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Does financial inclusion reduce poverty and income inequality in developing countries? A panel data analysis

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Abstract

Financial inclusion is a key element of social inclusion, particularly useful in combating poverty and income inequality by opening blocked advancement opportunities for disadvantaged segments of the population. This study intends to investigate the impact of financial inclusion on reducing poverty and income inequality, and the determinants and conditional effects thereof in 116 developing countries. The analysis is carried out using an unbalanced annual panel data for the period of 2004–2016. For this purpose, we construct a novel index of financial inclusion using a broad set of financial sector outreach indicators, finding that per capita income, ratio of internet users, age dependency ratio, inflation, and income inequality significantly influence the level of financial inclusion in developing countries. Furthermore, the results provide robust evidence that financial inclusion significantly reduces poverty rates and income inequality in developing countries. The findings are in favor of further promoting access to and usage of formal financial services by marginalized segments of the population in order to maximize society's overall welfare.

Keywords: Financial inclusion, Poverty, Income inequality, Developing countries

JEL Classification: G21, I32, O11, O15, O16, O53, O54, O55

1 Introduction

Financial inclusion connotes all initiatives that make formal financial services accessible and affordable, primarily to low-income people. In recent years, financial inclusion has been perceived as a dynamic tool for attaining multidimensional macroeconomic stability, sustainable and inclusive economic growth, employment generation, poverty reduction, and income equality for advanced and developing countries[1] alike. Moreover, financial inclusion seems an incremental and complementary approach to meeting the United Nations' Millennium Development Goals (Chibba 2009). The emergence of financial inclusion promotes social inclusion through convenient access, availability,

[1] This study defines developing countries or regions following World Bank-classified income groups of economies including low-income economies, lower-middle income economies, and upper-middle income economies in Asia, Africa, and Latin America and the Caribbean region depending on gross national income per capita of US$12,375 or less, calculated using the Atlas method.

and usage of rules-based formal financial services by the "newly banked". These are generally underprivileged population segments, vulnerable groups such as rural dwellers, women, and low-income families who benefit enormously from basic financial services like savings, borrowings, payment, and insurance (World Bank 2014). Due to insufficient income levels and market discrimination in developing regions, there are still millions of people involuntarily excluded from the financial system, which creates potential loss of savings, investable funds, and accumulation of wealth. Financial inclusion helps to fill these gaps and provide households and firms greater access to resources needed for finance consumption and investment and thereby raise the level of economic activity. In addition, financial inclusion makes growth inclusive: access to finance can enable economic agents to take part in long-term participatory investment activities, facilitate efficient allocation of productive resources and thus reduce the cost of capital, cope with unexpected short-term shocks, significantly improve day-to-day management of finances, and reduce usually exploitative informal sources of credit (Demirgüç-Kunt et al. 2015, 2018).

Despite decades of rapid progress in reducing poverty and boosting prosperity, a large portion of the world's poorer population still struggles to attain a minimum standard of living across developing regions, especially in Asia, Africa, and Latin America and the Caribbean. Progress in reducing extreme poverty seems uneven in these regions because of geographical and country-specific factors. The World Bank (2016) reports that more than half of the world's extreme poor (50.7%) live in sub-Saharan Africa. Asia contains 42.7% of the world's poor, though the whole region has a strong historical performance in reducing overall poverty by virtue of massive growth in emerging large economies. Latin America and the Caribbean contain the next-highest portion of the world's poor (4.4%).

Poverty reduction in developing regions is slowing because of the prevailing nature of extreme income inequality, which is considered a powerful threat to economic progress. To this end, the World Bank set goals to end extreme poverty by 2030 and raise the shared prosperity of the bottom 40% of people in each country through reducing income inequality.

Therefore, financial inclusion has moved up the global reform agenda and gained great interest for its potential to break the vicious cycle of poverty and lower income inequality. Real-world financial systems are far from inclusive, so more emphasis is being placed on financial inclusion, which reflects its potentially transformative power to accelerate inclusive development. Given its multifaceted implications, financial inclusion represents a core topic for the World Bank (2014). The United Nations member countries have included financial inclusion as a formal target and a key objective in their development agenda (Sahay et al. 2015). Despite progress in this direction, evidence on the macroeconomic effects of financial inclusion is limited due to inconsistent macro-level data across countries. Many studies have investigated the determinants of financial inclusion, appropriate measures of financial inclusion at the individual and country level, and effective types of financial services on the user level. There is also evidence on financial inclusion's effects on economic growth, financial stability, female empowerment, poverty alleviation, and income inequality, which has laid the foundation for this field of research. However, these studies are not enough to understand the broader

macroeconomic implications of financial inclusion. This study seeks to take another step in the existing literature by examining the relationship between financial inclusion, poverty, and income inequality, sampling entire developing countries, focusing on Asia, Africa, and Latin America and the Caribbean region, whose level of voluntary as well as involuntary financial exclusion is relatively higher than that of other countries. Thus, this study addresses the following questions: *first,* what are the crucial factors that affect the level of financial inclusion in developing countries? *Second,* does financial inclusion reduce poverty and income inequality in developing countries? *Third,* are there any conditions under which financial inclusion can play a more effective role in reducing poverty and income inequality in developing countries?

This study contributes to the following existent financial inclusion related literature. *First,* it constructs a novel index of financial inclusion using a broad set of financial sector outreach indicators with an extensive panel data set of 2004–2016, following Sarma's multidimensional approach (2012). *Second,* it identifies the determinants of financial inclusion and analyzes the impact of financial inclusion on reducing poverty and income inequality, focusing on entire developing countries in Asia, Africa, and Latin America and the Caribbean region. *Third,* it assesses conditional relationships between financial inclusion and other micro- or macroeconomic factors under which financial inclusion mitigates poverty and income inequality in developing countries. To our knowledge, there are no empirical studies that broadly examine the indirect provisions through which financial inclusion reduces poverty and income inequality. *Fourth,* it analyzes all major relationships between variables using a panel data set and fixed effect model to properly process endogeneity associated with financial inclusion.

This study finds that per capita real GDP and ratio of internet users positively influence the level of financial inclusion in developing countries, while age dependency ratio, inflation, and income inequality have a detrimental effect. Our results show robust evidence that economies with higher financial inclusion significantly reduce poverty rates and income inequality in developing countries. Moreover, the interaction terms of financial inclusion with GDP growth and secondary school enrollment ratio are statistically significant for poverty, whereas the interaction terms of financial inclusion with GDP growth and rule of law are statistically significant for income inequality. This suggests that the effectiveness of financial inclusion depends not only on itself, but also on other conditions in reducing poverty and income inequality.

The remainder of the paper is organized as follows. Chapter 2 reviews existing literature related to the topic. Chapter 3 reveals the empirical methodology, data measurement, and construction of the composite financial inclusion index for testing impacts through regression analysis. Chapter 4 presents the empirical results and discussions, and Chapter 5 concludes with a summary of our findings and policy implications.

2 Empirical literature review

This chapter initially reviews the concepts and measurement issues of financial inclusion, and the factors which significantly affect the level thereof; then it reviews the available evidence on financial inclusion's impact on poverty and income inequality.

2.1 Conceptual issues and measurement of financial inclusion

The concept of financial inclusion has been explained in diverse ways in the existing literature, but all seem to have analogous information content in terms of conclusions. The World Bank (2014) has defined financial inclusion as the share of households and firms who use financial services. Amidžić et al. (2014) defined financial inclusion as an economic state where nobody is denied access to primary financial services based on motivations other than efficiency criteria. Demirgüç-Kunt et al. (2013) conceptualized financial inclusion as the use of formal financial services among different groups that benefit the welfare of many individuals. Sahay et al. (2015) said that financial inclusion is the access, usage, and delivery of financial services at affordable costs to vulnerable segments of society, while Sarma (2012) gave a comprehensive definition of financial inclusion based on several dimensions including accessibility, availability, and usage of the formal financial system for all members of an economy.

Although there is consensus on the concept of financial inclusion, existing literature lacks a standard method by which financial inclusion can be measured across economies. Honohan (2007, 2008) constructed a financial access indicator by combining bank and MFI account numbers from household survey cross-sectional data in a limited number of countries. Amidžić et al. (2014) constructed a composite financial inclusion index by including outreach dimension (geographic and demographic penetration) and usage dimension (depositors and borrowers). They normalized each variable, statistically identified for each dimension using factor analysis, assigned weights to variables and sub-indices, and then aggregated the data through weighted geometric average. Cámara and Tuesta (2014) constructed a composite financial inclusion index by estimating three sub-indices covering usage dimension, access dimension, and barriers dimension (obstacles causing involuntary exclusion); dimension weights were estimated endogenously by employing a two-stage principal component analysis. Sarma (2012) proposed a multidimensional index of financial inclusion by combining accessibility, availability, and usage dimension, which satisfies some vital mathematical properties and is comparable across countries and over time. He computed a dimension index for each dimension, aggregated each index based on normalized Euclidian distance of achievement points from a worst and an ideal situation, and then took a simple average. This study uses Sarma's approach.

2.2 Empirical evidence on determinants of financial inclusion

There have been a number of empirical studies concentrating on the factors that affect a country's level of financial inclusion, but the results show no consensus. Sarma and Pais (2008, 2011) examined country-specific factors associated with the level of financial inclusion by using a classical OLS method for the sample year of 2004. Among possible variables, income measured by per capita GDP, adult literacy, rural population, income inequality, physical connectivity indicated by road network, electronic connectivity indicated by phone subscriptions, information availability indicated by internet usage, bank soundness measured by non-performing assets and capital asset ratio, and foreign ownership in the banking sector were significantly associated with the level of financial inclusion.

Evans and Adeoye (2016) evaluated the determinants of financial inclusion in Africa by using a dynamic panel data approach for 15 countries over the period of 2005–2014. The results show that lagged financial inclusion (implies a "catch-up effect"), GDP per capita, money supply as a percentage of GDP, adult literacy rate, internet access, and Islamic banking activities have great significance in explaining the level of financial inclusion in Africa. Allen et al. (2014) found that population density and GDP per capita are strongly positively linked, whereas natural resources are strongly negatively linked to both financial development and financial inclusion in sub-Saharan Africa than elsewhere in the world.

Rojas-Suarez and Amado (2014) analyzed the relevant factors explaining Latin America's financial inclusion gap relative to comparable countries and found that the core obstacles were socio-economic factors (represented as income inequality) and institutional deficiencies (measured as rule of law), while macroeconomic weaknesses (represented as inflation volatility) and financial sector inefficiencies (measured as overhead cost and bank concentration) were relatively less important factors in Latin America's low level of financial inclusion.

2.3 Empirical evidence on financial inclusion, poverty, and income inequality

Due to the limited time span of available data and a large number of missing data regarding financial inclusion, the literature's empirical impact analysis seems to cover this topic only partially. Only a few studies have investigated the link between financial inclusion, poverty, and income inequality, with mixed results. Park and Mercado (2015) tested the factors influencing financial inclusion and the significance of financial inclusion in reducing poverty and lowering income inequality, focusing on 37 developing Asian economies. They found that per capita income, rule of law, and demographic structure increased financial inclusion, while a higher age-dependency ratio significantly reduced financial inclusion. Primary education completion and literacy rates have no significant effect on the level of financial inclusion in developing Asia. Moreover, financial inclusion significantly reduces poverty; there is also evidence that it lowers income inequality when more regressors are considered.

In the latest version of their paper, Park and Mercado (2018) assessed the cross-country impact of financial inclusion on poverty and income inequality across country income groups by introducing a new financial inclusion index for 151 economies, using principal component analysis and a cross-sectional approach. The results indicate that higher financial inclusion significantly co-varies with higher economic growth and lower poverty rates, but only for high and middle-high-income economies, not those that are middle-low and low-income. However, they did not find significant effect of financial inclusion on income inequality in any income group.

Honohan (2007, 2008) examined the fraction of the adult population using formal financial intermediaries for 162 economies and its relationship with poverty and inequality. The composite financial access indicator was constructed by using a cross-sectional series that combined both household survey data sets and published data. The results show that financial access significantly reduced poverty on its own, but not when other control variables were included as regressors, such as per capita income, private credit

as a percentage of GDP, inflation, institutions (KKZ index), institutions (freedom house bank), population size, and a sub-Saharan Africa dummy. Furthermore, there was evidence that financial access significantly reduced income inequality on its own and also when financial depth measure (private credit as a percentage of GDP and inflation) was included, but the result did not hold when per capita income and a sub-Saharan Africa dummy were included.

Jabir et al. (2017) analyzed the effect of financial inclusion on reducing poverty among the low-income household level for 35 countries in sub-Saharan Africa. Taking cross-sectional data of 2011, they found that financial inclusion significantly reduced the level of poverty in sub-Saharan Africa through providing net wealth and larger welfare benefits to the poor.

Swamy (2014) found that gender dimension, particularly poor women's participation in financial inclusion programs in general, had a strong impact on increasing household income and improving family well-being in India. Burgess and Pande (2005) revealed that state-led bank branch expansions into rural unbanked locations significantly reduced rural poverty in India through access to formal sector credit provision and saving opportunities. Brune et al. (2011) determined that increased financial access by offering commitment savings accounts to poor smallholder cash-crop farmers in Malawi had a substantial impact on their well-being, as it provided access to funds for agricultural input.

García-Herrer and Turégano (2015) assessed the role of both dimensions of financial development (size of the financial sector and financial inclusion) in reducing income inequality. They found that financial inclusion contributed to reducing income inequality when the regression was controlled for key relevant factors, especially economic development and fiscal policy. Interestingly, financial deepening (size of the financial system) did not appreciably contribute to a more equal income distribution. Dabla-Norris et al. (2015) stated that reducing financial participation and monitoring costs and relaxing collateral constraints helped to encourage growth and lower inequality in Latin America and the Caribbean, though trade-offs were likely.

Salazar-Cantú et al. (2015) investigated the effect of financial inclusion on inequality in income distribution based on regional information in Mexico. The results indicated that higher financial inclusion would initially lead to greater income inequality, but later reduce inequality significantly as financial inclusion continued to grow within Mexican municipalities.

Although all of these studies suggest links between financial inclusion, poverty, and income inequality, they lack a comprehensive understanding of their relationship due to their lack of panel data study and a limited set of variables for constructing a financial inclusion index. This study tries to expand on existing literature regarding impact analysis of financial inclusion on poverty and income inequality with a broad set of variables for financial inclusion index, and a panel data set consisting of a large number of developing countries in Asia, Africa, and Latin America and the Caribbean.

3 Methodology

Based on previous studies, this chapter specifies an econometric model to analyze crucial factors that influence the level of financial inclusion, impact of financial inclusion on reducing poverty and income inequality, and conditional relationships of financial inclusion in reducing poverty and income inequality in developing countries. We then describe key measurements issues and compilation of data from different sources. Moreover, we explain the derivation of the three dimensions of financial inclusion by incorporating proxy variables and the construction of a composite financial inclusion index for using that index in different regression models.

3.1 Model specification

This study follows a dynamic panel regression framework and uses a fixed effect estimation method for empirical analysis. The Hausman test also supports the fixed effect model over the random effect model, as it rejects the null hypothesis at 1% significance level. For the econometric analysis, this study uses a one-way error component fixed effect model and robust standard errors to address heteroskedasticity. The explanatory variables in different regression equations mostly follow previous studies by Honohan (2007, 2008), Sarma and Pais (2008, 2011), Allen et al. (2014), Rojas-Suarez and Amado (2014), Swamy (2014), Alter and Yontcheva (2015), García-Herrer and Turégano (2015), Park and Mercado (2015, 2018), Evans and Adeoye (2016), Schmied and Marr (2016), Aslan et al. (2017), and Jabir et al. (2017).

For *determining the crucial factors that influence the level of financial inclusion* in developing countries, the following regression equation is specified:

$$\begin{aligned} cfii_{i,t} = {} & \alpha_0 + \beta_1 lngdppc_{i,t} + \beta_2 rule_{i,t} + \beta_3 lnpopu_{i,t} + \beta_4 lnagedep_{i,t} + \beta_5 lninflation_{i,t} \\ & + \beta_6 lngini_{i,t} + \beta_7 lnssenroll_{i,t} + \beta_8 lninternet_{i,t} + \alpha_i + u_{i,t}, \end{aligned} \tag{1}$$

where *cfii* = a composite financial inclusion index, *lngdppc* = log of per capita real GDP, *rule* = rule of law, *lnpopu* = log of total population, *lnagedep* = log of age dependency ratio, *lninflation* = log of inflation rate, *lngini* = log of Gini coefficient to measure income inequality, *lnssenroll* = log of secondary school enrollment ratio, *lninternet* = log of ratio of internet users, $i = 1,2,3,\ldots$ n country, $t = 1,2,3,\ldots$ 13 time period, α_i = the unobserved effects for ith country observation, and $u_{i,t}$ = the idiosyncratic error term for ith country on the tth year. Here, per capita income, rule of law, population size, secondary school enrollment ratio, and ratio of internet users are expected to be positively associated with financial inclusion, whereas age dependency ratio, inflation rate, and income inequality are expected to have a negative relationship with financial inclusion.

In order to analyze the relationship between *financial inclusion and poverty* in developing countries, the following regression equation is employed:

$$\begin{aligned} lnpovhead_{i,t} = {} & \alpha_0 + \beta_1 cfii_{i,t} + \beta_2 gdpgr_{i,t} + \beta_3 lngdppc_{i,t} + \beta_4 lngini_{i,t} + \beta_5 lnssenroll_{i,t} \\ & + \beta_6 lnpcredit_{i,t} + \beta_7 rule_{i,t} + \beta_8 lninflation_{i,t} + \beta_9 lngovtexp_{i,t} \\ & + \beta_{10} lntradeopen_{i,t} + \alpha_i + u_{i,t}, \end{aligned} \tag{2}$$

where *lnpovhead* = log of poverty headcount ratio, *gdpgr* = GDP growth rate, *lnpcredit* = log of credit to the private sector by banks, *lngovtexp* = log of government

expenditure, *lntradeopen* = log of trade openness, and the other specifications are similar to Eq. (1). Here, financial inclusion is expected to be negatively associated with poverty rates because higher access to financial services by lower-income people generally helps to reduce poverty by facilitating consumption and engaging in economically productive activities.

To analyze the relationship between *financial inclusion and income inequality* in developing countries, the following regression equation is employed:

$$\begin{aligned} lngini_{i,t} = {} & \alpha_0 + \beta_1 cfii_{i,t} + \beta_2 lngdppc_{i,t} + \beta_3 lnssenroll_{i,t} + \beta_4 lninflation_{i,t} + \beta_5 rule_{i,t} \\ & + \beta_6 lntradeopen_{i,t} + \beta_7 lnict_{i,t} + \beta_8 lnmobile_{i,t} \\ & + \beta_9 lnpcredit_{i,t} + \beta_{10} lngovtexp_{i,t} + \alpha_i + u_{i,t}, \end{aligned} \tag{3}$$

where *lnict* = log of ICT service exports, *lnmobile* = log of mobile cellular users, and the other specifications are similar to Eqs. (1) and (2). Here, financial inclusion is expected to be negatively associated with income inequality because higher access to financial services by lower- and irregular-income people allows them to save and build assets for the future, which helps to reduce unequal income distribution.

For analyzing *the conditional effects of financial inclusion on poverty* in developing countries, the following regression equation is used:

$$lnpovhead_{i,t} = \alpha_0 + \beta_1 cfii_{i,t} + \beta_2 gdpgr_{i,t} + \beta_3 lngini_{i,t} + \beta_4 (cfii_{i,t} * lnZ_{i,t}) + \beta_5 lnZ_{i,t} + \alpha_i + u_{i,t}, \tag{4}$$

where *cfii*lnZ* = the interaction between a composite financial inclusion index and other specific control variables (*lnZ*) that can affect the outcome of financial inclusion in reducing poverty. The other specifications are similar to the above equations.

To analyze *the conditional effects of financial inclusion on income inequality* in developing countries, the following regression equation is used:

$$lngini_{i,t} = \alpha_0 + \beta_1 cfii_{i,t} + \beta_2 lngdppc_{i,t} + \beta_3 (cfii_{i,t} * lnZ_{i,t}) + \beta_4 lnZ_{i,t} + \alpha_i + u_{i,t}, \tag{5}$$

where *cfii*lnZ* = the interaction between a composite financial inclusion index and other specific control variables (*lnZ*) that can affect the outcome of financial inclusion in reducing income inequality. The other specifications are similar to the above equations.

3.2 Measurement and sources of data

The analysis uses 13 years of unbalanced annual panel data for the period of 2004–2016. By excluding developed countries, 116 developing countries are taken in total from three regions: 36 countries from Asia, 53 countries from Africa, and 27 countries from Latin America and the Caribbean (Appendix A). Most of the variables are chosen from empirical literature, with some additional variables and modifications. Due to excessive fluctuations of the data among economies, almost all of the variables (except for financial inclusion index, GDP growth rate, and rule of law) are expressed in logarithm scale in order to improve the robustness of empirical analysis. The data set is compiled from the Financial Access Survey (FAS) database of the International Monetary Fund (IMF), Standardized World Income Inequality Database (SWIID), World Development

Indicator (WDI), and World Governance Indicator. A detailed description of variables and their sources is presented in Appendix B.

3.3 Construction of composite financial inclusion index (CFII)

Constructing a composite financial inclusion index (CFII) is the study's preliminary and principal task before testing the significance of financial inclusion with other variables. Such a comprehensive measure of financial inclusion is needed to check the extent of financial inclusion across economies, standardize the measure for a large number of developing economies, monitor progress in reaching national financial inclusion targets, and make cross-country comparisons. This study considers a variety of financial sector outreach indicators under three basic dimensions of an inclusive financial system such as penetration, availability, and usage of financial services, with relevant and consistent macro-level data for a large number of developing economies. The data are collected from the Financial Access Survey (FAS) database of the International Monetary Fund (IMF).[2] All of the data for computing each dimension are a panel spanning the period of 2004–2016.

3.3.1 Penetration dimension

This reflects the maximum number of users entered into the formal financial system. Here, penetration of financial services is indicated by the number of deposit accounts with financial institutions per 1000 adults (Honohan 2007; Sarma 2012; Cámara et al. 2014; Rojas-Suarez and Amado 2014; García-Herrer and Turégano 2015) and the number of depositors with financial institutions per 1000 adults (Honohan 2007; Amidžić et al. 2014; Park and Mercado 2015; Evans and Adeoye 2016). Then a weighted average of these two indices is considered, using 0.70 weight for the deposit account index and 0.30 weight for the depositor index. As deposit accounts index is an imperative indicator to identify the size of the banked population and a measure of more consolidated stages of financial system, we assign a weighted average of 0.70 for this index. Furthermore, the depositor index gets less weight of 0.30, as all depositors who have deposit accounts are not active in the financial system. Finally, as penetration in the financial system is the primary measure of financial inclusion and data in determining whether an individual has penetrated in the financial system are also available, we assign an overall weight of 1 to the penetration dimension for calculating CFII.

3.3.2 Availability dimension

This indicates the depth of geographic or demographic penetration of financial services in the form of financial institutions' outlets, such as offices, branches, and ATMs. Here, availability of financial services is indicated by two indicators: the number of financial

[2] The FAS database is the primary source of supply-side cross-country data surveys on financial services gathered from financial regulators. It provides insights on the access, availability, and usage of financial services by households and firms for 189 reporting jurisdictions, covering 99% of the world's adult population. This database contains 152 series, resulting in 47 basic indicators that are expressed as the ratios to GDP, geographic outreach, and adult population.

Table 1 List of indicators for constructing CFII

Dimension of financial inclusion	Variables	Weight to each indicator
Penetration dimension (overall dimension weight to calculate *CFII* = 1)	Number of deposit accounts with financial institutions per 1000 adults	0.70
	Number of depositors with financial institutions per 1000 adults	0.30
Availability dimension (overall dimension weight to calculate *CFII* = 0.60)	Number of financial institution's branches per 100,000 adults	0.70
	Number of automated teller machines (ATMs) per 100,000 adults	0.30
Usage dimension (overall dimension weight to calculate *CFII* = 0.50)	Number of loan accounts with financial institutions per 1000 adults	0.50
	Number of borrowers from financial institutions per 1000 adults	0.50

institution's branches per 100,000 adults (Sarma 2012; Cámara and Tuesta 2014; Rojas-Suarez and Amado 2014; Park and Mercado 2015) and the number of automated teller machines per 100,000 adults (Sarma 2012; Cámara and Tuesta 2014; Rojas-Suarez and Amado 2014; Park and Mercado 2015). Then a weighted average of these two indexes are considered for this dimension, using 0.70 weight for the financial institution's branch index and 0.30 weight for the automated teller machine index.[3] Although traditional financial services are shifting towards an electronic base (internet banking, mobile banking, etc.) in many countries, the lack of consistent data creates a hurdle in using these indicators to quantify availability dimension. Thus, because of the difficulty of considering some significant indicators, this study assigns a lesser weight of 0.60 to this dimension for calculating CFII.

3.3.3 Usage dimension

This measures how regularly and adequately clients utilize financial services in different forms, such as savings, borrowings, making payments, remittances, transfers, etc. This dimension represents the efficiency of a financial system, as greater access is not enough in itself for an inclusive financial system. However, because of the unavailability of cross-country comparable data on payments, remittances, and transfers, the usage dimension only uses two indicators, the number of loan accounts with financial institutions per 1000 adults (Cámara and Tuesta 2014) and the number of borrowers from financial institutions per 1000 adults (Amidžić et al. 2014; Park and Mercado 2015). Then a weighted average of these two indices are considered in determining this dimension, using 0.50 weight for the loan account index and 0.50 weight for the borrower index. As the loan account index represents a stage of greater financial inclusion, since most people who have a loan account already have another financial product, such as a bank account or payroll account, we assign a weighted average of 0.50 for this index. Besides, the borrower index gets equal weight of 0.50, as majority of borrowers who have loan accounts are active in the financial system. Finally, we assign a relatively lesser overall weight of 0.50 to this dimension due to data unavailability of many significant indicators for calculating CFII.

[3] As per the empirical observations in the data set covering the time period of 2004–2016, the average ratio of ATM to branch per 100,000 adults is found to be 2.21, which implies that on an average per bank branch is equivalent to more than 2 ATMs. Thus, this study uses a weightage of almost 2/3 or 0.70 (rounded) for financial institution's branch index and a weightage of almost 1/3 or 0.30 (rounded) for ATM index in the availability dimension.

As assigning weights to each indicator and dimension of any index is a complex task, this study assigns weights for calculating the CFII, which is consistent with Sarma and Pais (2008), Sarma (2012), Cámara and Tuesta (2014), and Amidžić et al. (2014). Though there is a computational difference of the CFII in the empirical studies, the weights are assigned or derived based on the relevance and availability of information to measure each indicator and dimension of financial inclusion index. However, an accurate estimate of CFII is not possible due to lack of adequate and appropriate data, such as unavailability of new forms of banking data, geographical aspects of financial inclusion (rural or urban divide), gender related aspects, etc. Appropriate methods and corresponding weights for incorporating these data into the CFII could be devised when data become available. Table 1 summarizes the indicators used to compute the financial inclusion index.

This study follows the main methodology of Sarma (2012) for constructing a multidimensional index of financial inclusion. The index is constructed similarly to that used by UNDP for computation of the well-known human development index (HDI), human poverty index (HPI), gender development index (GDI), etc. However, the composite financial inclusion index is methodologically improved, as it follows the distance-based approach, unlike the UNDP's methodology of using an average of dimension indices. The index used in this study is based on a notion of distance from both the worst and ideal points with a little variation to the "method of displaced ideal" of Zeleny (1974), where only the displacement from the ideal point is considered. The distance-based approach is suitable because it satisfies essential mathematical properties like boundedness, unit-free measure, homogeneity, and monotonicity. UNDP's methodology does not satisfy all the properties due to 'perfect substitutability' across dimensions, i.e., an increase in one dimension can be compensated for by a decrease of equal (in case of arithmetic average) or proportional (in case of geometric average) magnitude in another dimension. This is not a relevant assumption in the particular case like financial inclusion, as all dimensions are assumed to be equally important for the overall index value (Desai 1991). Moreover, while the UNDP's methodology uses prefixed minimum and maximum values for each indicator to compute the dimensional index, this study uses empirically observed minimum and maximum values for a particular indicator of financial inclusion, as the values are not straight forward in that case. In computing the CFII, the initial step is to compute indices for each dimension of financial inclusion (penetration, availability, and usage) by using the following formula:

$$d_i = w_i \frac{A_{ik,t} - m_i}{M_i - m_i}, \tag{6}$$

where d_i = the index/indicator value for the dimension i; w_i = weight attached to a certain indicator for the dimension i; A_i = actual value of a certain indicator for dimension i for an economy k on the year t; m_i = lower limit of a certain indicator for dimension i, fixed by assigning 0; and M_i = upper limit of a certain indicator for dimension i, fixed by taking the 90th percentile value (the upper limit is fixed here to remove excessively high benchmarks and smooth the value of the index).

From Eq. (6), the value of d_i is the normalized value of any indicator for any specific dimension where the higher value of d_i indicates higher achievement of an economy therein. The last step is to compute the CFII for an economy i by using the following

formulae, based on a notion of distance of achievement point ($X=d_1, d_2, d_3$) from a worst ($O=0, 0, 0, 0$) and an ideal situation ($W=w_1, w_2, w_3$):

$$X_1 = \frac{\sqrt{d_1^2 + d_2^2 + \cdots + d_n^2}}{\sqrt{(w_1^2 + w_2^2 + \cdots + w_n^2)}}, \tag{7}$$

$$X_2 = 1 - \frac{\sqrt{(w_1 - d_1)^2 + (w_2 - d_2)^2 + \cdots + (w_n - d_n)^2}}{\sqrt{(w_1^2 + w_2^2 + \cdots + w_n^2)}}, \tag{8}$$

$$\text{CFII}_i = \frac{1}{2}[X_1 + X_2]. \tag{9}$$

The equation for X_1 (7) provides normalized Euclidian distance between the achievement position X and the worst position O on the nth-dimensional space. The equation for X_2 (8) represents the normalized inverse Euclidian distance between the achievement position X and the ideal situation W. Both these distances are normalized to position them between 0 and 1. Finally, the CFII (Eq. 9) is computed by taking a simple average of Eqs. (7) and (8). Here, a larger distance between X and O would indicate higher financial inclusion, and a smaller distance between X and W would indicate higher financial inclusion. Thus, the CFII is a number that lies between 0 and 1 (meaning that the index has well-defined bounds) and is monotonically increasing (meaning that a higher value of the index indicates a higher level of financial inclusion).

4 Empirical results and discussion

This chapter shows the empirical results and discussions in different sections. First, it presents the findings on the crucial factors that influence the level of financial inclusion in developing countries. Then it reports our findings on the impact of financial inclusion

Table 2 Determinants of financial inclusion (fixed effect estimation)

Variables	(1) *cfii*	(2) *cfii*	(3) *cfii*
lngdppc	0.476*** (0.0684)	–	0.460*** (0.0745)
lnagedep	–	− 0.777*** (0.173)	− 0.491*** (0.141)
lninflation	− 0.00699* (0.00393)	− 0.0129*** (0.00472)	− 0.0153*** (0.00466)
lngini	− 0.609*** (0.221)	− 0.645** (0.303)	− 0.498** (0.225)
rule	0.0146 (0.0389)	0.102 (0.0619)	0.0416 (0.0485)
lnpopu	− 0.000729 (0.0975)	− 0.243 (0.200)	− 0.154 (0.144)
lnssenroll	–	0.0460 (0.0500)	− 0.0283 (0.0377)
lninternet	–	0.0388** (0.0187)	0.00682 (0.0149)
Constant	− 1.090 (1.722)	9.718*** (3.695)	3.298 (2.955)
Observations	897	644	638
R-squared	0.538	0.488	0.602
Number of id	106	95	94

The dependent variable is composite financial inclusion index. For details of the explanatory variables, see Appendix B. All standard errors are robust and reported in parentheses. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively

on poverty and income inequality, and the findings on the conditional relationships of financial inclusion on poverty and income inequality.

4.1 Findings on the determinants of financial inclusion

Table 2 presents our empirical findings on the crucial factors that influence the level of financial inclusion in developing countries. Different macroeconomic variables and models are included to check the robustness of the regression results. Model (1) includes per capita real GDP with a reduced number of control variables, while model (2) excludes per capita real GDP, as it is strongly correlated with age dependency ratio (the pairwise correlation is −0.7733), secondary school enrollment ratio (0.7748), and ratio of internet users (0.8026). Model (3) includes all the control variables in order to see the combined outcome.

The fixed effect estimates show that per capita real GDP, age dependency ratio, inflation rate, ratio of internet users, and income inequality significantly influence the level of financial inclusion in developing countries. In particular, per capita real GDP and ratio of internet users positively influence the level of financial inclusion, while age dependency ratio, inflation rate, and income inequality have a negative influence.

The coefficient for *per capita real GDP* is positive and highly significant, suggesting that countries with higher per capita income experience higher financial inclusion. This finding is consistent with Sarma and Pais (2011), Chithra and Selvam (2013), Allen et al. (2014), Cámara and Tuesta (2014), Cámara et al. (2014), Rojas-Suarez and Amado (2014), Park and Mercado (2015), Tuesta et al. (2015), and Evans and Adeoye (2016).

Ratio of internet users is also positive and significantly associated with financial inclusion, meaning that connectivity and access to information through internet subscriptions enhance financial inclusion by facilitating easy mobility of financial services, a finding similar to Sarma and Pais (2011) and Evans and Adeoye (2016). However, the evidence is mild in the sense that the ratio of internet users loses its significance when per capita income is considered in the model.

On the other hand, *age dependency ratio* is negative and highly significant, indicating that economies with a high dependency ratio in the form of a rapidly aging population or too young-aged population have lower access to financial services. This result supports the empirical finding of Park and Mercado (2015).

Inflation has a negative and highly significant impact on the level of financial inclusion, suggesting that countries with high inflation volatility experience low financial inclusion, as the value of savings decreases in the financial system. This finding is similar to Allen et al. (2014) and Rojas-Suarez and Amado (2014), but contradicts Evans and Adeoye (2016), who find an insignificant impact of inflation on the level of financial inclusion.

Income inequality as measured by Gini coefficient is also negative and significantly associated with financial inclusion, indicating that countries with a highly skewed distribution of income lead to worsening household financial inclusion as they block or manipulate financial reforms so as to maintain upper-income benefits. This finding is consistent with Sarma and Pais (2011) and Rojas-Suarez and Amado (2014).

Interestingly, there is no evidence of a significant effect of *rule of law*, *population size*, and *secondary school enrollment ratio* on the level of financial inclusion in developing countries. As expected, good governance and high institutional quality through

Table 3 Financial inclusion and poverty (fixed effect estimation)

Variables	(1) *lnpovhead*	(2) *lnpovhead*	(3) *lnpovhead*	(4) *lnpovhead*	(5) *lnpovhead*
cfii	−2.709*** (0.433)	−2.050*** (0.515)	−1.561*** (0.527)	−1.559*** (0.513)	−1.430*** (0.465)
gdpgr		0.0126* (0.00695)	0.0128* (0.00701)	0.0115 (0.00742)	0.00580 (0.00713)
lngini		4.227*** (1.436)	3.667*** (1.319)	3.395** (1.366)	3.468*** (1.244)
lnssenroll			−0.459* (0.256)	−0.560** (0.257)	−0.481** (0.240)
lnpcredit			−0.180 (0.212)	−0.232 (0.220)	−0.243 (0.212)
rule				0.196 (0.273)	0.166 (0.256)
lninflation				−0.0576 (0.0440)	−0.0883** (0.0373)
lngovtexp					−0.421 (0.316)
lntradeopen					0.359 (0.312)
Constant	2.664*** (0.133)	−13.42** (5.478)	−8.992* (5.397)	−7.132 (5.643)	−8.131 (5.230)
Observations	385	384	306	294	290
R-squared	0.359	0.432	0.489	0.501	0.514
Number of id	96	96	77	76	73

The dependent variable is poverty headcount ratio. For details of the explanatory variables, see Appendix B. All standard errors are robust and reported in parentheses. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively

strengthening the rule of law is more likely to reduce involuntary financial exclusion. Although our result is positive in this respect, it is insignificant, which disagrees with Honohan (2008), Allen et al. (2014), Rojas-Suarez and Amado (2014), and Park and Mercado (2015). Economies with large population sizes are expected to have greater access to financial services due to convenient networking effects. This result is not positive and significant, which contrast with the findings of Chithra and Selvam (2013), Allen et al. (2014), and Park and Mercado (2015). Education in the form of a higher secondary school enrollment ratio is also expected to raise financial inclusion. This result is not significant, which is consistent with Honohan (2008), Allen et al. (2014), and Park and Mercado (2015).

4.2 Findings on the impact of financial inclusion on poverty

Table 3 presents our empirical findings on the impact of financial inclusion on poverty in developing countries. This analysis starts from a parsimonious model that considers only one variable and gradually considers additional control variables. It should be noted that considering additional control variables across models significantly reduces the number of observations, as some countries are dropping out from the sample due to data unavailability.

The fixed effect estimates show that there is a highly significant negative association between *financial inclusion and poverty* across the models. This implies that economies with higher financial inclusion have strongly lower poverty rates in developing countries. This result is highly significant with expected negative signs, even after controlling for many control variables. The finding for the main variable of interest of this study is consistent with Burgess and Pande (2005), Brune et al. (2011), Swamy (2014), Park and Mercado (2015, 2018), and Jabir et al. (2017), who also found

a significant effect of financial inclusion on reducing poverty. But when per capita income is added to the specification, the effect of financial inclusion on reducing poverty seems insignificant across the models, though the relationship remains negative. This finding is suggestive that financial inclusion is strongly correlated with per capita income (the pairwise correlation is 0.7269), and per capita income is highly correlated with poverty rates (−0.6249). Also, at any given income level, the percentages of access to financial services vary widely. This finding is similar to Honohan (2007, 2008), who found an insignificant effect of financial inclusion on reducing poverty when per capita income is included as a regressor. Park and Mercado (2015, 2018) did not control for per capita income in their specification, probably because financial inclusion becomes insignificant in the regression in the presence of per capita income.

The robustness of the above findings is checked by conducting a 3-year average panel data analysis and cross-sectional analysis. For a 3-year average panel analysis, data for the initial year of 2004 are dropped because of data scarcity and the necessity of matching whole sample periods into similar groups (i.e., by excluding 2004 data, the remaining 12 sample periods turn into 4 groups). The 3-year average fixed effect estimates show that financial inclusion is highly significant in reducing poverty rates in developing countries, and the results are robust across the models. By taking the period average values of cross-sectional data and applying OLS regression method, the results are also robust, suggesting that financial inclusion will be effective in reducing poverty in developing countries in the long term. As the main variable of interest could possibly be endogenous in the form of reverse-causality or omitted variable bias, it may lead to a biased estimation of coefficients. To deal with this issue, a two-stage least squares (2SLS) estimation is applied by using *latitude* and *ethnic fractionalization index* as instrumental variables, but the Stock and Yogo test (2005) indicated that both of these instrumental variables are implausible. Alternatively, the system generalized method of moments (GMM) is inconsistent because huge missing variables of the poverty headcount ratio in the sample periods render the lagged independent variable ineffective as a tool variable. However, Honohan (2007) mentioned that potential endogeneity is not a serious problem in explaining poverty or inequality, as it would be in explaining growth or income levels.

Among other control variables, *secondary school enrollment ratio* is significantly related to poverty with expected negative signs, meaning that a higher level of education increases the knowledge, skills, and productivity of poor households, and enhances their income level, which helps to reduce poverty rates. Contrary to expectations, *inflation* is negatively significant, suggesting that higher inflation reduces poverty in developing countries. The probable reason is that as inflation depreciates higher income people's value of cash holdings, inflation encourages the rich to invest their idle cash holdings into real capital expenditures, which in turn employs more unemployed low-income people and thereby reduces poverty rates. On the other hand, *income inequality* as measured by Gini coefficient is significantly related to poverty with expected positive signs, indicating that income inequality is detrimental to reduced poverty rates because countries with high initial levels of inequality favor the non-poor. *GDP growth* is positively significant, indicating that higher GDP growth increases poverty, but it loses

Table 4 Financial inclusion and income inequality (fixed effect estimation)

Variables	(1)	(2)	(3)	(4)	(5)
	lngini	*lngini*	*lngini*	*lngini*	*lngini*
cfii	−0.131*** (0.0332)	−0.121*** (0.0361)	−0.113*** (0.0330)	−0.109*** (0.0332)	−0.101*** (0.0343)
lngdppc		−0.0204 (0.0293)	−0.0415 (0.0315)	−0.0288 (0.0423)	−0.0290 (0.0476)
lnssenroll		−0.00766 (0.0248)	−0.0150 (0.0236)	−0.00414 (0.0391)	0.00109 (0.0391)
lninflation		−0.00284 (0.00178)	−0.00246 (0.00184)	−0.00149 (0.00195)	−0.00182 (0.00210)
rule			0.0559** (0.0215)	0.0504* (0.0277)	0.0529* (0.0276)
lntradeopen			−0.000612 (0.0102)	−0.0216 (0.0231)	−0.0217 (0.0229)
lnict				−0.00303 (0.00563)	−0.00299 (0.00533)
lnmobile				−0.00577 (0.00568)	−0.00497 (0.00553)
lnpcredit					−0.00555 (0.0122)
lngovtexp					−0.0155 (0.0232)
Constant	3.753*** (0.00762)	3.945*** (0.200)	4.174*** (0.225)	4.154*** (0.350)	4.191*** (0.392)
Observations	953	654	633	558	551
R-squared	0.162	0.190	0.253	0.287	0.291
Number of id	108	95	94	87	85

The dependent variable is income inequality measured by Gini coefficient. For details of the explanatory variables, see Appendix B. All standard errors are robust and reported in parentheses. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively

significance when more control variables are considered. Other variables, such as *rule of law* and *trade openness*, show insignificant positive signs, while *credit to private sector by banks* and *government expenditure* show insignificant negative effects on poverty rates.

4.3 Findings on the impact of financial inclusion on income inequality

Table 4 presents our empirical findings on the impact of financial inclusion on income inequality in developing countries.

The fixed effect estimates show that there is a highly significant negative association between *financial inclusion and income inequality* across the models. This implies that higher financial inclusion is effective in reducing income inequality in developing countries. This result is highly significant with expected negative signs, even after controlling for many control variables. The finding for the main variable of interest of this study is consistent with Dabla-Norris et al. (2015), García-Herrer and Turégano (2015), and Salazar-Cantú et al. (2015), but differs significantly from Honohan (2007, 2008) and Park and Mercado (2015), who found little econometric evidence that financial inclusion lowers income inequality. Moreover, Park and Mercado (2018) found an insignificant relationship between financial inclusion and income inequality. These different findings may be due to differences in measuring financial inclusion, differences in sample sizes and time periods, different methodology, etc.

The robustness of the above findings is checked by conducting a 3-year average panel data analysis and cross-sectional analysis. The 3-year average fixed effect estimates show that financial inclusion is highly significant in reducing income inequality in developing

countries, and the results are robust across the models. The cross-sectional OLS regression estimates show an insignificant relationship, though the negative sign holds, suggesting that financial inclusion might not be effective in the long term in reducing income inequality in developing countries. As the main variable of interest could in principle be endogenous in the form of reverse-causality or omitted variable bias, it may lead to a biased estimation of coefficients. To deal with this issue, the system GMM is applied, and the estimates show that financial inclusion significantly reduces income inequality in developing countries. The Hansen test indicates that the instruments are valid and financial inclusion is exogenous, but the second-order serial correlation test AR (2) rejects the null hypothesis in favor of the presence of serial correlation. Alternatively, a two-stage least squares (2SLS) estimation is not considered due to the absence of plausible instrument variables.

Among other control variables, *rule of law* is positive and significantly related to income inequality, meaning that improving the rule of law tends to worsen income distribution in developing countries. A possible explanation is that institutional reforms render the informal economy ineffective, which generates higher additional costs for the poor at the early stages of development while benefiting those in the formal sector, resulting in higher income inequality. Nevertheless, better institutional quality eventually leads to improving the efficiency of the overall economy and thereby reduces income inequality. This finding is consistent with Chong and Calderón (2000), who found a positive relationship between institutional quality and income inequality. No other control variable is significant, likely due to the annual nature of the unbalanced panel study.

4.4 Findings on the conditional effects of financial inclusion on poverty

Assessing the conditional effects between financial inclusion and other micro- or macroeconomic factors is worthwhile, as the basic models of impact study only provide evidence on whether financial inclusion itself is a sufficient factor in reducing poverty and income inequality. The basic models also do not provide evidence on the factors, scenarios, and conditions under which financial inclusion is effective in influencing poverty and income inequality in an economy. Beck et al. (2009) suggested that financial access might reduce poverty and income inequality, not through direct provisions of financial services to the poor so much as indirect effects, such as more efficient products and labor. Thus, this study broadly examines which factors are favorable and which are not by employing interaction terms between financial inclusion and other control variables.

Table 5 presents our empirical findings on the conditional effects of financial inclusion on poverty in developing countries. Here, control variables and their interactions with financial inclusion are considered separately in order to determine the independent effect of those specific variables on poverty. The fixed effect estimates show that the interaction term of financial inclusion with GDP growth and secondary school enrollment ratio are statistically significant, while the interaction terms of financial inclusion with income inequality as measured by Gini coefficient, per capita income, rule of law, and inflation rate are not statistically significant for poverty in developing countries.

The *interaction term between financial inclusion and GDP growth* shows a highly significant negative effect on poverty, indicating that higher GDP growth increases the marginal effect of financial inclusion in lowering poverty rates. The result is consistent

Table 5 Conditional effects of financial inclusion on poverty (fixed effect estimation)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	lnpovhead	*lnpovhead*	*lnpovhead*	*lnpovhead*	*lnpovhead*	*lnpovhead*	*lnpovhead*
cfii	−2.050***	−1.590***	−16.74	3.883	5.722*	−1.948***	−2.096***
	(0.515)	(0.548)	(12.00)	(4.747)	(3.411)	(0.497)	(0.553)
gdpgr	0.0126*	0.0435**	0.0105	0.0165***	0.0144**	0.0127*	0.0116
	(0.00695)	(0.0170)	(0.00687)	(0.00504)	(0.00616)	(0.00708)	(0.00717)
lngini	4.227***	4.389***	3.211**	3.361***	3.653***	4.109***	4.117***
	(1.436)	(1.445)	(1.594)	(1.154)	(1.332)	(1.544)	(1.493)
*cfii*gdpgr*		−0.0871**					
		(0.0335)					
*cfii*lngini*			3.908				
			(3.170)				
*cfii*lngdppc*				−0.477			
				(0.535)			
lngdppc				−2.228***			
				(0.452)			
*cfii*lnssenroll*					−1.643**		
					(0.751)		
lnssenroll					−0.350*		
					(0.199)		
*cfii*rule*						0.322	
						(0.728)	
rule						−0.137	
						(0.310)	
*cfii*lninflation*							−0.00564
							(0.164)
lninflation							−0.0274
							(0.0508)
Constant	−13.42**	−14.19**	−9.617	6.868	−9.996*	−13.05**	−12.92**
	(5.478)	(5.520)	(6.080)	(5.962)	(5.443)	(5.903)	(5.675)
Observations	384	384	384	383	309	383	371
R-squared	0.432	0.448	0.440	0.545	0.496	0.433	0.430
Number of id	96	96	96	95	78	95	95

The dependent variable is poverty headcount ratio. For details of the explanatory variables, see Appendix B. All standard errors are robust and reported in parentheses. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively

in the sense that strong economic growth creates demand for labor, raises real wages for low-skilled jobs, improves general living standards, and generates positive cycles of prosperity and opportunity in developing countries. This leads to develop an efficient and inclusive financial system that promotes participatory investment and financial risk management from poor households and ultimately helps reduce poverty. Thus, both the pace and pattern of economic growth matter for increasing financial inclusion and lowering poverty.

The *interaction term between financial inclusion and secondary school enrollment ratio* is highly significant and negatively associated with poverty, implying that the marginal effect of financial inclusion in reducing poverty rates increases with a higher secondary school enrollment ratio. The result is consistent in the sense that the higher the level of education in poor households, the lower the poverty rates will be, as education imparts the knowledge and general workforce skills, generates

Table 6 Conditional effects of financial inclusion on income inequality (fixed effect estimation)

Variables	(1) *lngini*	(2) *lngini*	(3) *lngini*	(4) *lngini*	(5) *lngini*	(6) *lngini*	(7) *lngini*
cfii	−0.105*** (0.0345)	0.363 (0.332)	−0.114*** (0.0354)	0.342 (0.485)	−0.0749*** (0.0263)	−0.106*** (0.0341)	0.0926 (0.117)
lngdppc	−0.0269 (0.0212)	−0.0313 (0.0213)	−0.0347 (0.0213)	−0.0244 (0.0294)	−0.0228 (0.0205)	−0.0195 (0.0203)	0.0136 (0.0219)
*cfii*lngdppc*		−0.0535 (0.0369)					
*cfii*gdpgr*			0.00439*** (0.00133)				
gdpgr			−0.000511* (0.000306)				
*cfii*lnssenroll*				−0.0979 (0.108)			
lnssenroll				−0.0162 (0.0266)			
*cfii*rule*					0.136*** (0.0404)		
rule					0.00620 (0.0136)		
*cfii*lninflation*						−0.00450 (0.00763)	
lninflation						0.000570 (0.00190)	
*cfii*lnmobile*							−0.0386 (0.0238)
lnmobile							−0.00496 (0.00403)
Constant	3.952*** (0.159)	3.980*** (0.158)	4.011*** (0.159)	3.995*** (0.205)	3.927*** (0.153)	3.898*** (0.152)	3.655*** (0.160)
Observations	947	947	947	691	946	898	942
R-squared	0.166	0.181	0.184	0.196	0.241	0.168	0.205
Number of id	107	107	107	97	106	107	106

The dependent variable is income inequality measured by Gini coefficient. For details of the explanatory variables, see Appendix B. All standard errors are robust and reported in parentheses. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively

higher productivity, and raises income levels (Park and Mercado 2015). Education also indirectly influences poverty with respect to "human poverty" through the fulfillment of basic needs and raising living standards, which leads to a decrease in human poverty (Awan et al. 2011). In addition, better human development and literacy levels raise awareness and involve a large section of the lower-income population in the financial system in utilizing financial services towards reducing poverty rates in the developing countries (Atkinson and Messy 2013). Moreover, Arora (2012) suggested that measures on improving educational variables should be taken contemporaneously for increasing financial inclusion. Thus, countries with a higher education level and subsequent higher financial inclusion reduce poverty rates more quickly.

4.5 Findings on the conditional effects of financial inclusion on income inequality

Table 6 presents our empirical findings on the conditional effects of financial inclusion on income inequality in developing countries. The fixed effect estimates show that the

interaction term of financial inclusion with GDP growth and rule of law are statistically significant, while other interaction terms are not.

The *interaction term between financial inclusion and GDP growth* is highly significant and positively associated with income inequality, suggesting that higher GDP growth lowers the marginal effect of financial inclusion in reducing income inequality. The most plausible explanation is that strong economic growth creates job opportunities and provides some income to the unemployed, which reduces the level of poverty but does not reduce the level of income inequality due to the temporary nature of jobs with minimum wages (Niyimbanira 2017). Moreover, only the non-poor reap the benefits of the early stages of economic growth with a broader and persistent income gap between rich and poor. Thus, higher economic growth reduces overall incentives and benefits of poor households' access to financial services in a country with highly unequal income. However, sustained economic growth will reverse the marginal effect of financial inclusion in reducing income inequality in the long run by improving human capital and general skills level, correcting labor market policies, and better utilizing financial services.

The *interaction term between financial inclusion and rule of law* shows a highly significant positive effect on income inequality, indicating that better rule of law decreases the marginal effect of financial inclusion in reducing income inequality. The probable reason is that institutional quality improvements generate high additional costs to the poor belonging to the informal or underground sector and render the informal economy ineffective in the early stages of development, while such improvements simultaneously benefit those in the formal sector, resulting in higher income inequality in developing countries (Chong and Calderón 2000). At this stage of institutional reform, financial inclusion further widens income inequality as the non-poor population benefits much more from improved financial services. However, high institutional quality eventually leads to improvement in the efficiency of the overall economy in which poor households better utilize financial services in productive investment activities and thereby help to reduce income inequality.

5 Conclusions

As it is believed that financial inclusion contributes to faster and more equitable macroeconomic growth, reduces poverty, and promotes income equality in developing countries by providing access to formal financial services, this study empirically examines relationships therein by taking a large sample of developing countries, focusing on Asia, Africa, and Latin America and the Caribbean. For this purpose, a one-way error component fixed effect model is used with an unbalanced annual panel data of 13 years. Moreover, this study constructs a new composite financial inclusion index using penetration, availability, and usage dimension of financial inclusion by following Sarma's distance-based multidimensional approach (2012).

Using the financial inclusion index, this study initially investigates the crucial factors that influence the level of financial inclusion in developing countries. The results show that per capita real GDP and ratio of internet users positively influence the level of financial inclusion, while age dependency ratio, inflation, and income inequality negatively influence this level. There is no evidence of a significant effect of rule of law, population size, and secondary school enrollment ratio on the level of financial inclusion.

This study then assesses the impact of financial inclusion on reducing poverty and income inequality in developing countries. The fixed effect estimates present robust evidence that higher financial inclusion significantly reduces poverty rates and income inequality in developing countries.

This study also examines some important conditions under which financial inclusion is effective in influencing poverty and income inequality in developing countries. The fixed effect estimates show that the interaction term of financial inclusion with GDP growth and secondary school enrollment ratio are statistically significant on poverty, and the interaction terms of financial inclusion with GDP growth and rule of law are statistically significant on income inequality. This finding provides evidence that financial inclusion is not a sufficient factor in itself that can affect the real economy in a similar magnitude; rather, the effectiveness of financial inclusion depends on different economic factors, scenarios, and conditions.

The findings of this study suggest important policy implications for the developing countries. *First,* financial institutions should cater innovative and need based formal financial services suited to financially excluded segments of the population as the demand for financial services varies due to differences in culture, customs, beliefs, and income levels. *Second,* governments, central banks, financial institutions, and development partners should cooperate mutually to develop the financial services infrastructure and upgrade the financial services network in rural and urban areas. *Third,* a concrete time action bound targeted policy on increasing financial literacy in the rural and remote areas is necessary to raise financial awareness and change financial behavior among low-income people. *Fourth,* efforts should be supplemented by supportive policies like transfer of government subsidy to accountholders for effective use of dormant accounts, as higher rates of inactive accounts are not expanding financial inclusion in a true sense. *Fifth,* economies in developing countries must continue to improve per capita income and access to information in order to minimize involuntary financial exclusion of large segments of the population. *Finally,* policies should initiate necessary actions regarding specific socio-economic constraints, macroeconomic volatility, institutional inefficiencies, and financial system inefficiencies at country level to promote a more inclusive financial system.

Even though this study reveals a significant relationship between financial inclusion, poverty, and income inequality in developing countries, this is far from understanding the same relationship in individual countries. The disparity among developing countries in Asia, Africa, and Latin America and the Caribbean in terms of literacy rates, religion status, gender inequality, human rights, natural resources, road networks, etc., is not considered, though these could influence the level of financial inclusion in each country. The index of financial inclusion does not include micro-finance institutions, financial cooperatives, credit unions, SMEs, and mobile financial services measures, which also enhances access to financial services for excluded individuals in the present days. Moreover, this index does not include micro-level or demand-side data, which helps to understand users' financial needs, socio-economic and demographic characteristics, and barriers encountered to avail financial services. The panel nature of data with a short time span and lots of missing observations basically on the main variables of interest, prevent this study from doing some statistical diagnostic

tests and using sophisticated econometric models. For this reason, admittedly it is not possible to fully control for the potential endogeneity associated with financial inclusion and it may cause the empirical findings weaker.

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Authors' contributions
Both authors contributed for conceptualizing the main focus of the study, processing and calculating data, conducting econometric analysis, and analyzing the major findings of the study. Both authors read and approved the final manuscript.

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Competing interests
The authors declare that they have no competing interests.

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Appendix

Appendix A: List of countries included in the sample

Asia (comprising East Asia, Central Asia, South Asia, and the Middle East)

Afghanistan, Armenia, Azerbaijan, Bangladesh, Bhutan, Cambodia, China, Georgia, India, Indonesia, Iran, Islamic Rep., Iraq, Jordan, Kazakhstan, Korea, Dem. People's Rep., Kyrgyz Republic, Lao PDR, Lebanon, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Syrian Arab Republic, Tajikistan, Thailand, Timor-Leste, Turkey, Turkmenistan, Uzbekistan, Vietnam, West Bank and Gaza, Yemen, Rep.

Africa (comprising North Africa and sub-Saharan Africa)

Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Dem. Rep., Congo, Rep., Cote d'Ivoire, Djibouti, Egypt, Arab Rep., Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, The, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.

Latin America and the Caribbean

Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, St. Lucia, St. Vincent and the Grenadines, Suriname, Turks and Caicos Islands, Venezuela, RB.

Appendix B

See Table 7.

Table 7 Description of variables and sources

Variables	Measurement	Source
Composite financial inclusion index *(cfii)*	Composite financial inclusion index consists of penetration, availability, and usage dimensions of financial inclusion which is computed by following the methodology proposed by Sarma (2012)	FAS database of the IMF
Poverty headcount ratio *(lnpovhead)*	Percentage of total population living on less than USD 1.90 per day at 2011 international prices (PPP)	WDI
Income inequality *(lngini)*	Income inequality is measured by the Gini coefficient after deducting taxes and transfers. The SWIID uses multiple imputation technique to convert both micro- and macro-data into a common standard and provides the largest number of observations	SWIID (Version-6.1) constructed by Frederick Solt
GDP growth *(gdpgr)*	Annual GDP growth rate based on constant 2010 USD	WDI
Per capita real GDP *(lngdppc)*	Per capita real GDP at constant 2010 USD	WDI
Secondary school enrollment ratio *(lnssenroll)*	Gross secondary school enrollment as a percentage of total population, regardless of age	WDI
Rule of law *(rule)*	Rule of law reflects the extent to which agents have abided by the rules of society (estimate of governance ranges from appr. − 2.5 (weak) to 2.5 (strong))	World Governance Indicator
Inflation rate *(lninflation)*	Annual percentage change in the average consumer price index	WDI
Credit to private sector *(lnpcredit)*	Domestic credit to private sector by banks as a percentage of GDP	WDI
Govt. expenditure *(lngovtexp)*	General government final consumption expenditure as a percentage of GDP	WDI
Trade openness *(lntradeopen)*	Sum of exports and imports of goods and services measured as a percentage of GDP	WDI
Population *(lnpopu)*	Total residents in a country	WDI
Age dependency ratio *(lnagedep)*	The percentage of dependents (people younger than 15 or older than 64) to working-age population	WDI
Ratio of internet users *(lninternet)*	Individuals using the internet as a percentage of total population	WDI
Mobile users *(lnmobile)*	Mobile cellular subscribers per 100 people	WDI
ICT capital *(lnict)*	Information and communication technology service exports as a percentage of total service exports	WDI

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