

Financial inclusion and poverty: evidence from developing economies

Financial
inclusion
and poverty

1719

Eunice Stella Nyarko

*Department of Accounting and Finance, Faculty of Business Administration,
Methodist University College Ghana, Accra, Ghana and
Department of Finance, University of Ghana, Accra, Ghana*

Kofi Amoateng

*School of Business, North Carolina Central University,
Durham, North Carolina, USA, and*

*Anthony Qabitoo Quame Aboagye
University of Ghana, Accra, Ghana*

Received 14 January 2022
Revised 3 January 2023
Accepted 15 May 2023

Abstract

Purpose – This paper examines the impact of financial inclusion on poverty through access to mobile money in developing economies.

Design/methodology/approach – The authors employ the principal component analysis to construct an index of financial inclusion using demand and supply indicators, including mobile accounts. The authors use the two-step system GMM estimator for the analysis because of its efficiency and robustness in addressing heteroscedasticity and autocorrelation.

Findings – The main finding is that financial inclusion generally increased and significantly reduces poverty in the sample period. Furthermore, income inequality worsens poverty.

Research limitations/implications – This study has few limitations. First, the empirical analysis of the study is restricted to macroeconomic factors only because of limited Household Finance Survey data set and time availability. Second, the study is limited to developing countries and the results cannot be generalized.

Practical implications – Financial inclusion is a significant policy tool for poverty reduction. There is the need to enhance strategies that further improve financial inclusion by expanding and improving the use of mobile money accounts.

Social implications – The paper sheds light on how developing countries can harness financial inclusion to reduce poverty.

Originality/value – The paper differs from the previous studies in two ways. Firstly, mobile money account is included in the computation of financial inclusion index over the sample period. It also determines the impact of financial inclusion on poverty for short-run and long-run periods.

Peer review – The peer review history for this article is available at: <https://publons.com/publon/10.1108/IJSE-11-2021-0690>

Keywords Financial inclusion, Financial access, Financial usage and poverty

Paper type Research paper

1. Introduction

Income poverty is a challenge confronting most developing countries. World Bank (2018) reports that though extreme poverty has reduced globally, nearly half of the population of the world still live in poverty. About half of the population in developing countries live on less than US\$1.90 a day. Those who live in extreme poverty usually suffer deprivation and have less access to financial resources, good health, adequate food, and education.



International Journal of Social
Economics
Vol. 50 No. 12, 2023
pp. 1719-1734
© Emerald Publishing Limited
0306-8293
DOI 10.1108/IJSE-11-2021-0690

One of the causes of poverty in developing countries is inadequate access to financial resources, and related opportunities (Abebe and Quaicoe, 2014). The World Bank and some researchers have pointed out that limited access to financial resources contribute to poverty (Beegle *et al.*, 2016). It becomes imperative to empirically investigate how financial inclusion impacts poverty in developing countries.

Financial inclusion is defined as the delivery of financial services at an affordable cost to those in need especially the marginalized, underprivileged and low-income groups. Global Findex (2017) database shows that globally about 1.7 billion adults remain unbanked and only 69% of adults have bank accounts. Most of these unbanked are in developing countries.

Financial inclusion is a multidimensional concept and its measure needs to capture all its dimensions. Some studies have measured it using a single indicator on the demand or supply sides (World Bank: G20 Basic Set of Financial Inclusion Indicators). Others have measured the concept using an index of indicators (Sarma, 2008; Wang and Guan, 2016; Park and Mercado, 2018). How to weigh indicators when computing an index has been an issue as the weighting approach affects the size of the index. Some researchers use equal weighting, suggesting that all indicators have equal relevance to the index (Sarma, 2008). Others compute weights of indicators (Wang and Guan, 2016). Still others use factor analysis and principal component analysis to determine the weights of indicators based on their eigenvalues. Using principal component analysis tends to assign weights based on the relevance of an indicator to the index and does not assume that all indicators are of equal importance to the index.

This study seeks to compute an index of financial inclusion using both demand and supply indicators, including mobile money accounts to ascertain the extent of financial inclusion an observed period. A measure of financial inclusion that captures mobile money accounts is relevant in evaluating poverty because mobile money accounts make it possible for the poor who do not have access to mainstream financial institutions to have access to financial services which help them to meet their basic needs. This study focuses on the dimensions of access and usage but not quality because there is currently no data on the quality dimension.

Furthermore, it examines factors that affect financial inclusion in developing countries in order to throw light on specific areas that need attention in the quest to achieve greater financial inclusion. Finally, it seeks to analyze how financial inclusion affects poverty in developing countries using a panel analysis. A panel study is likely to provide more insights on how financial inclusion affects poverty across different economies over time. The study uses income poverty indicators such as Poverty Head Count Ratio 2011 Purchasing Power Parity (PPP) and Poverty Gap 2011 PPP. It uses income poverty indicators instead of the multidimensional poverty index that captures education, health and general welfare because income serves as the basis to access quality health care and education.

This study contributes to the literature by examining the level of financial inclusion over a period in one hundred and forty-two developing countries. This helps to track how financial inclusion has progressed over period especially with the use of mobile money transactions unlike other measures in the literature that focus on single or few countries at a point in time. The study also adds to the literature by demonstrating that financial inclusion has both short run and long run effect on poverty reduction.

The rest of the paper is organized as follows: Section 2 provides the relevant literature review. Section 3 provides the methodology for constructing the index of financial inclusion; investigating the factors that affect financial inclusion; and for examining the relationship between financial inclusion and poverty. Section 4 presents the results and findings of the study. Section 5 concludes the study and highlights some policy implications.

2. Literature review

Different authors have defined financial inclusion to cover three dimensions of access/availability/outreach/penetration; usage and quality of financial services/products. Quality of financial services refers to financial products serving the purpose for which they are accessed. Generally, financial inclusion is the process of ensuring that appropriate financial products/services such as savings, credit, payments, insurance, and remittances offered by formal financial institutions are effectively accessible to individuals and businesses at affordable costs; and the usage meets needs in a cost effective and sustainable manner. Effective access involves convenient and responsible service delivery, at a cost affordable to the customer and sustainable for the provider with the result that financially excluded customers use formal financial services rather than existing informal options. There are two main participants in the process of financial inclusion -those who demand and those who supply financial services.

Similarly, there is no widely accepted definition of poverty, but the consensus is that any definition of poverty needs to recognize specific social, cultural, income contexts, and well-being. Poverty can be viewed from the absolute or relative perspectives. Absolute poverty considers the number of people living below an income threshold while relative poverty compares a group of poor people with others in each population. The World Bank defines poverty in absolute terms as living on less than an income threshold per day. Living below US\$1.90 per day (PPP) to meet basic needs is considered extreme poverty and less than \$3.10 a day as moderate poverty. The United Nations (2012) describes poverty in terms of a range of interrelated and mutually reinforcing deprivations, and draws attention to the stigma, discrimination, insecurity and social exclusion. It views poverty as a condition characterized by severe deprivation of basic human needs, including food, safe drinking water, sanitation facilities, health, shelter, education, and information. UNDP views poverty as multidimensional which goes beyond income and captures the reality of living with less than the essentials needed to lead a decent life which does not allow the poor to develop their full potential. This paper adopts the World Bank's definition of poverty and looks at poverty from an income point of view because it is usually income that gives people access to the other non-income dimension of poverty.

The relationship between financial inclusion and poverty is important because when the poor have access to financial services, they are able to engage in productive economic activities or expand their business activities which enable them to cater to their basic needs. Some studies have examined how access to finance impacts poverty at the individual country level. [Ayyagari et al. \(2013\)](#) suggest that financial inclusion contributes to poverty alleviation in the rural areas of India by strengthening the productive base of the poor, enhancing the productive capacity and promoting entrepreneurship. These studies examined only an aspect of financial inclusion, for instance the access dimension and in a limited jurisdiction either at the community or country level. In order to provide more insights into the impact of financial inclusion on poverty, it would be helpful to consider access and usage dimensions of financial inclusion.

[Lal \(2017\)](#) reports that financial inclusion through cooperative banks reduces poverty among the poor because access to finance enables the beneficiaries to raise their standard of living, obtain quality food, purchase basic needs, increase the quality of flooring materials, and consumption level. [Shaban et al. \(2019\)](#) report that financial inclusion is positively and significantly associated with GDP per capita, employment, bank competition, human development, government integrity, and Internet usage. This current study investigates how financial inclusion affects poverty in 142 developing countries. This study differs from the cited studies in the literature in two ways. First, it constructs a composite measure of financial inclusion using both demand and supply side indicators including mobile money transactions over a period. Second, it evaluates the short- and long-term impact of financial inclusion on poverty.

On the measurement of financial inclusion, some studies use single indicators of access and usage as a proxy for financial inclusion. [Amidžic et al. \(2014\)](#) use saving/deposit and loans/borrowings as a measure of financial inclusion. Nonetheless, financial inclusion is a multidimensional concept; hence, using a single indicator to proxy for it does not capture the other dimensions. [Sarma \(2008\)](#) computes a composite measure of financial inclusion using indicators of access and usage dimensions. In Sarma's approach, each of the indicators is normalized to lie between 0 and 1 in order to remove the scale effect. Weights are then assigned without a clear justification of the weighting method. [Beck et al. \(2009\)](#) use variables that relate to physical access, affordability, and eligibility (deposits, loans, and payments). Their study ranked the performance of countries by dimensions and a country had different rankings in different dimensions which makes it challenging to determine the extent of financial inclusion in each country and to compare across countries. [Honohan \(2008\)](#) uses econometric model to measure the share of individuals that have access to financial products to the total populace. In that study, the usage dimension of financial inclusion was not analyzed, and econometric estimates arguably provide a one-time estimate of financial inclusion which cannot be used to measure variations across time and countries ([Sarma, 2012](#)). [Demirgüç-Kunt and Klapper \(2012\)](#) focus on demand side indicators that suggest usage to measure financial inclusion. The core indicators address five areas of activity: borrowing, saving, insurance, making payments, and operating an account. The limitation of this measurement is that it does not account for the supply side factors such as use and access to banking facilities and mobile money transactions, number of access points, and percentage administrative units.

Further, [Chakravarty and Pal \(2013\)](#) compute a composite financial inclusion index using indicators of access, usage, and availability of banking services. They use equal weighting of variables in the dimensions in their analysis without providing a basis for the weighting method. [Amidžic et al. \(2014\)](#) criticize an index that assigns equal weights to all variables and dimensions because applying the same weights suggest that all dimensions have the same relevance on financial inclusion which may not reflect the reality in practice. They use factor analysis to derive the weights for their analysis which makes the weighting approach relatively objective compared to the equal weighting.

Finally, [Park and Mercado \(2018\)](#) use demand side indicators such as savings, borrowing and financial literacy to construct an index of financial inclusion following the approach [Sarma \(2008\)](#) but use principal component analysis to determine weights for the indicators.

Income poverty is measured using absolute, relative and multidimensional measures ([Alkire et al., 2015](#)). An example of an absolute measure is poverty headcount ratio at \$1.90 a day (2011 PPP) (%). The relative measure like the poverty gap index considers the intensity of poverty in a country. The multidimensional measure of poverty considers both the income and non-income dimensions of poverty such as health, education and standard of living. This paper uses income poverty measure because the other non-income dimensions of poverty such as health, education, living standard and quality of well-being to a large extent are contingent on income level.

The measure of financial inclusion in this paper is an improvement over existing measures because it broadly captures financial inclusion to include mobile money transactions compared to [Honohan \(2008\)](#) who uses only demand side indicators such as bank and MFI account numbers from household cross-sectional data to construct a measure of financial access in a limited number of countries.

The factors that affect financial inclusion emanate from demand and supply sides. Demand side indicators relate to what enables demanders of financial services to access products. These indicators are education, health, electricity, roads, transport, and marketing opportunities. The supply side variables enable providers of financial services to meet the needs of especially small borrowers at a cost-effective manner. The supply side indicators

include regulation, rule of law, products, accessibility, and cost of service delivery. Some studies have examined either demand or supply factors that affect financial inclusion at individual country levels. [Kaur \(2017\)](#) examines factors that affect financial inclusion in Pakistan and finds that literacy rate and gross domestic product significantly impacts financial inclusion positively. [Akudugu \(2013\)](#) evaluates the determinants of financial inclusion in Ghana and reports that age of individuals, literacy levels, wealth, lack of documentation, and trust for formal financial institutions are significant determinants of financial inclusion. [Sahoo \(2017\)](#) investigates the determinants of financial inclusion in tribal districts of Odisha in India and finds that years of education by the household head, size of private-owned land, income of the household, and participation in a guaranteed scheme are significant determinants of financial inclusion.

3. Methodology

This study analyzes 142 developing countries for the sample period of 2004–2018. It computes an index of financial inclusion using five indicators of access (three) and usage (two). It also uses pooled ordinary least squares, least square dummy variable, and fixed effects estimation techniques to examine factors that affect financial inclusion. The reason for using different estimation techniques to analyze factors that affect financial inclusion is to ascertain whether the results will be comparable to other techniques. Finally, this study applies the system generalized method of moments (SGMM) regression proposed by [Arellano and Bover \(1995\)](#) and [Blundell and Bond, \(1998\)](#) to evaluate the relationship between financial inclusion and poverty.

This study computes each normalized indicator of financial inclusion using the following formula:

$$X_{ij} = (A_{ij} - m_{ij}) / (M_{ij} - m_{ij}) \quad (1)$$

where X_{ij} is the transformed value of each indicator j in the dimension (Access, Usage); A_{ij} is the actual value; M_{ij} and m_{ij} are the maximum and minimum of each indicator respectively. The variables are transformed to normalize them to lie between 0 and 1. The purpose of the normalization is to remove the scale effect and to allow for easy comparison of country performance across indicators. The Index of Financial Inclusion in dimension i is computed as follows:

$$IFI_i = 1 - \sqrt{\frac{w_{i1}^2 * (1 - x_{i1})^2 + w_{i2}^2 * (1 - x_{i2})^2 + \dots + w_{in}^2 * (1 - x_{in})^2}{w_{i1}^2 + w_{i2}^2 + \dots + w_{in}^2}} \quad (2)$$

where X_{ij} is the transformed value ($0 \leq X_{ij} \leq 1$). w_{ij} denotes the weights (factor loadings) derived from PCA of indicator j in dimension i .

Access is measured by account at a financial institution or with a mobile service provider (% of population ages 15+); ATM per 10,000 population and Mobile cellular subscriptions (per 100 people). The usage dimension is measured by savings and borrowings.

The paper employs pooled ordinary least squares; least squares dummy variable; random effects and fixed effects estimation techniques to examine factors that affect financial inclusion. Fixed effects model is usually used when one is interested in analyzing the impact of variables that vary over time. The least square dummy variable model offers a means to appreciate fixed effects. Including a dummy for each country helps estimate the pure effect of the independent variable. Each dummy absorbs the effects specific to each country. The random effects model assumes that the variation across entities is random and uncorrelated with the independent variables. Pooled OLS provides unbiased and consistent estimates of parameters even when time invariant attributes are present.

The factors that affect financial inclusion are modelled as follows:

$$IFI_{it} = \beta_1 LR_{it} + \beta_2 SECSCHCR_{it} + \beta_3 INFRASTRUC_{it} + \beta_4 AGEDR_{it} + \beta_5 GNIPC_{it} \\ + \beta_6 BANKRESI_{it} + \beta_7 POP_{it} + \beta_8 RLAW_{it} + \varepsilon_{it} \\ \text{and } \varepsilon_{it} = \vartheta_t + \eta_i + e_{it}$$

where IFI is index of financial inclusion, *LR* is Loan rate (interest rate); *SECSCHCR* is secondary school completion rate; *INFRASTRUC* is infrastructure (technological); *AGEDR* is age dependency ratio; *GNIPC* is income; *BANKRESI* is bank resilience; *POP* is population; and *RLAW* is rule of law. ε_{it} is the error term which decomposes into time effect), (country specific effect) and e_{it} is the stochastic error term assumed to be independently and identically distributed.

Index of financial inclusion (IFI) is the composite measure of financial inclusion. Interest rate on loans is a proxy for the cost of accessing credit. It is expected that higher interest rates on loans will hinder financial inclusion. Cost to income ratio measure the efficiency with which bank deliver financial services. Pasiouras and Kosmidou (2007) note that the more efficient and cost effective a bank is, the more it yields a positive effect on financial inclusion. Thus efficient and effective cost reduction improves financial inclusion. Secondary school completion rate shows the average level of education of the population. Higher level of education can lead to more access to financial services. Access to mobile phone is a proxy for infrastructure. Access to mobile phones may enable people to access their account on their phones to facilitate payments, borrowings, and getting information from the financial institutions. It is expected that financial inclusion will increase if a greater number of people have mobile phones. Age dependency ratio shows the percentage of the population that do not earn income and must rely on the working population for their survival. A lower dependency ratio is likely to improve access to financial services and a higher ratio may hinder access to financial services as they do not earn income. Income tends to increase financial inclusion in two ways. Firstly, people with higher income are more likely to be included in the financial system as they can save. Secondly, economies with higher income are more inclined to have developed financial sectors which help provide the public with better access to financial services.

Bank resilience measures how sound a bank is in relation to performing its key functions. The more resilient a bank is, the better it is positioned to serve a greater percentage of the population and hence, increase financial inclusion. Population density indicates a larger market size, and this is likely to enhance financial inclusion. Rule of law is a proxy for quality of institutions and how effective and efficient the systems of the institutions work in each economy. Better rule of law gives indication of enforcement of financial contracts which is likely to improve financial inclusion. Table 1 describes the variables.

We present the model to examine the relationship between financial inclusion and poverty as follows:

$$POV_{i,t} = \alpha_0 + \alpha_1 POV_{i,t-1} + \alpha_2 IFI_{i,t} + \alpha_3 GINI_{i,t} + \alpha_n X_{i,t} + \varepsilon_{it} \\ \text{and } \varepsilon_{it} = \vartheta_t + \eta_i + e_{it}$$

where $POV_{i,t}$ is the dependent variable(s) capturing poverty, $POV_{i,t-1}$ is the lag of poverty. Poverty is measured by two indicators – Poverty Head Count Ratio 2011 PPP (P0) and Poverty Gap 2011 PPP (P1). IFI is a measure of financial inclusion, GINI account for income inequality and X_{it} is a vector of all other control variables that have the potential to affect the dependent variable. These are banking sector credit to private sector (CRETOPSB) as a measure of financial depth; GDP per capita (GDPPC) as a measure of income, inflation (INFL) as a measure of macroeconomic stability; rule of law (RLAW) a measure of institutional

Table 1.
Description of
variables

Variable	Notation	Description	Data
Financial access	ACCM	Account at a financial institution or with a mobile service provider	WDI
Financial access	ATM	ATM per 10,000 populations	WDI
Financial access	MOBILE	Mobile cellular subscriptions (per 100 people)	WDI
Financial usage	SAV	Savings	WDI
Financial usage	BORR	Borrowings	WDI
Income	INCOME	GNI per capita	WDI
Education	SECSCHCR	Secondary school completion rate	WDI
Age dependency ratio	AGEDR	Age Dependency ratio	WDI
Infrastructure	IFRASTRUC	Access to mobile phones	WDI
Cost of loan/credit	INTL	Interest rate on loan/credit	WDI
Bank resilience	BANKRESI	Capital adequacy ratio	WDI
Institutional quality	RLAW	Rule of law Index	WDI
Population	POP	Population	WDI

Source(s): Compiled by Authors, 2021

quality; INFRASTRUC is technological infrastructure proxied by access to mobile phone; population (POP) as a measure of population density; and secondary school completion rate (SECSCHCR) as a measure of education. The paper also controls for time using a dummy variable for the countries. ε_{it} is already explained above. Table 2 describes the variables and expected signs.

The SGMM overcomes a potential weakness in the Arellano and Bond (1991) estimator where lagged levels are shown to be weak instruments for first differenced variables. SGMM estimator comprises the lagged levels and lagged differences. It has been argued that SGMM is more useful in generating efficient results when the panel units (countries) are large, and the time periods are relatively small. This estimation technique adds additional moment

Variable	Notation	Description	Data	Expected sign
Dependent variable	P0	Poverty headcount ratio at \$1.90 a day (2011 PPP) (% of population)	PovcalNet	
	P1	Poverty gap (2011 PPP) (% of population)	PovcalNet	
Independent variables	IFI	Index of financial inclusion	Computed by authors	Negative (–)
Control variables	GINI	Income inequality, GINI coefficient	WDI	Positive (+)
	CRETOPSB	Financial depth, Banking sector credit to private sector to GDP	WDI	Negative (–)
	GDPPC	Income, GDP per capita		
	INFL	Inflation, Consumer prices (annual %)	WDI	Positive (+)
	RLAW	Rule of law index	World Justice Project	Positive (+)
	INFRASTRUC	Technological infrastructure, access to mobile phones	WDI	Negative (–)
	POP	Population, Population density	WDI	Positive
	SECSCHCR	Education, Secondary school completion rate	WDI	Negative (–)
	Dummy	Year = 1; otherwise = 0	WDI	

Source(s): Created by Authors, 2021**Table 2.**
Table of variables and
expectations for the
relationship between
poverty and financial
inclusion

restrictions and allows lagged first differences to be employed as instruments in the level equations and this corrects for any bias in the DGMM by [Arellano and Bond \(1991\)](#). In addition, SGMM is more efficient in the presence of weak instruments as it uses more conditions compared to DGMM. Like the DGMM, SGMM further requires that the unobserved effects and error terms do not correlate over cross-section units.

The SGMM has gained much attention in the growth literature. [Levine et al. \(2002\)](#) examined the impact of financial expansion on growth using a linear dynamic panel model. They used the SGMM model to capture the unobserved, country specific effects in the face of the lagged dependent variable. The main assumptions about the data generating process of these estimators are some regressors may be endogenous; the process is usually dynamic with current dependent variable being influenced by the previous ones.

4. Results

The financial inclusion index for the countries is grouped into three main categories – low, medium, and high – based on the Index of Financial Inclusion (IFI) values. These values are categorized as follows: high financial inclusion, $0.5 < IFI \leq 1$; medium financial inclusion, $0.3 < IFI \leq 0.5$; and low financial inclusion, $0 < IFI \leq 0.3$. The result shows that generally, most countries (113) exhibited IFI values between medium ($0.3 < IFI \leq 0.5$) and high ($0.5 < IFI \leq 1$); and these are increasing over the period. This suggests that financial inclusion has been increasing over the period in developing countries. Twenty-nine (29) countries showed IFI values that range from low, medium and high but did not show consistent pattern in the increase of financial inclusion over the period. It is worthy of note that these countries were predominantly in Africa. The graph in [Figure 1](#) shows that generally financial inclusion increased over the period 2005 to 2018 except for 2011 and 2017 where there was a decline relative to the previous years. The cause of this decline is yet to be ascertained to ensure that financial inclusion improves steadily in subsequent years. Refer to [Appendix](#) for the index of financial inclusion for the countries over the period.

The results of the estimations of the factors that affect financial inclusion in the sample is presented in [Table 3](#). It uses the computed financial inclusion indicator for the period as the dependent variable partially following [Honohan \(2008\)](#). The analysis of the factors that affect financial inclusion is done using pooled ordinary least squares (OLS), least squares dummy variables (LSDV), random effects and fixed effects estimation techniques. The results of the estimations using the four approaches look similar. The dependent variable is financial

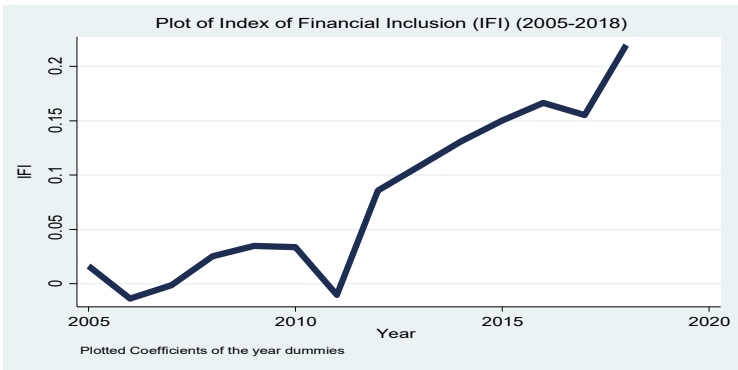


Figure 1.
Plot of index of
financial inclusion (IFI)
for 2005–2018

Source(s): Created by authors (2021)

Variables	OLS	LSDV	FE	RE
<i>Dependent variable: Financial inclusion</i>				
Loan Rate, LR	0.0001*** (0.24)	0.0006*** (2.08)	0.0006*** (2.08)	0.0006 * (1.99)
Sec. Sch. Compl. Rate, SECSCHCR	-0.0004 (-0.98)	-0.0004 (-1.27)	-0.0004 (-1.27)	-0.0004 (-1.28)
Infrastructure, IFRASTRUC	0.0007** (1.96)	0.0025 (7.94)	0.0025** (7.94)	0.0024*** (7.91)
Age Dependency Ratio, AGEDR	-0.0002 (-0.31)	0.0015 (0.81)	0.0015 (0.81)	0.0015 (1.08)
Gross National Product Per Capita, GNIPC	0.0000*** (14.64)	0.0000*** (9.11)	0.0000** (9.11)	0.0000*** (10.06)
Bank Resilience, BANKRESI	0.0108 (4.31)	-0.0014 (-0.61)	-0.0014 (-0.61)	-0.0007 (-0.33)
Population, POP	-0.0003 (-4.10)	-0.0006 (-1.83)	-0.0006 (-1.83)	-0.0005* (-2.18)
Rule of Law, RLAW	0.1155* (4.89)	0.2322* (5.43)	0.2322* (5.43)	0.2076*** (5.65)
Constant	0.4849 (7.82)	0.6838 (3.03)	0.4236 (3.00)	0.3910 (3.33)
<i>Year Dummies</i>				
2005		0.0163		
2006		-0.0137		
2007		-0.0012		
2008		0.0253		
2009		0.0349		
2010		0.0337		
2011		-0.0103		
2012		0.0857		
2013		0.1081		
2014		0.1310		
2015		0.1501		
2016		0.1664		
2017		0.1553		
2018		0.2198*		
Constant	0.3910**	0.2996	0.4236	0.3910***
Number of Observations	2130	2130	2130	2130
R-squared	0.1936	0.1917	0.1889	0.1936
Wald χ^2 /F-Statistic	42.52	66.02	5.17	341.41

Note(s): Legend: * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.001$

OLS – Ordinary Least Squares; LSDV – Least Squares Dummy Variable; FE – Fixed Effects; RE – Random Effects

Source(s): Created by Authors, 2021

Table 3.
Factors that affect
financial inclusion

inclusion which is proxied by the index. The coefficients of the independent variables loan rate, level of infrastructure, level of income, and rule of law have the predicted signs.

Loan rate shows a statistically significant positive impact on financial inclusion at 1% level. The finding on loan rate is consistent with that of [Olaniyi and Babatunde \(2016\)](#), and [Sarma and Pais \(2011\)](#) who find that the level of interest rates has a significant positive impact on financial inclusion.

As expected, income shows a statistically positive effect on financial inclusion at 1% significance level. This suggests that as income level increases, financial inclusion increases all things being equal. These findings are consistent with that of [Park and Mercado \(2018\)](#), [Zins and Weill \(2016\)](#), and [Sarma and Pais \(2011\)](#).

Technological infrastructure also impacts financial inclusion positively and statistically significant at the 5% level. This indicates that as technological infrastructure in an economy improves, financial inclusion increases *ceteris paribus*. [Lyons *et al.* \(2017\)](#) find similar results.

Finally, rule of law shows a positive impact on financial inclusion at a statistically significant level of 10%. Enhanced rule of law increases financial inclusion as administration of financial transactions improves. This finding is consistent with [Park and Mercado \(2018\)](#).

The results of the impact of financial inclusion on poverty are presented in [Tables 4–7](#). The dependent variable poverty is proxied by two indicators – poverty head count ratio 2011 PPP (P0) and poverty gap 2011 PPP values (P1). The results of the estimations using poverty head count ratio 2011 PPP values as the dependent variable is presented in [Table 4](#).

[Table 4](#) reports the two-step variant of Blundell and Bover estimator which gives more robust and more efficient estimates. The results show that the coefficient of the first lag of the dependent variable, poverty head count ratio 2011PPP has statistically significant association with the dependent variable at the 1% level which suggests that current level of poverty is significantly influenced by previous level.

Financial inclusion is inversely and statistically significant with poverty at the 1% level. This indicates that a unit increase in financial inclusion is associated 1.2572 reduction in income poverty in the short run, on average holding all other factors constant. This finding is consistent with the works of [Park and Mercado \(2018\)](#) which suggests that access and usage of financial services enable people to come out of poverty.

In addition, income inequality is directly related with poverty at 1% level of significance. Hence, a unit increase in income inequality leads to 0.2411 increase in poverty in the short run, other factors remaining constant. This implies that as income inequality widens more people become poor. This finding lends support to that of [Fosu \(2010\)](#) which shows that a more equitable distribution of income is effective in reducing poverty.

Credit to private sector by banks, a measure of financial sector development is inversely related with poverty. As financial sector develops by a unit, poverty reduces by 0.0138

Variables	Two-step sys GMM (coefficients)	Corrected std. Errors	P-values
P0_1	−0.0557*** (−3.23)	0.0172	0.002
Financial Inclusion, IFI	−1.2572*** (−3.04)	0.4134	0.003
Income Inequality, GINI	0.2411*** (6.49)	0.0372	0.000
Credit to Priv. Sector by Banks, CRETOPSB	−0.0138 (−1.01)	0.0136	0.314
GDP Per Capita, GDPPC	−0.0524 (−0.91)	0.0573	0.363
Inflation, INFL	−0.0063 (−0.45)	0.0140	0.651
Rule of Law, RLAW	−0.3038 (−0.42)	0.7226	0.675
Infrastructure, IFRASTRUC	−0.0428*** (−3.03)	0.0141	0.003
Population, POP	0.0011 (0.77)	0.0014	0.442
Sec. Sch. Compl. Rate, SECSCHCR	−0.0122 (−1.53)	0.0080	0.128
Year Dummies		YES	
Number of Observations		1861	
F-Statistic		4.56	
Groups		133	
Instruments		37	
AR(2)		0.968	
Hansen Statistic		0.015	

Table 4.

System GMM results
(dependent variable:

P0 - poverty head count
ratio, 2011PPP)

Note(s): *, **, *** are statistical significance at the 10%, 5 and 1% levels respectively; t-Statistics are based on white heteroscedasticity-consistent standard errors, *p*-values are reported for AR (2) and Hansen statistic

Source(s): Created by Authors, 2021

Table 5.

System GMM results
(dependent variable:
P1 -poverty gap,
2011PPP)

Variables	Two-step sys GMM (coefficients)	Corrected std. Errors	P-values
P1_1	−0.0491*** (−3.05)	0.0161	0.003
Financial Inclusion, IFI	−0.4278** (−2.56)	0.1670	0.012
Income Inequality, GINI	0.0877*** (5.66)	0.0155	0.000
Credit to Priv. Sector by Banks, CRETOPSB	−0.0060 (−1.12)	0.0054	0.265
GDP Per Capita, GDPPC	−0.0202 (−1.27)	0.0159	0.208
Inflation, INFL	0.0001 (0.01)	0.0054	0.993
Rule of Law, RLAW	−0.0731 (−0.27)	0.2740	0.790
Infrastructure, IFRASTRUC	−0.0160** (−3.11)	0.0052	0.002
Population, POP	0.0003 (0.45)	0.0006	0.654
Sec. Sch. Compl. Rate, SECSCHCR	−0.0046 (−1.55)	0.0030	0.123
Year Dummies	YES		
Number of Observations	1862		
F-Statistic	3.88		
Groups	133		
Instruments	37		
AR(2)	0.551		
Hansen Statistic	0.082		

Note(s): *, **, *** are statistical significance at the 10%, 5 and 1 % levels respectively; t-Statistics are based on white heteroscedasticity-consistent standard errors, *p*-values are reported for AR (2) and Hansen statistic

Source(s): Created by Authors, 2021

Table 6.

Long-run GMM
coefficients for
significant coefficients
(dependent variable:
P0 -poverty
head count)

Variables	Two-step sys GMM (coefficients)	Std. Errors	P-values
Financial Inclusion, IFI	−1.1909*** (−3.05)	0.3909	0.002
Income Inequality, GINI	0.2284*** (6.45)	0.0354	0.000
Infrastructure, IFRASTRUC	−0.04053*** (−3.05)	0.0133	0.002

Note(s): Legend: **p* < 0.1, ***p* < 0.05, and ****p* < 0.001

Source(s): Processed Data by Authors, 2021

Table 7.

Long-run GMM
coefficients for
significant coefficients
(dependent variable:
(P1 -poverty
gap 19PPP)

Variables	Two-step sys GMM (coefficients)	Std. Errors	P-values
Financial Inclusion, IFI	−0.4019*** (−2.58)	0.1559	0.010
Income Inequality, GINI	0.0825*** (5.76)	0.0143	0.000
Infrastructure, IFRASTRUC	−0.0149*** (−3.12)	0.0048	0.002

Note(s): Legend: **p* < 0.1, ***p* < 0.05, and ****p* < 0.001

Source(s): Created by Authors, 2021

though this is not statistically significant. This finding corroborates that of [Rashid and Intartaglia \(2017\)](#), [Jeanneney and Kpodar \(2011\)](#), and [Akhter et al. \(2010\)](#) who find that financial development reduces poverty.

Technology infrastructure shows an inverse relationship with poverty as expected at a significance level of 1%. A unit increase in technological infrastructure is associated with 0.0428 reduction in poverty in the short run, ceteris paribus. This finding is in line with [Prodi \(2015\)](#) who argues that infrastructure, particularly information and communications technology (ICT) can reduce poverty. This is possible because information and communications technology (ICT) can

improve people's access to health, education, agricultural productivity and financial services. In addition, technology enables people to mobilize each other more efficiently, enhance social inclusion and interdependence which improve well-being.

Another variable that impacts poverty is human capital proxied by secondary school completion rate. The result shows an inverse association between human capital and poverty though not statistically significant. The coefficient shows that a unit increase in human capital leads to a 0.0122 reduction in poverty, holding other things constant. [Olopadea et al. \(2019\)](#) confirm that human capital development has a significant effect on poverty reduction in selected OPEC member countries as improved human capital generates opportunities for growth through its effects on total factor productivity and this tends to reduce poverty.

[Table 5](#) presents the output of the relationship between financial inclusion and poverty using the poverty gap 2011 PPP as the dependent variable. This result is very similar to the results of using poverty headcount ratio as the dependent variable. It shows that financial inclusion and infrastructure have statistically significant positive impact on poverty. Hence, financial inclusion and infrastructure reduce poverty. Similarly, as indicated in the previous results income inequality has a statistically significant negative impact on poverty which indicates that income inequality worsens poverty. This clearly shows that each of the measure of poverty can be used in poverty estimations to get comparable results.

The long run estimates verify whether the variables that impact poverty in the short run have similar impact in the long run when all other factors change. The results of the long run estimations are presented in [Tables 6 and 7](#). [Table 6](#) shows the results for poverty head count ratio as the dependent variable. The coefficient of financial inclusion -1.1909 which suggests that a unit increase in financial inclusion leads to 1.1909 decline in poverty in the long run, at the 1% level of significance on average *ceteris paribus*. Financial inclusion has a relatively smaller positive impact on poverty in the long run (-1.1909) compared to the short run coefficient of -1.2572 . Nonetheless, financial inclusion has both short run and long run influence in reducing poverty.

Further, the coefficient of the long run estimate of income inequality on poverty is 0.2284 . This gives indication that a unit increase in income inequality leads to 0.2284 increase in poverty at 1% significance level on average *ceteris paribus*. Income inequality has a slighter smaller effect on poverty in long run (0.2284) than in the short run (0.2411); though income inequality aggravates poverty in both the short and long run.

Technological infrastructure has a positive impact on poverty in the long run. The coefficient of -0.04053 suggests that a unit increase in technological infrastructure leads to a 0.04035 -unit reduction in poverty. This is significant at 1% level on average. Comparing this to the short run estimate, infrastructure has a slightly greater positive impact on poverty in the short run (-0.0428) than in the long run (-0.04053).

To generate the long-run estimate, estimate the Stata command for the two-step system GMM for the model that is estimated to generate the short run coefficients and identify the significant explanatory variables. From the estimation, the variables with significant short-term coefficients are financial inclusion (IFI), income inequality (GINI), and infrastructure. Generate the long-run GMM estimates using the following commands: `nlcom(_b[IFI])/(1-_b[L1.P0]); nlcom(_b[GINI])/(1-_b[L1.P0])` and `nlcom(_b[IFRASTRUC])/(1-_b[L1.P0])`, where IFI, GINI, and IFRASTRUC are the short-term significant explanatory variables and P0 is Poverty Head Count Ratio 19 PPP, the dependent variable.

Lastly, the long-run coefficients for the explanatory variables that were significant in the short run are estimated using poverty gap as the dependent variable. The result is presented in [Table 7](#). The significant variables that significantly impact poverty in the short run also significantly influences poverty in the long run. It can be observed from the table that the financial inclusion has a relatively smaller positive impact on poverty or ability to reduce poverty in the long run (-0.4019) compared to the short run (-0.4278). However, financial inclusion has both short run and long run impact of reducing poverty.

Similarly, the long-run effect of income inequality on poverty is slightly lower in the long run (0.0825) than in the short run (0.0877), though income inequality worsens poverty in both the short and long run. Finally, the long-run impact of technological infrastructure on poverty has a slightly greater positive impact in the short run (-0.0160) than in the long run (-0.0149).

Similarly, the long-run coefficients for the significant explanatory variables in the short run are generated using Stata. The results show that financial inclusion and infrastructure reduces poverty in the long run while income inequality worsens poverty in the long run.

5. Conclusion

This paper empirically examines the impact of financial inclusion on poverty in developing countries. It employs principal component analysis to construct an index of financial inclusion with demand and supply indicators, including mobile accounts. For the first in the literature, financial inclusion index is modelled using mobile money accounts for the poor in the society.

It further examines factors that affect financial inclusion using pooled ordinary least squares, least square dummy variable and fixed effects estimation. The system GMM estimator is used to account for the dynamic nature of the data. In addition, this paper uses the two-step system GMM estimator because it is more efficient and more robust to heteroscedasticity and autocorrelation.

The main finding of this study is that most developing countries have financial inclusion index between medium and high with increasing rates over the observed period. This indicates that financial inclusion has generally increased over the period.

In addition, it finds that loan rate, technology infrastructure, level of income, and rule of law have significant positive impact on financial inclusion. This suggests that improving rule of law, income, infrastructure, and reducing loan rate would be effective strategies to enhance financial inclusion significantly.

Another evidence is that financial inclusion significantly reduces income poverty in both the short run and long run irrespective of the proxies for poverty. However, income inequality exacerbates poverty. The results suggest that financial inclusion is an effective tool to alleviate poverty in developing countries. Also, equitable distribution of income is effective in reducing poverty.

The study has several policy implications for developing economies. Firstly, there is the need to further expand financial inclusion in developing economies because it significantly reduces poverty. To implement this, policymakers need to create a conducive environment to expand technological infrastructure and make it affordable to all and sundry. Improving the use of mobile accounts has the tendency to reach the poor in areas where there are no traditional financial services providers. This enables the poor to have access to financial products that helps them out of poverty as mitigation of poverty is key to sustainable growth and development.

Secondly, it is imperative for policy bearers to enhance the quality of rule of law to instil confidence in the populace and motivate those who are involuntarily excluded from the financial system to participate in the system in order to increase financial inclusion. There is also the need for policymakers to improve the level of income and livelihood of the poor and vulnerable through economic empowerment initiatives. These initiatives are important because rule of law and level of income are found to significantly reduce poverty in the study.

Thirdly, financial inclusion is a policy tool for poverty reduction. Finally, government organizations must double their efforts to narrow income inequality with the goal of reducing poverty in developing countries.

References

- Abebe, T. and Quaicoe, N. (2014), "Causes of poverty in Sub-Saharan Africa: a layered theory approach to understanding significant factors", *Journal of Economics and International Finance*, No. 6, pp. 112-124.
- Akhter, S., Liu, Y. and Daly, K. (2010), "Cross country evidence on the linkages between financial development and poverty", *International Journal of Business and Management*, Vol. 5 No. 1, pp. 3-19.
- Akudugu, M.A. (2013), "The determinants of financial inclusion in Western Africa: insights from Ghana", *Research Journal of Finance and Accounting*, Vol. 4 No. 8, pp. 1-9.
- Alkire, S., Foster, J.E., Seth, S., Santos, M.E., Roche, J.M. and Ballon, P. (2015), *Multidimensional Poverty Measurement and Analysis*, Oxford University Press, Oxford.
- Amidžić, G., Alexander, M. and Andre, M. (2014), *Assessing Countries' Financial Inclusion-A New Composite Index*, IMF Working Paper, WP/14/36, International Monetary Fund, Washington, DC.
- Arellano, M. and Bond, S. (1991), "Some tests of specification for panel data: monte Carlo evidence and an application to employment equations", *The Review of Economic Studies*, Vol. 58, pp. 277-297.
- Arellano, M. and Bover, O. (1995), "Another look at the instrumental variable estimation of error-components models", *Journal of Econometrics*, No. 68, pp. 29-51.
- Ayyagari, M., Beck, T. and Hoseini, M. (2013), "Finance and poverty: evidence from India", CEPR Discussion Paper No. DP9497, pp. 1-70.
- Beck, T., Demirgüç-Kunt, A. and Honohan, P. (2009), "Access to Financial Services: Measurement, Impact, and Policies", *The World Bank Research Observer*, No. 24, pp. 119-145.
- Beegle, K., Christiaensen, L., Dabalen, A. and Gaddis, I. (2016), *Poverty in a Rising Africa*, The World Bank, Washington.
- Blundell, R. and Bond, S. (1998), "Initial conditions and moment restrictions in dynamic panel data models", *Journal of Econometrics*, Vol. 87, pp. 115-143.
- Chakravarty, R.S. and Pal, R. (2013), "Financial Inclusion in India: an axiomatic approach", *The Journal of Policy Modeling*, No. 35, pp. 813-837.
- Demirgüç-Kunt, A. and Klapper, L. (2012), *Measuring Financial Inclusion: The Global Findex Database*, World Bank Policy Research Working Paper, (6025), The World Bank, Washington.
- Fosu, A.K. (2010), "Does inequality constrain poverty reduction programs? Evidence from Africa", *Journal of Policy Modeling*, No. 32, pp. 818-827.
- Global Findex (2017), available at: <http://www.worldbank.org/globalfindex>
- Honohan, P. (2008), "Cross-country variation in household access to financial services", *Journal of Banking and Finance*, Vol. 32 No. 11, pp. 2493-2500.
- Jeanneney, S.G. and Kpodar, K. (2011), "Financial development and poverty reduction: can there be a benefit without a cost?", *Journal of Development Studies*, Vol. 47 No. 1, pp. 143-163.
- Kaur, J. (2017), *Rural-Urban Disparities in Financial Inclusion in India: A District Level Study*, Post-Doctoral Fellowship Report, ICSSR, New Delhi.
- Lal, T. (2017), "Impact of financial inclusion on poverty alleviation through cooperative banks", *International Journal of Social Economics*, Vol. 45 No. 5, pp. 808-828, doi: [10.1108/IJSE-05-2017-0194](https://doi.org/10.1108/IJSE-05-2017-0194).
- Levine, R., Loayza, N. and Beck, T. (2002), "Financial intermediation and growth: causality and causes", *Central Banking, Analysis, and Economic Policies Series*, No. 3, pp. 031-084.
- Lyons, A.C., Grable, J.E. and Zeng, T. (2017), *Infrastructure, Urbanization, and Demand for Bank and Non-bank Loans of Households in the People's Republic of China*, ADBI Working Paper 767, Asian Development Bank Institute, Tokyo, available at: <https://www.adb.org/publications/infrastructure-urbanization-and-demand-bank-and-nonbank-loans-households-prc>

- Olaniyi, E. and Babatunde, A. (2016), "Determinants of financial inclusion in Africa: a dynamic panel data approach", *University of Mauritius Research Journal*, No. 22, pp. 310-336.
- Olopadea, B.C., Okoduwa, H., Oladosuna, M. and Asaleyeba, A.J. (2019), "Human capital and poverty reduction in OPEC member-countries", *Helikon*, Vol. 5 No. 2, pp. 02-27.
- Park, C.Y. and Mercado, R. Jr. (2018), "Financial inclusion, poverty, and income inequality", *The Singapore Economic Review*, No. 63, pp. 185-206.
- Pasiouras, F. and Kosmidou, K. (2007), "Factors influencing the profitability of domestic and foreign commercial banks in the European Union", *Research in International Business and Finance*, Vol. 21 No. 2, pp. 222-237.
- Prodi, R. (2015), *Poverty Alleviation: A Role for Technology and Infrastructure?*, Concept note, Foundation for World Wide Cooperation, Bologna, pp. 1-21.
- Rashid, A. and Intartaglia, M. (2017), "Financial development—does it lessen poverty?", *Journal of Economic Studies*, Vol. 44 No. 1, pp. 69-86, doi: [10.1108/JES-06-2015-0111](https://doi.org/10.1108/JES-06-2015-0111).
- Sahoo, A.K. (2017), "Determinants of financial inclusion in tribal districts of Odisha: an empirical investigation", *Social Change*, Vol. 47 No. 1, pp. 1-20.
- Sarma, M. (2008), *Index of Financial Inclusion*, Working Paper 215, Indian Council for Research on International Economic Relations (ICRIER), New Delhi.
- Sarma, M. (2012), "Index of Financial Inclusion—a measure of financial sector inclusiveness", *Berlin Working Papers on, Money, Finance, Trade and Development*, Vol. 25 No. 1207, pp. 1-37.
- Sarma, M. and Pais, J. (2011), "Financial inclusion and development", *Journal of International Development*, Vol. 23 No. 5, pp. 613-628.
- Shaban, M., Girardone, C. and Sarkisya, A. (2019), "Financial inclusion: trends and determinants", in *Frontier Topics in Banking*, Palgrave Macmillan.
- Wang, X. and Guan, J. (2016), "Financial inclusion: measurement, spatial effects and influencing factors", *Applied Economics*, Vol. 49 No. 18, pp. 1751-1762.
- World Bank (2018), "The World Bank annual report 2018", available at: www.worldbank.org
- Zins, A. and Weill, L. (2016), "The determinants of financial inclusion in Africa", *Review of Development Finance*, Vol. 6 No. 1, pp. 46-57.

Further reading

- Abor, J.Y., Amidu, M. and Issahaku, H. (2018), "Mobile telephony, financial inclusion and inclusive growth", *Journal of African Business*, Vol. 19 No. 3, pp. 430-453.
- Aghion, P., Howitt, P., Howitt, P.W., Brant-Collett, M. and García-Peñalosa, C. (1997), *Endogenous Growth Theory*, MIT Press, Cambridge, MA.
- Ahlburg, D.A. (1996), "Population growth and poverty", in Ahlburg, D.A., Kelley, A.C. and Mason, K.O. (Eds), *The Impact of Population Growth on Well-Being in Developing Countries Population Economics*, Springer, Berlin, Heidelberg.
- Fosu, A.K. (2017), "Growth, inequality, and poverty reduction in developing countries: recent global evidence", *Research in Economics*, Vol. 71 No. 2, pp. 306-336.
- Inoue, T. and Hamori, S. (2016), "Financial access and economic growth: evidence from sub-Saharan Africa", *Emerging Markets Finance and Trade*, Vol. 52, pp. 743-753.
- Kosmidou, K., Pasiouras, F. and Tsaklanganos, A. (2007), "Domestic and multinational determinants of foreign bank profits: the case of Greek banks operating abroad", *Journal of Multinational Financial Management*, No. 17, pp. 1-15.
- World Bank (2008), *Finance for All? Policies and Pitfalls in Expanding Access*, World Bank, Washington, DC.

Table A1.
Index of Financial
Inclusion for some of
the 142 Developing
Countries

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Afghanistan	0.52	0.52	0.52	0.52	0.49	0.49	0.49	0.49	0.49	0.49	0.50	0.50	0.50	0.49	0.49
Albania	0.40	0.25	0.02	0.11	0.37	0.36	0.53	0.63	0.73	0.69	0.75	0.70	0.79	0.63	0.62
Algeria	0.31	0.33	0.33	0.29	0.28	0.23	0.23	0.20	0.17	0.15	0.17	0.15	0.20	0.18	0.15
American Samoa	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Angola	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.40	0.39	0.38	0.37	0.33	0.35
Antigua and Barbuda	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Argentina	0.54	0.56	0.59	0.61	0.65	0.71	0.73	0.76	0.78	0.83	0.83	0.84	0.86	0.88	0.90
Armenia	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Azerbaijan	0.52	0.35	0.23	0.02	0.13	0.05	0.16	0.40	0.75	0.45	0.89	0.52	0.52	0.52	0.52
Bangladesh	0.21	0.23	0.24	0.20	0.20	0.20	0.21	0.22	0.21	0.16	0.12	0.18	0.16	0.17	0.17
Belarus	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.54	0.58	0.60	0.64	0.65
Belize	0.54	0.55	0.58	0.60	0.64	0.73	0.73	0.76	0.78	0.81	0.82	0.81	0.85	0.73	0.75
Benin	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52

Note(s): The full Table for all the 142 countries is available on request

Source(s): Created by Authors, 2021

Corresponding author

Kofi Amoateng can be contacted at: amoateng@nccu.edu