influencing income inequality, the model includes economic growth (reflected by GDP per capita growth), trade openness (trade-to-GDP ratio), human capital (gross secondary school enrollment), redistributive policy (government spending), unemployment, and inflation. These variables are commonly used in the literature and capture structural and macroeconomic dynamics that can affect income distribution (Aghion et al., 2009; Castelló-Climent & Doménech, 2021; Berisha et al., 2022).

The following equation outlines the general structure of the panel data model; detailed definitions of the variables are presented in Table 1*:*

$$Gini_{it} = \beta_0+\beta_1 Branhes_{it-1} + \beta_2 ATMs_{it} + \beta_3 Borrowers_{it} + \beta_4 Accounts_{it} + \beta_5\, TradeOpen_{it} + \beta_6 GovExp_{it-1} + \beta_7 GDP_{it} + \beta_8 InfRate_{it-1} + \beta_9 Unemp_{it} + \beta_9 SecGER_{it} + \mu_{it} \quad [1]$$

Table 1. *Variable Specification and Data Sources*

Variable	Description	Source	References/literature
Gini	Gini index, ranging from [0,1], where 0 represents absolute equality and 1 absolute inequality.	CEPAL	UNU-WIDER (2025)
Branches	Number of commercial bank branches per 100,000 adults.	World Bank	Ofori et al. (2022); Ouechtati (2020)
ATMs	Number of ATMs per 100,000 adults.	World Bank	Chinoda and Mashamba (2021); Ouechtati (2020)
Borrowers	Number of commercial bank borrowers per 1,000 adults.	World Bank	Chinoda and Mashamba (2021); Ouechtati (2020)
Accounts	Number of bank accounts per 1,000 adults.	IMF	Serna Borja et al. (2019); Turégano and Herrero (2018);
TradeOpen	Sum of exports and imports as a percentage of GDP.	World Bank	Dorn et al., 2022; Mahesh, 2011); Zakaria and Fida, 2016

GovExp	Government expenditure as a percentage of GDP.	CEPAL	Izquierdo et al. (2018; Jaén-García (2017); Nuru and Zeratsion, (2022); Sidek (2021); Verberi and Yaşar (2021)
GDP	GDP per capita growth rate in PPP terms.	World Bank	Aghion et al. (2009; Odhiambo & Saungweme (2024); Shen & Zhao (2023; Topuz (2022
InfRate	Consumer price index growth rate	World Bank	Berisha et al. (2022); Göcen (2024; Mumtaz and Theophilopoulou (2017)
Unemp	Percentage of unemployed individuals in relation to the total labor force.	World Bank	Shabnum and Malik (2023; Sheng (2011; Cysne (2009)
SecGER	Proportion of students enrolled in secondary education as a percentage of the total school-age population.	UNESCO, CEPAL	Castelló-Climent and Doménech (2021); Keller (2010; Gregorio and Lee (2002); K. H. Park (1996)
μ_{it}	Disturbance term for country i and period t.		

Source: Prepared by the authors

To assess the stationarity of the variables, the Levin–Lin–Chu (LLC), Im–Pesaran–Shin (IPS), and Fisher–ADF panel unit root tests were applied. The results, presented in Table 2, indicated that branches, public spending, and inflation were non-stationary in the panel, leading to the use of their first differences in the estimation.

Table 2 *Stationarity Analysis*

Variable	LLC (p-value)	IPS (p-value)	Fisher-ADF (p-value)	Stationarity
Gini	0.0109	0.0596	0.0386	Yes
Branches	0.1090	0.7010	0.7269	No
ATM´s	0.0083	0.0589	0.0094	Yes
Borrowers	0.0001	0.0601	0.0099	Yes
Accounts	0.0212	0.0970	0.0203	Yes
TradeOpen	0.0106	0.0508	0.0299	Yes
GovExp	0.1092	0.4582	0.5384	No
GDP	0.0001	0.0000	0.0000	Yes
InfRtate	0.2167	0.1066	0.0882	No
Unemp	0.0057	0.0056	0.0008	Yes
SecGER	0.0135	0.1022	0.0401	Yes

Note: Prepared by the authors

To account for potential distortions arising from macroeconomic shocks, the analysis employed fixed-effects panel data models with robust corrections for autocorrelation and heteroskedasticity. This specification ensured the reliability of the estimates in the presence of such shocks. The main model included country fixed effects to control for time-invariant unobserved heterogeneity across countries. Although two-way fixed effects—i.e., simultaneously including both country and year fixed effects—were not used in the baseline specification, year fixed effects were incorporated in a set of alternative models to capture the impact of major shocks occurring between 2000 and 2020, such as the 2008 global financial crisis, the 2015 oil price collapse, and the 2020 COVID-19 pandemic. This complementary strategy enhanced the robustness of the results by accounting for structural breaks and common macroeconomic disturbances.

3.1. Model validation and diagnostic tests

To validate the econometric specification and obtain the correct model, sequential specification tests were conducted. Initially, the F-test was applied to compare the pooled OLS and fixed-effects specifications, suggesting statistically significant individual (country-specific) effects and supporting the use of a panel data estimator. Subsequently, the Lagrange Multiplier (LM) test indicated that the random-effects model was preferable to the pooled OLS specification. Finally, the Hausman test was employed to distinguish between the fixed- and random-effects models; its results supported the fixed-effects specification, revealing the correlation between the regressors and unobserved individual heterogeneity.

Once the fixed-effects panel data model was selected, additional diagnostic tests were performed: the modified Wald test identified heteroskedasticity, and the Wooldridge test revealed first-order autocorrelation. To address these issues, country-clustered robust standard errors were employed, thereby improving the reliability of the estimated coefficients and the statistical inference.

4. RESULTS AND DISCUSSION

This section consists of two parts: the first presents the statistical description of income inequality, financial inclusion, and the relationship between the two variables; the second part develops the econometric modeling to identify the relationship between the main variables and the control variables used in the model.

The variables in the model reveal strong disparities among Andean Community countries. The Gini index shows high variability, indicating uneven income distribution. Financial inclusion indicators, such as the number of bank branches and ATMs, display notable heterogeneity—Peru and Bolivia have broader coverage, while others show more limited access. Financial depth, measured through bank loans and deposit accounts, also presents significant dispersion, suggesting unequal access to credit and banking services across the region. Moreover, trade openness and public spending as a share of GDP vary considerably between countries, reflecting different governmental priorities and redistribution strategies. Overall, these differences highlight the structural and institutional heterogeneity within the Andean economies, shaping the diverse impact of financial inclusion on income inequality.

4.1. Descriptive analysis of variables

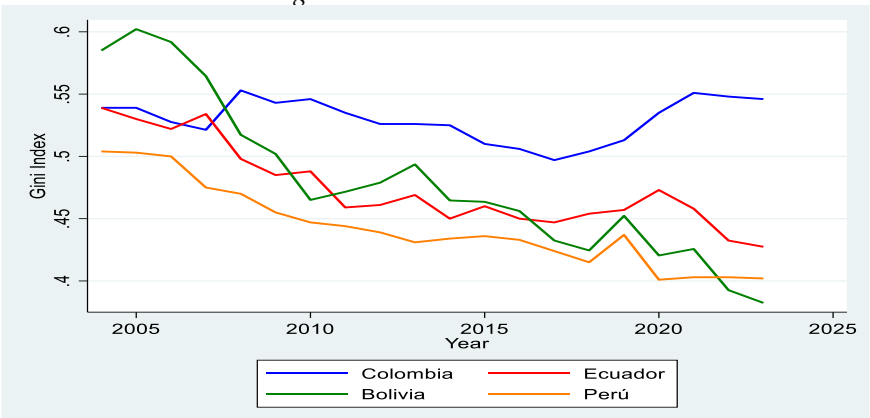
Table 3. *Descriptive Statistics*

Variable	Mean	Std. Dev.	Min	Max
Gini	0.4816	0.0507	0.3824	0.6022
Branches	2.5243	0.6704	0.1425	4.3055
ATM´s	3.5215	0.6572	1.9867	5.0004
Borrowers	4.8346	0.7055	3.1062	5.9720
Accounts	6.7077	0.7790	4.5999	8.0327
TradeOpen	0.5349	0.1366	0.3406	0.8526
GovExp	0.2728	0.0733	0.1430	0.4059
GDP	0.0257	0.0396	-0.1199	0.1227
InfRtate	0.0386	0.0259	-0.0034	0.1401
Unemp	0.0551	0.0335	0.0202	0.1598
SecGER	0.9233	0.0982	0.5741	1.0590

Note: Prepared by the authors

Figure 1 shows the average Gini coefficients for the four Andean countries. Bolivia has a high average Gini coefficient (0.48) but is the country that has shown the greatest improvement in income redistribution, falling from 0.585 in 2004 to 0.382 in 2023. Similarly, Peru has improved this indicator between 2004 and 2023, falling from 0.504 to 0.402, respectively. Ecuador has also seen a significant improvement in the Gini index, which decreased from 0.549 in 2004 to 0.427 in 2023. Finally, Colombia has made little progress in income redistribution, as indicated by the Gini index, which shows nearly stable trends for this indicator. Its average value is 0.530, starting at 0.539 in 2004 and ending at 0.546 in 2023.

Figure 1. Gini Index in CAN

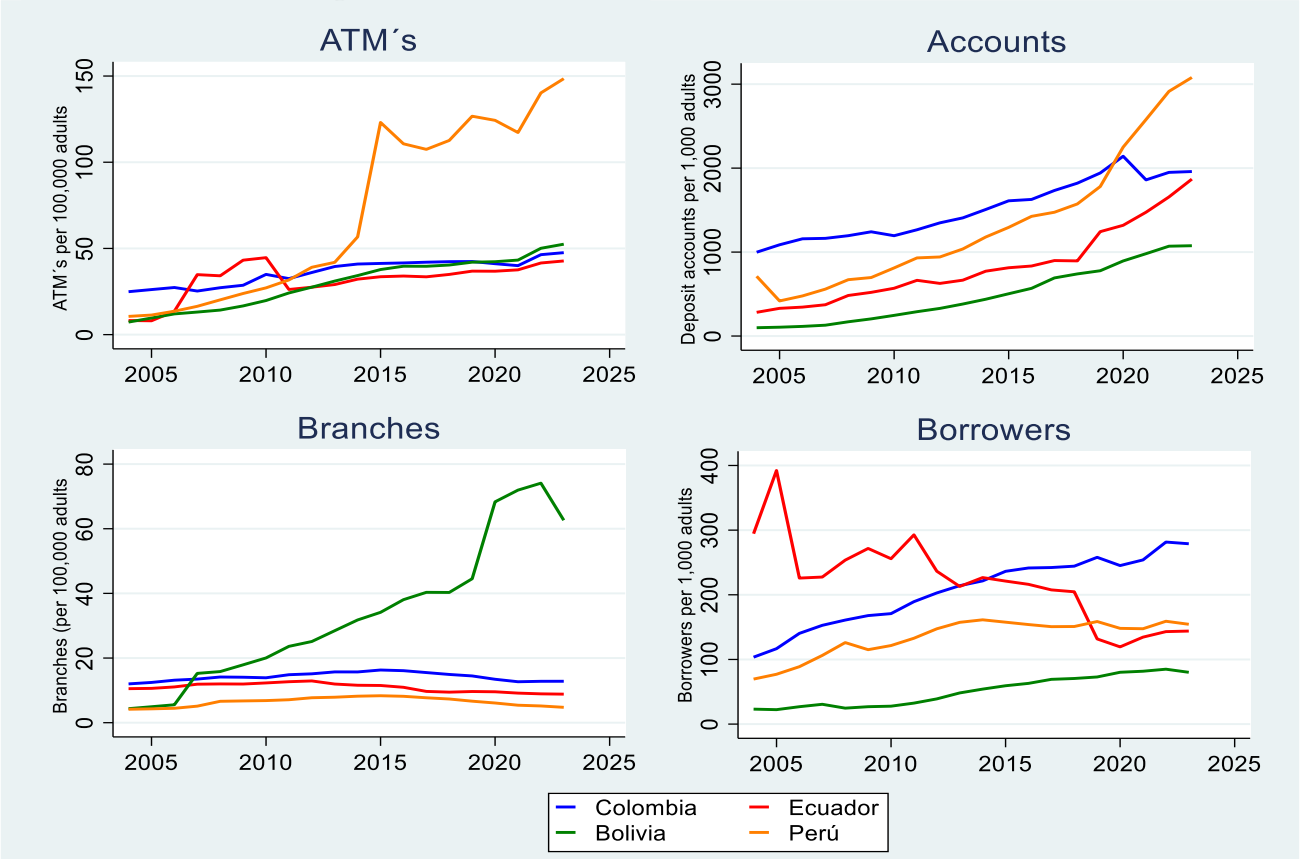


Note: Prepared by the authors using data from the World Bank (2024)

Figure 2 shows the indicators used to measure financial inclusion. With regard to ATMs and deposit accounts, Peru has the highest figures, with 148.4 ATMs per 100,000 inhabitants and 3,080 deposit accounts per 1,000 adults, respectively. In terms of bank branches per 100,000 adults, Bolivia has the highest indicator, with 62.6. Finally, Colombia leads in terms of bank borrowers per 1,000 adults, with a figure of 279.

On the other hand, Bolivia is the country that has achieved the best results in financial inclusion within the CAN. For all indicators, the growth experienced by this country is the highest among all the countries: bank branches per 100,000 adults grew 13.4 times between 2004 and 2023; the number of ATMs per 100,000 adults increased by 6.20 times; the number of borrowers per 1,000 adults grew by 2.4 times; and finally, the number of deposit accounts per 1,000 adults increased by 9.8 times.

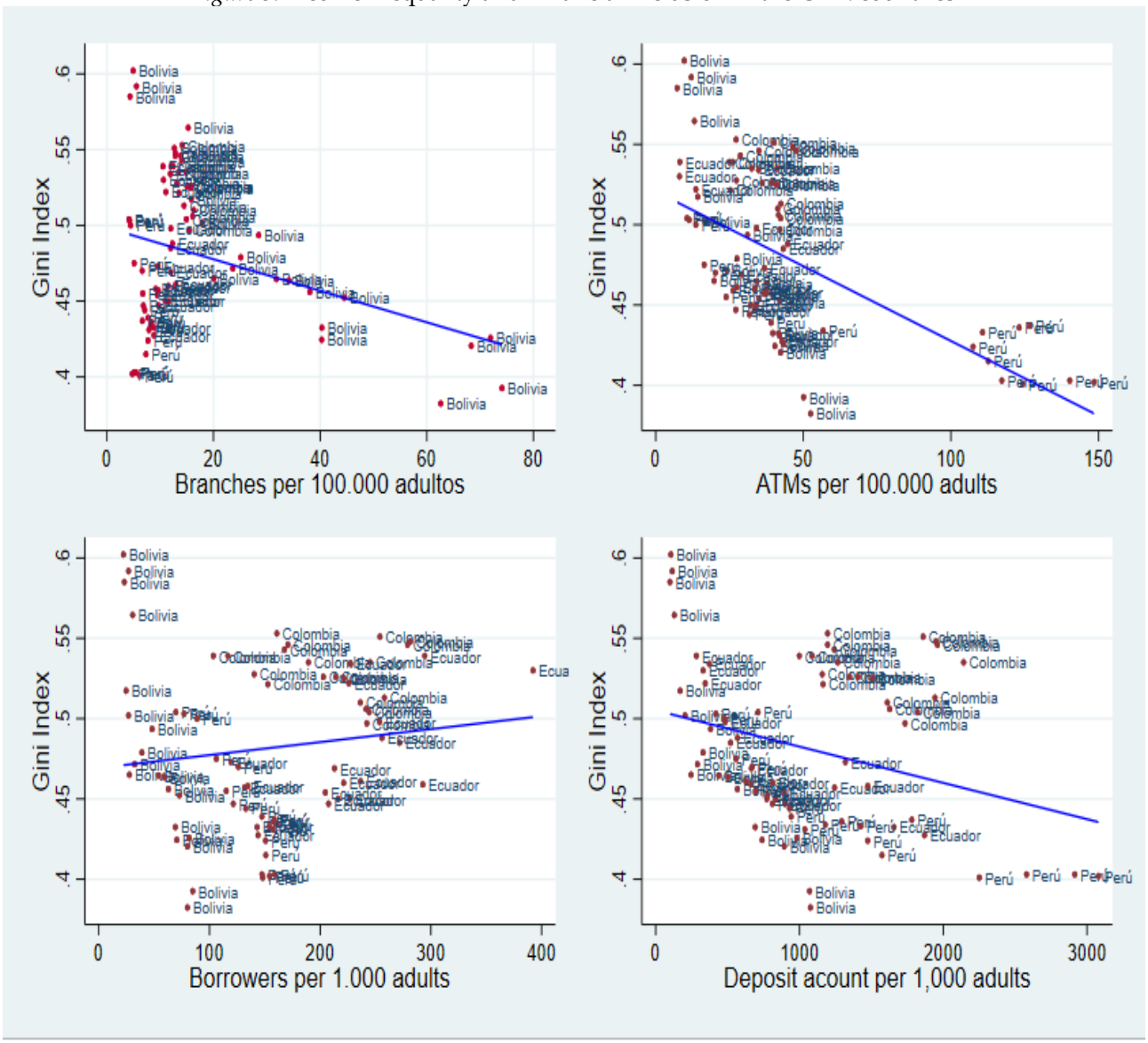
Figure 2. Financial Inclusion Variables in CAN Countries



Note: Prepared by the authors using data from the World Bank (2024)

Figure 3 illustrates the relationship between financial inclusion indicators and income inequality. The analysis reveals that an increase in the number of bank branches tends to reduce income inequality, as indicated by the negative correlation with the Gini coefficient. However, the wide dispersion of the data suggests that other contextual factors may also influence inequality. Bolivia exemplifies this pattern, exhibiting the highest Gini values alongside the lowest branch density. Similarly, ATMs show a negative relationship with inequality, implying that greater ATM availability promotes income redistribution. Peru, for example, combines a high number of ATMs with the lowest Gini index values in the region. Conversely, the relationship between bank borrowers and the Gini index is weak and highly dispersed, indicating that access to credit does not necessarily translate into reduced inequality. This likely reflects the concentration of formal lending among higher-income groups and limited access for low-income sectors. In contrast, the number of bank accounts shows a clear negative relationship with inequality, confirming that broader account ownership fosters financial inclusion and equity. Nonetheless, the dispersion suggests that effective use and quality of services are key determinants. Among all variables, ATMs exhibit the steepest regression slope, highlighting their strong impact on financial inclusion and their potential to enhance income redistribution within the Andean region.

Figure 3. Income Inequality and Financial Inclusion in the CAN countries



Note: Prepared by the authors using data from the World Bank (2024)

The correlation analysis (see Annex 2) reports the coefficients among the study variables. The results show a moderate correlation among the variables. For the correlation analysis, a significance level of 5% was applied, and the results reveal statistically significant associations among the main variables of the study. The Gini index exhibits a positive correlation with both the unemployment rate and inflation, indicating that higher income inequality intensifies under conditions of macroeconomic instability. Conversely, the Gini index maintains significant negative correlations with the number of bank branches, ATMs, accounts, and loans, suggesting that greater financial inclusion is associated with reduced inequality levels.

4.2. Results of the Modeling

Five panel data models were estimated to assess the effect of financial inclusion on income inequality. Model 1 includes all financial inclusion indicators, while Models 2 to 5 focus individually on branch density, ATMs, account ownership, and the number of borrowers. This approach aims to provide a comprehensive assessment of the specific impact of each dimension of financial access. The results are presented in the Table 4.

Model 1 incorporates all financial inclusion indicators. Account ownership exhibits a large, negative, and highly significant effect, indicating that broader access to savings accounts substantially reduces inequality. The number of borrowers also shows a negative and highly significant effect, supporting the role of credit access in mitigating disparities. In contrast, branch density and ATM availability display positive but non-significant coefficients, suggesting a limited direct impact of physical banking infrastructure. Among the control variables, GDP and

unemployment are positively and significantly associated with inequality, whereas other macroeconomic factors are not significant.

Model 2 examines the number of bank branches, finding that the associated coefficient is negative and highly significant ($p < 0.01$), suggesting that the expansion of physical financial infrastructure contributes to reducing income inequality. Secondary school enrollment also exerts a strongly significant effect in lowering inequality, whereas GDP growth, inflation, unemployment, and government expenditure display positive and statistically significant relationships with income inequality. Trade openness, on the other hand, does not have a significant impact.

Model 3 employs the number of ATMs per 100,000 adults as an indicator of financial inclusion. The results confirm that greater technological access to financial services contributes to inequality reduction, underscoring the role of digital infrastructure in promoting inclusion. Secondary education enrolment remains an important determinant of lower inequality, while unemployment and inflation have positive and significant effects on income inequality, suggesting that these macroeconomic factors may widen income disparities. The remaining variables are not statistically significant.

Model 4 considers the number of borrowers from financial institutions per 1,000 adults. The estimated coefficient is negative but statistically insignificant, indicating that access to formal credit has yet to become an effective mechanism for financial inclusion. Secondary school enrollment remains negative and significant, reaffirming the role of education in mitigating inequality, while unemployment continues to exhibit a positive association with income inequality. GDP growth, inflation, and unemployment all display direct relationships with inequality, whereas trade openness shows a negative but statistically insignificant effect.

Finally, Model 5 incorporates the number of deposit accounts per 1,000 adults and reveals a negative and significant relationship with the Gini coefficient. Broader account ownership appears to foster savings, financial planning, and access to financial products, all of which contribute to reducing inequality. However, unemployment, trade openness, and economic growth exhibit positive and highly significant associations with income inequality. Nonetheless, the inverse and statistically robust effect of trade openness suggests that greater integration into international trade could help improve income distribution. In this model, the secondary school enrollment rate ceases to be statistically significant.

Table 4. *Panel Data Model Results*

Gini	All variables	Branches	ATM´s	Borrowers	Accounts
Branches	0.0100	-0.0350***			
	(0.0185)	(0.0069)			
ATM´s	0.0108		-0.0319***		
	(0.0077)		(0.0069)		
Borrowers	-0.0138*			-0.0050	
	(0.0077)			(0.0091)	
Accounts	-0.0655***				-0.0491***
	(0.0087)				(0.0066)
TradeOpen	0.0164	0.0412	-0.0573	-0.0740	-0.1165***
	(0.0375)	(0.0575)	(0.0467)	(0.0461)	(0.0406)
GovExp	0.0693	0.2876***	0.0822	0.0263	0.0593
	(0.0812)	(0.0735)	0.0585	0.0636	0.0502
GDP	0.0159***	0.2050**	0.1011	0.0976	0.1446***
	.0709734	(0.0985)	(0.0519)	(0.0450)	(0.0426)
InfRate	0.1160	0.3606**	0.2685**	0.0901	0.3003***
	(0.0916)	(0.1638)	(0.1069)	(0.1038)	(0.0982)
Unemp	0.5082***	0.1114***	0.6172***	0.4852***	0.8022***
	(0.1940)	(0.1916)	(0.1405)	(0.1587)	(0.1344)
SecGER	-0.0173	-0.3008***	-0.0874*	-0.1816***	-0.0656
	(0.0327)0.	(0.0487)	(0.0529)	(0.0444)	(0.0423)
Cons	.9290222	0.6667***	0.6356***	0.6702***	0.8588***
	.0615275	(0.0613)	(0.0522)	(0.0689)	(0.0510)
Observations	80	80	80	80	80
R2 (whithin)	0.8233	0.7248	0.4936	0.3776	0.5295

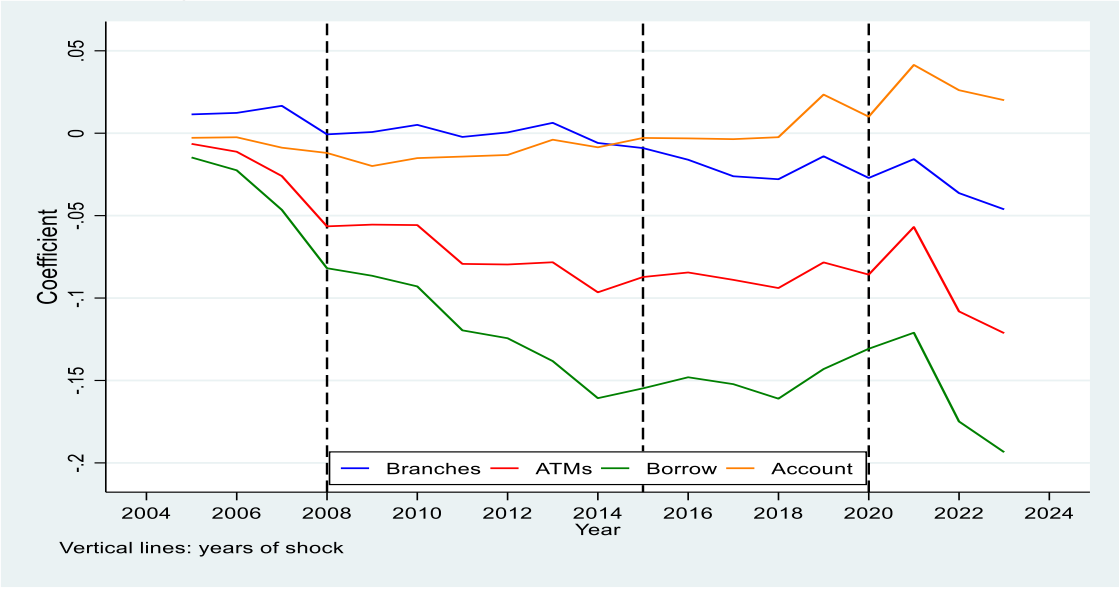
*p < 0.10, ** p < 0.05, *** p < 0.01.

Source: Authors' own work

Figure 4 presents a preliminary robustness analysis that incorporates fixed effects by year to account for the overall impacts of the crises of 2008, 2015, and 2020. The results are shown in Figure 3 and confirm that the coefficients of the financial inclusion variables retain their sign, magnitude, and statistical significance. This stability indicates that the relationship between financial inclusion and the reduction of income inequality is not determined by any specific year and remains

constant even during periods of major global economic disruptions. In other words, the results are robust to potential biases arising from international macroeconomic conditions.

Figure 4. Year fixed effects: Gini vs. financial inclusion (2005–2023)



Source: Obtained from STAT results

To complement the robustness analysis, two-way fixed effects panel models (country and year) were estimated, accounting for time-invariant heterogeneity across countries, such as structural, institutional, or cultural differences, which could bias the estimated effect of financial inclusion on income inequality. Sequential exclusion of each country shows that Bolivia, Ecuador, and Peru slightly modify the magnitude of ATMs and savings accounts, without altering the main findings. In contrast, Colombia has the largest influence on the results, primarily affecting the coefficients of branch density and private sector credit. Across all exclusions, the negative effects of ATMs and savings accounts remain statistically significant throughout the Andean region, confirming their robust role in reducing income inequality independently of country-specific or global shocks. These results highlight the central contribution of digital and basic financial infrastructure to mitigating income disparities, while demonstrating the stability of the relationships across different country samples. The final results are presented in the Table 6.

Table 5 *Two-Way Fixed Effects Panel Model Results*

Country excluded	Branches	ATMs	Borrowers	Accounts
Bolivia	0.0184	0.0180***	-0.0113	-0.1089 ***
	(0.0390)	(0.0056)	(0.0073)	(0.0122)
Colombia	0.0319 *	0.0228***	-0.0231**	-0.0527**
	(0.0169)	(0.0062)	(0.0093)	(0.0222)
Ecuador	0.0060	0.0359 ***	0.0422*	-0.0527**
	(0.0206)	(0.0123)	(0.0242)	(0.0222)
Perú	0.0151	0.0214	-0.0065	-0.1044***
	(0.0209)	(0.0138)	(0.0074)	(0.0121)

*p < 0.10, ** p < 0.05, *** p < 0.01.

Source: Authors' own work

4.3. Discussion

This study found that, within the Andean Community of Nations (CAN), the availability of ATMs and bank account ownership are the financial inclusion indicators most strongly associated with reductions in income inequality. Conversely, the expansion of bank branches and the number of borrowers also exert redistributive effects, albeit to a lesser extent. Among these four indicators, access to and use of ATMs and accounts reflect the most direct utilization of financial services by low-income households, thereby enhancing their equalizing impact.

These findings align with those of Rubio and León (2025), who show that in fifteen Latin American and Caribbean economies, indicators of effective financial system use generate stronger

redistributive impacts than mere access, consistent with our observation that account ownership and ATM availability are more significant than branch expansion. Similarly, Polloni-Silva et al. (2021) demonstrate that financial inclusion in Latin America reduces inequality more substantially when access translates into active use, such as electronic payments or credit utilization, reinforcing the relevance of account ownership in our study.

Regarding bank branches, the results indicate a positive effect on equity, though smaller than that of accounts and ATMs. This is consistent with Álvarez-Gamboa et al. (2022) for Ecuador, who found that branch expansion improves credit accessibility and contributes to inequality reduction, with effects dependent on location and infrastructure concentration, being more effective in rural or underserved areas, in line with findings by Fonseca and Matray (2024) in Brazil.

Concerning the number of borrowers, the redistributive effect observed is moderate but consistent with Omar and Inaba (2020), who show that access to formal credit reduces the Gini coefficient, particularly when targeted at microenterprises and low-income households. This relationship is further supported by Perea et al. (2012) in Peru, where credit expansion has reduced inequalities, although urban-rural disparities persist.

Comparing these findings with other developing regions, Ashenafi and Dong (2022) and Verma and Giri (2022) report that access to accounts, microcredit, and digital financial services promotes equity, whereas Atadouanla Segning et al. (2024) show that inadequate infrastructure and service concentration can limit or even reverse these effects. In developed countries, Ganic (2023)indicates that ATM expansion reduces inequality, though with smaller magnitude due to high prior penetration of financial services, confirming that the relevance of each indicator depends on the existing banking context and access levels.

Analysis of macroeconomic variables reveals that GDP per capita growth and inflation are positively associated with inequality, while unemployment exacerbates income gaps, highlighting that labor exclusion and inflationary pressures disproportionately affect vulnerable households. Trade openness shows a mixed effect: it reduces inequality in contexts with strong financial systems but may increase disparities in concentrated or less diversified economies. These results are consistent with Dabla-Norris et al. (2015) and Turégano and Herrero (2018), who emphasize that the interaction between financial inclusion and macroeconomic stability is critical for achieving inclusive growth.

Overall, these results indicate that within the CAN, bank accounts and ATMs are the most effective channels of financial inclusion for reducing inequality, while branches and borrowers play complementary roles. Comparative evidence from Latin America and other developing regions confirms that redistributive effects depend on both access and active use of financial services, as well as complementary policies that promote financial education and institutional strengthening.

5. CONCLUSIONS

This study provides empirical evidence on the impact of financial inclusion in reducing income inequality within the Andean Community of Nations (CAN), contributing to both academic understanding and policy formulation. Using fixed-effects panel data models and disaggregating financial inclusion into four dimensions—deposit accounts, ATMs, bank branches, and credit access—the analysis reveals heterogeneous effects of these services on income distribution.

The results confirm that financial inclusion is multidimensional, with each component exerting distinct and measurable impacts. Among the indicators, deposit account ownership shows the strongest and most statistically significant inequality-reducing effect, emphasizing that access to basic accounts is a crucial entry point to the formal financial system. By enabling savings, credit, and investment opportunities, such access enhances household resilience and upward mobility.

ATMs and bank branches also contribute to reducing inequality, though their effects are more moderate, likely due to their concentration in urban centers and limited presence in rural areas. In contrast, the insignificant effect of the number of borrowers points to persistent structural barriers in credit markets, where formal lending remains concentrated among higher-income groups. These findings underscore the need to move beyond expanding financial availability toward ensuring equitable access and effective utilization.

Beyond financial inclusion, unemployment emerges as the most influential factor driving inequality, confirming the critical role of stable labor markets. Secondary school enrollment displays a negative relationship with inequality, reaffirming education's function as a long-term equalizer. Conversely, the positive links between inequality, economic growth, and public expenditure suggest distributional inefficiencies consistent with the Kuznets curve hypothesis within the CAN context.

When analysed independently the number of bank branches demonstrates the highest explanatory power among inclusion indicators, indicating that physical financial infrastructure remains vital for fostering inclusive development in underserved regions. Thus, even amid digital transformation, expanding branch networks continues to play a key redistributive role by bridging geographic and informational gaps.

Implications

Overall, the findings indicate that financial inclusion functions as a multidimensional structural mechanism whose redistributive impact depends primarily on effective usage rather than the mere availability of financial channels. Account ownership and access to ATMs foster active engagement with the financial system by facilitating savings, payments, and potential investment, thereby constituting the principal transmission channel linking inclusion to income distribution. These results underscore that functional access reduces transaction costs, expands the availability of financial resources, and enhances productive opportunities for low-income households. By contrast, the limited effect of loans highlights persistent segmentation within credit markets, where formal lending often remains concentrated among relatively advantaged groups. Consequently, expanding credit supply alone is insufficient to ensure equitable resource allocation unless institutional and informational frictions are effectively addressed.

From a macroeconomic standpoint, the positive association between inequality, GDP growth, and inflation suggests that financial inclusion interacts with broader structural development dynamics rather than operating in isolation. The pronounced impact of unemployment further indicates that inclusion policies must be coordinated with labor market strengthening and human capital formation—particularly through education—to foster genuinely inclusive growth. Addressing institutional weaknesses and informational asymmetries is therefore essential to transforming financial access into sustained economic empowerment.

Limitations

Methodologically, the study provides robust associations by estimating fixed effects; however, limitations remain because this study focuses on the Andean Community of Nations (CAN), a subregional bloc characterized by relatively similar institutional and financial development trajectories. While this improves internal comparability and analytical consistency, the findings are intrinsically rooted in this specific regional configuration, which could limit interregional generalization. Therefore, the results should be interpreted within the structural and historical context of the CAN economies. The use of macroeconomic data strengthens comparability between countries and the robustness of the panel estimation, but they only capture aggregate dynamics rather than intra-country heterogeneity. Therefore, the results reflect macro-level structural relationships between financial inclusion and income distribution and may obscure important microeconomic relationships or differences, such as urban-rural financial access, or by income level or age range. Similarly, the use of aggregate annual indicators may obscure short-term dynamics. Finally, although the inclusion of lagging variables mitigates endogeneity, omitted variable bias cannot be completely ruled out, since the indicators used to measure financial inclusion were limited to the dimensions of access and use (accounts, ATMs, branches, and borrowers) which, despite being widely accepted, do not fully incorporate complementary aspects such as service quality and financial education.

Future research

Future research should explore nonlinear and threshold models to better capture interactions among financial development, institutional quality, and income distribution. Expanding datasets to other Latin American regions and incorporating microeconometric analyses at household or firm levels would strengthen the causal understanding of how financial inclusion operates across diverse socioeconomic contexts, ultimately guiding more equitable and effective financial inclusion policies.

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Anexx 1. Model validation tests

Test	Model 1: All variable	Model 2: Branches	Model 3: ATM´s	Model 4: Borrowers	Model 5: Accounts
LM (p-value)	1.0000	1.0000	1.0000	1.0000	1.0000
Hausman test (χ^2, p-value)	19.82 (0.0192)	166.75 (0.0000)	16.45 (0.0213)	55.17 (0.0000)	39.59 (0.0000)
F-test for individual effects	0.0000	0.0000	0.0020	0.0000	0.0000
Wald heteroskedasticity	0.0000	0.08987	0.0040	0.0000	0.0248
Wooldridge test (p-value)	0.8786	0.0143	0.0204	0.0319	0.0248

Note: Prepared by the authors based on STATA results

Anexx 2. Correlation Matrix

	Gini	Bran	ATMs	Borrw	Acoun	ComApe	PubSpe	PIBpc	Inf	Unemp	Secrat
Gini	1.0000										
Bran	-0.1534	1.0000									
ATMs	-0.6348*	0.0786	1.0000								
Borrw	-0.0662	-0.1738	0.3592*	1,0000							
Acoun	-0.4032*	-0.0357	0.7675*	0.6524*	1.0000						
ComApe	-0.1029	0.2033	-0.2833*	-0.5517*	-0.6896*	1.0000					
PubSpe	-0.0686	0.5823*	0.0852	-0.3241*	-0.0290	0.1897*	1.0000				
PIBpc	0.1252	-0.1251	-0.2540*	-0.0510	-0.1650	0.2367*	-0.2721*	1.0000			
Inf	0.3326*	-0.0060	-0.0712	-0.1519	-0.1560	0.2658*	0.0226	0.1673	1.0000		
Unemp	0.4570*	0.0619	0.0923	0.4236*	0.5168*	-0.7354*	-0.0117	-0.1404	0.0914	1.0000	
Secrat	-0.3032*	-0.0353	0.6055*	0.1806	0.6262*	-0.4391*	0.3226*	-0.1145	-0.0222	0.2711*	1.0000

Note: Prepared by the authors based on STATA results