The Relevance of Financial Inclusion on Social Problems, A Causality Demonstration

La relevancia de la inclusión financiera en los problemas sociales, una demostración de causalidad

Fernando Vera Sánchez
Escuela de Economía y Negocios, Universidad Anáhuac Puebla
fernando.verasa@anahuac.mx

https://orcid.org/0000-0003-3670-2672

Date of receipt: January 18, 2023
Date of acceptance: June 29, 2023
Date of publication: July 3, 2023

The Relevance of Financial Inclusion on Social Problems, A Causality Demonstration / Fernando Vera Sánchez
https://doi.org/10.18800/360gestion.202308.002
RCG. 20230802

This study aims to contribute to the literature by assessing the causal relation between financial inclusion and social variables. By using Generalized Method of Moments and Directed Acyclic Graphs on data provided by the World Bank from 92 countries in 2019, we can prove that variables like number of automated teller machines and commercial bank branches (financial inclusion variables) have an impact on child mortality and education (social variables). This study´s limitations include the availability of data for every country, so we recommend a panel data analysis where we can incorporate time series analysis for the available data set and other econometric techniques like Autoregressive Vectors and Cointegration. To our knowledge, this is the first study to use Directed Acyclic Graphs to estimate causality in any research related to financial inclusion.

Keywords: financial inclusion, child mortality, Generalized Method of Moments, Directed Acyclic Graphs

Este estudio tiene como objetivo contribuir a la literatura al evaluar la relación causal entre la inclusión financiera y las variables sociales. Usando el Método Generalizado de Momentos y Gráficas Dirigidas Acíclicas en datos de 92 países en el año 2019 provenientes del Banco Mundial, podemos probar que variables como el número de cajeros automáticos y sucursales de bancos comerciales (variables de inclusión financiera) tienen un impacto en la mortalidad infantil y la educación (variables sociales). Las limitaciones de este estudio incluyen la disponibilidad de datos para todos los países, por lo que recomendamos un análisis de datos de panel donde podemos incorporar series de tiempo para el conjunto de datos disponibles, además de otras técnicas econométricas como Vectores Autorregresivos y Cointegración. Hasta donde sabemos, este es el primer estudio que utiliza la técnica de Gráficas Dirigidas Acíclicas para estimar causalidad en cualquier investigación relacionada con la inclusión financiera.

Palabras clave: inclusión financiera, mortalidad infantil, Método Generalizado de Momentos, Gráficas Dirigidas Acíclicas.

1. Introducción

For the World Bank (2022), "Financial inclusion means that individuals and businesses have access to useful and affordable financial products and services that meet their needs—transactions, payments, savings, credit and insurance—delivered in a responsible and sustainable way". Authors such as Van *et al.* (2021) point out the importance of investigating the relationship between financial inclusion and economic growth because of the lack of empirical studies on the subject, specifically in countries with underdeveloped economies. Hathroubi (2019) considers that the effect of financial inclusion or financial development and economic growth on the development of socioeconomic variables is relatively small.

The investigation of financial inclusion on social variables has received relatively little attention compared to research on the nexus among economic variables. However, the soothing effects of financial inclusion on the economies are subject to social conditions. We would expect variables related with financial inclusion, such as number of ATMs and branches, to improve general conditions in the economy reflected in GDP per capita, having a positive impact on social variables like child mortality and education.

This study investigates these questions using the methodology of Generalized Method of Moments (GMM) to ensure unbiased and consistent estimates of errors with White error correction model (Abrigo & Love, 2016). We further extended the analysis using Directed Acyclic Graphs (DAG) and the concept of d-separation, which allows to infer causal relationships among variables. DAGs are different from the more commonly used Granger causality, which makes better predictions of time series variables but does not estimate causality *per se* (Vera, 2021). They allow schematically displaying causal relationships in a rigorous and systematic way, not only enabling us to identify the possible determinants of a phenomenon, but also to describe the scope of a research problem or even schedule the collection of data. These DAGs, based on graphic forms built on the researcher's *a priori* expert knowledge, facilitate the causal understanding of the phenomenon and the type of link between the variables involved, minimizing the introduction of biases during the design of the study and in the analysis of results (Werlinger & Cáceres, 2018).

Section 2 of this article reviews relevant literature on financial inclusion and social variables. The third section presents the data used in the analysis, while the fourth section describes the method used to estimate the causal relationship between financial inclusion and social variables, and shows the main results obtained with it. The fifth and final section offers a general conclusion.

2. Literature review

The first references regarding the relationship among financial inclusion and economic growth can be traced back to Schumpeter in the early 1900´s. This author assumed that financial inclusion allows for easier capital arrangements and contributes to finance activities which increase economic activity and economic growth (Schumpeter, 1912). Later, McKinnon highlighted the importance of an efficient financial system on economic development (McKinnon, 1973). In the early 2000´s one of the first efforts to measure the impact of the financial sector in the world was presented by Beck and De la Torre (2007),

who designed an indicator on the impact of the banking system. Around the same time, Mohan identified supply and demand factors of the financial system and the impact on economic growth (Mohan, 2006). More relevant literature on the topic of financial systems and economic development can be found on Calderón and Liu (2003), Christopoulos and Tsionas (2004), Demetriades and Luintel (1996), Kim *et al*. (2018), and Odedokun (1996).

On recent years, the literature on financial inclusion has been studied from different angles. In this section we will focus on the variables related with this concept and the statistical techniques used in the analysis. Furthermore, we will also specify some general conclusions obtained from different studies. The following table aims to facilitate this literature review:

Table 1. Main variables studied with financial inclusion

Variables	Statistical techniques	Authors
Determinants of financial inclusion	Survey and a Logit model	Wardhono *et al*. (2016)
Economic efficiency of banks	Principal components	Nair (2015)
Economic growth	Time series and Cointegration	Ali *et al*. (2019)
Economic growth	Granger causality	Calderón and Liu (2003)
Economic growth	Principal components	Lenka and Sharma (2017)
Economic growth and human development	Time series and Cointegration	Hathroubi (2019)
Education and income	Surveys	Nyoka (2019)
Financial inclusion as a quasi-public good	Index creation	Gupte (2012)
Foreign direct investment and GDP	Granger causality	Farouq and Sulong (2021)
General conditions of the financial system	Surveys	Abidi (2014)
General conditions of the financial system	Surveys	Kappoor (2013)
Human development index and GDP growth rate	Multiple regressions	Unnikrishnan and Jagannathan (2015)
Income inequality	Panel data and instrumental variables	Park and Shin (2017)
Income inequality and economic growth	Two-stage regression model and cross-sectional data	Kim (2016)
Interest rate volatility	Time series and Cointegration	Hajilee and Niroomand (2018)
Macroeconomic variables, savings	Kohonen mapping technique	Orazi *et al*. (2020)
Remittances	Survey and instrumental variables	Ajefu and Ogebe (2019)
Supply and demand services	Generalized Method of Moments and a quantile regression	Uddin *et al*. (2017)

Source: own elaboration.

In addition to economic growth, several variables are analyzed together with financial inclusion. An example of this is the research carried out by Farouq and Sulong in 2021, which analyzed the effect of foreign investment on economic development, financial inclusion and financial development in Nigeria. The authors concluded that an increase in financial inclusion improves the development of the financial sector. Also, they identified

that there is a positive relationship between GDP and financial development, since an increase in GDP generates an increase in financial development, passing through inclusion.

Orazi *et al*. (2020) identified the relationship between financial inclusion and macroeconomic variables through the Kohonen mapping technique. The research obtained results similar to those of the literature in general, showing that economies with a high level of GDP imply high level of financial inclusion. They highlighted the relationship of financial inclusion with savings, investment and economic growth. Nyoka (2019) analyzed the relationship between the level of education and the level of income with the degree of financial inclusion and its impact in South Africa.

Another study about macroeconomic variables was carried out by Ajefu and Ogebe (2019) in an article in which they analyzed the relationship between remittances and financial inclusion in Nigeria. They concluded that the amount of remittances increases the use of bank accounts, as well as mobile banking and financial operations. However, the flow of remittances does not show an influence on the use of debit cards and the use of ATMs in financial operations in that country.

Through a study about a series of relevant socioeconomic variables, Hathroubi (2019) tried to offer a measure of financial inclusion in Saudi Arabia, where he studied the impact of financial inclusion on growth and human development. According to the author, the relationship between financial inclusion and economic growth has been extensively studied in the literature. In the same vein, Unnikrishnan and Jagannathan (2015) analyzed the relationship between the global Financial Inclusion Index and its relationship with the GDP growth rate, as well as its impact on the Human Development Index. They concluded that having a high level of income in terms of GDP does not guarantee balanced economic growth. Regarding income inequality, Kim (2016) carried out a study on the effect of financial inclusion on the relationship between income inequality and economic growth. Its main conclusions were that reducing income inequality through financial inclusion changes the relationship between income inequality and economic growth from negative to positive, with this pattern being stronger in countries with high fragility than in countries with low fragility. Additionally, Park and Shin (2017) concluded that financial development contributes to reducing inequality to a certain extent, but as financial development increases, this contributes to greater inequality. On the other hand, they found that financial inclusion is particularly efficient in reducing income inequality. Hajilee and Niroomand (2018) analyzed interest rate volatility and its impact on financial inclusion in Brazil, China, India, Turkey, and Mexico. They highlighted the stability in interest rates and the effect on financial inclusion.

There is a great diversity of methodologies that have been used to analyze financial inclusion. In the following lines we will name some of these methodologies. As mentioned above, Farouq and Sulong (2021), when analyzing the effect of foreign investment on economic development and financial inclusion in Nigeria, used the Financial Development Index with data from the World Bank and, among other techniques, a Granger Causality type mechanism. Calderón and Liu (2003) used Geweke decomposition, which is based on the Granger Causality estimation. For their part, Van (2021) used panel data, although only for three years, with the aim of defining a multidimensional index of financial inclusion. Orazi *et al*. (2020) identified the relationship between financial inclusion and macroeconomic variables through the Kohonen map technique. Ali *et al*. (2019) investigated the impact of

financial inclusion on the economic growth of Pakistan using time series from 1985 to 2017. They found that economic growth and financial inclusion are cointegrated and that financial inclusion positively impacts economic growth in the short term with a lag of one year. Using cointegration analysis, Hajilee and Niroomand (2018) analyzed the volatility of the interest rate and its impact on financial inclusion. They also considered the error correction model for five countries: Brazil, China, India, Turkey and Mexico. Park and Shin (2017) used panel data and a series of instrumental variables in order to analyze the impact of financial inclusion on income inequality.

Using principal component analysis to construct a financial inclusion index which measures financial access in the Indian economy, Lenka and Sharma (2017) examined the effect of financial inclusion on economic growth over the period of 1980 to 2014. In addition, they used autoregressive distributed lags and the error correction model. Uddin *et al*. (2017) analyzed the determinants of financial inclusion in Bangladesh using the Generalized Method of Moments and a quantile regression, and observed they separate the effects on both the supply side and the demand side. Using a two-stage regression model and cross-sectional data from several countries, Kim (2016) carried out a study of the effect of financial inclusion on the relationship between income inequality and economic growth. Wardhono *et al*. (2016), through a survey and a Logit model, analyzed the determinants of financial inclusion in Indonesia.

As cited above, Unnikrishnan and Jagannathan (2015) analyzed the relationship between the global financial inclusion index and its relationship with the GDP growth rate, as well as the impact it has on the Human Development Index. For this, they used the concept of multiple regressions defining financial inclusion as a mediation variable, identifying it as a control variable to capture the relationship between the GDP growth rate and the Human Development Index.

Nair (2015) conducted a principal components study to capture the relationship of financial inclusion with economic efficiency in Indian banks. Also, based on surveys, both Abidi (2014) and Kappoor (2013) analyzed the conditions of financial inclusion in India. To our knowledge, this was the first study to use Directed Acyclic Graphs to estimate causality in any research related with financial inclusion.

As we can see, many of the studies on financial inclusion are specific for some regions or countries. The main country studied recently is India, with works by Laghate and Chotaliya (2021), Shylaja (2021), Noronha and Kumar (2019), Varghese and Viswanathan (2018), Hajilee and Niroomand (2018), Lenka and Sharma (2017), Jain *et al*. (2017), Sethy (2016), Balakrishnan (2015), Nair (2015), Abidi (2014), Jalaludeen (2014), and Goyal (2008). We can also find several works on the African continent by Farouq and Sulong (2021), Ajefu and Ogebe (2019), Nyoka (2019), Fowowe and Folarin (2019), and Burns (2018). There are some other countries studied in the literature like Bangladesh (Uddin et. al, 2017), Pakistan (Ali *et al.*, 2019), Saudi Arabia (Hathroubi, 2019), Indonesia (Wardhono *et al.*, 2016), Fiji (Finau *et al.*, 2016). In studies for Latin America we can mention works by Lumsden (2018) and Cabral (2017).

Another discussion that has been carried out in the recent literature on financial inclusion is the one that seeks to determine whether financial inclusion should be treated as a public good. Because of its importance in the economic and financial development

of a country and the supply problems from private institutions, some authors argue that the government should intervene to offer this service. In this sense, we can cite Nyoka (2019), who points out that financial inclusion should be treated as a public good due to the importance it has on personal and economic development. Also, according to Kelkar (2010), financial inclusion is perceived as a quasi-public good in most developing countries, and this is recognizable by identifying that it is a non-rival good in its consumption and not excludable. In this case the author points out that the degree of public good may be different from a typical public good such as national defense. However, it is just as important as access to clean water, energy, health services and basic education. For their part, Gupte *et al*. (2012) identified that recognizing financial inclusion as a quasi-public good has made it to be considered a priority objective of development policy, concluding that the government should provide these services jointly with other institutions.

3. Data used

In order to evaluate the relevance of financial inclusion on social variables, we used data from The World Bank (2022). The last available data when this paper was written was from 2020, but since it was limited we decided to use data from 2019 retrieved from 217 countries. The data from 92 of these countries, listed in Table 2, allowed us to use the same variable for each case. The variables used are presented as follows: first the dependent variables, followed by independent variables, and finally the control variables. The description, in quotation marks, comes directly from The World Bank data base.

Table 2. Countries used in the analysis

Albania	Ecuador	Latvia	Qatar
Algeria	Egypt, Arab Rep.	Lithuania	Romania
Argentina	Estonia	Luxembourg	Russian Federation
Armenia	Fiji	Malaysia	Rwanda
Austria	Finland	Maldives	Saudi Arabia
Belize	Gambia, The	Malta	Serbia
Benin	Georgia	Mauritania	Seychelles
Bhutan	Germany	Mauritius	Singapore
Bolivia	Greece	Mexico	Slovak Republic
Bulgaria	Guatemala	Moldova	Slovenia
Burkina Faso	Honduras	Mongolia	Solomon Islands
Cabo Verde	Hungary	Montenegro	South Africa
Cambodia	Iceland	Morocco	Spain
Chile	India	Mozambique	Sweden
Colombia	Ireland	Namibia	Switzerland
Costa Rica	Israel	Nepal	Thailand
Cote d'Ivoire	Italy	Niger	Timor-Leste
Croatia	Jamaica	Oman	Togo
Cyprus	Jordan	Pakistan	Turkey

Czech Republic	Kazakhstan	Peru	Uzbekistan
Denmark	Korea, Rep.	Philippines	Vanuatu
Djibouti	Kuwait	Poland	West Bank and Gaza
Dominican Republic	Kyrgyz Republic	Portugal	Zimbabwe

Source: adapted from The World Bank (2022).

Dependent variables:

- Child mortality or mortality rate under-5 (per 1 000 live births) "is the probability per 1 000 that a newborn baby will die before reaching age five" (The World Bank, 2022).
- Education level in terms of primary completion rate (% of relevant age group) "is the number of new entrants (enrollments minus repeaters) in the last grade of primary education, regardless of age, divided by the population at the entrance age for the last grade of primary education" (The World Bank, 2022).

Independent variables:

- Automated teller machines (ATMs) (per 100 000 adults) "are computerized telecommunications devices that provide clients of a financial institution with access to financial transactions in a public place" (The World Bank, 2022).
- Commercial bank branches (per 100 000 adults) "are retail locations of resident commercial banks and other resident banks that function as commercial banks that provide financial services to customers and are physically separated from the main office but not organized as legally separated subsidiaries" (The World Bank, 2022).

Control variables:

- Foreign direct investment and net inflows (% of GDP)

  are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows (new investment inflows less disinvestment) in the reporting economy from foreign investors, and is divided by GDP (The World Bank, 2022).
- GDP per capita (current US$)

  is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources (The World Bank, 2022).

- Gross savings (% of GDP) "are calculated as gross national income less total consumption, plus net transfers" (The World Bank, 2022).
- Personal remittances, received (% of GDP),

  comprise personal transfers and compensation of employees. Personal transfers consist of all current transfers in cash or in kind made or received by resident households to or from nonresident households. Personal transfers thus include all current transfers between resident and nonresident individuals. Compensation of employees refers to the income of border, seasonal, and other short-term workers who are employed in an economy where they are not resident and of residents employed by nonresident entities (The World Bank, 2022).
- Trade (% of GDP) "is the sum of exports and imports of goods and services measured as a share of gross domestic product" (The World Bank, 2022).

We considered to use some other variables like interest rate spread, government expenditure in education, Gini coefficient, literacy rate, life expectancy, and poverty. However, the coincidences in data available were less than 50, which is not statiscally significant in any econometric study. Nevertheless, indexes like Human Development Index and Social Progress Index give an important role to the social variables selected in this study.

In the case of account ownership, another variable considered, there is available data for limited countries and from only three years: 2011, 2014 and 2017. Also, we didn't use the variable income due to the high correlation with the variable savings, already in use. The correlation matrix generated from our data set is shown in Table 3.

Table 3. Correlation matrix from the variables used in the analysis

	ATMs	Branches	GDPpc	FDI	Educ	Remitt	Savings	Trade	ch_mort
ATMs	1,000								
Branches	0,353	1,000							
GDPpc	0,418	0,285	1,000						
FDI	- 0,040	0,202	0,090	1,000					
Educ	0,321	0,194	0,196	0,088	1,000				
Remitt	- 0,292	0,029	- 0,385	- 0,048	0,031	1,000			
Savings	0,152	- 0,074	0,298	- 0,101	0,199	- 0,046	1,000		
Trade	0,117	0,327	0,521	0,298	- 0,011	- 0,144	0,154	1,000	
ch_mort	- 0,562	- 0,415	- 0,472	- 0,142	- 0,676	0,101	- 0,137	- 0,263	1,000

Note. ATMs is the number of automated teller machines per 100 000 adults. Branches is the number of commercial bank branches per 100 000 adults. GDPpc is GDP per capita in current US$. FDI is foreign direct investment, net inflows as a % of GDP. Educ is education level in terms of primary completion rate as a % of relevant age group. Remitt is personal remittances, received as a % of GDP. Savings are calculated as gross national income minus total consumption, plus net transfers as a % of GDP. Trade is the sum of exports and imports as a % of GDP. ch_mort is child mortality of children under 5 years old per 1 000 births. This table was made using the software EViews.

Source: own elaboration.

As described in the literature review, recent studies on financial inclusion consider the estimation of indexes in order to generate quantitative analysis (Van *et al*., 2021). These indexes agree to consider variables like ATMs, branches and account ownership from the supply side. This is the reason why we consider the first two variables as a general approximation to financial inclusion (Bhalli & Raghavan, 2019; Lenka & Sharma, 2017; Mialou *et al*., 2017; Sethy, 2016; Vera-Sánchez, 2023).

On social variables, we consider child mortality and education due to the general availability of this information.

4. Estimation results and methodology

In order to explain the relationship between financial inclusion and social variables, we first used a model where the dependent variable is child mortality and the rest of the variables are the explanatory variables. We were able to avoid multicollinearity as we didn't identify high correlation in the correlation matrix in Table 3. Due to the presence of autocorrelation and heteroscedasticity we estimated the Generalized Method of Moments (GMM) with White´s covariance in a similar fashion to the studies by Uddin *et al.* (2017). The results are shown in Table 4.

Table 4. Generalized Method of Moments model with child mortality as a dependent variable

Variable	Coefficient	Std. Error	t-Statistic	Prob.	
C	129,2326	15,30063	8,446226	0,000	
ATMs	-0,138663	0,041121	-3,372073	0,001	Significant
Branches	-0,164183	0,104239	-1,575067	0,119	
Educ	-1,004757	0,150799	-6,662876	0,000	Significant
FDI	-0,035549	0,034944	-1,017318	0,312	
GDPpc	-0,000206	7,16E-05	-2,880371	0,005	Significant
Remitt	-0,202834	0,321675	-0,630555	0,530	
Savings	0,199646	0,174733	1,142581	0,257	
Trade	-0,037913	0,020794	-1,82324	0,072	

Note. ATMs is the number of automated teller machines per 100 000 adults. Branches is the number of commercial bank branches per 100 000 adults. Educ is education level in terms of primary completion rate as a % of relevant age group. FDI is foreign direct investment, net inflows as a % of GDP. GDPpc is GDP per capita in current US$. Remitt is personal remittances, received as a % of GDP. Savings are calculated as gross national income minus total consumption, plus net transfers as a % of GDP. Trade is the sum of exports and imports as a % of GDP. The J-test in this case is 2.00E-27. This table was made using the software EViews.

Source: own elaboration.

We identified from this model that one of the significant variables that help explain child mortality in this data set are ATMs. As we expected, there is a negative relationship between the number of ATMs available in the country and child mortality. Since an ATM is a sign of better financial inclusion, we can infer that an increase in this variable is related to a decrease in child mortality and its prevention, thus contributing to alleviate one of the main concerns in any society searching for better social conditions. As one of the revisors

pointed out, when banks and other financial institutions decide to install more contact points (ATMs or branches) in a region to serve their customers, they do so because they are convinced that economic activity in that region has increased. The greater demand for financial products and services is in tune with higher income of individuals and higher profits of companies, which cause an increase in private consumption. This leads people to spend more and to better quality of education and health care, which eventually implies a reduction in child mortality.

In other words, child mortality is related to, among other things, health access and health conditions. Not all countries have guaranteed good health conditions and free access to health services and to stablished hospitals and clinics, and because of this in many cases families have to find alternatives to the country's health system program. In many cases, these other alternatives require payments in cash, leading us to infer that ATMs, which allow for rapid access to cash, have an important role on the social variable of child mortality. However, in order to access cash at an ATM, you must have a bank account with a sufficient balance. This is facilitated by an increase in personal income, which is proportional to an increase in economic activity.

The variable related to the number of commercial bank branches is also negatively related with child mortality, as we would expect. However, the coefficient is not statistically significant.

The GMM model identifies the education variable as relevant to explain child mortality. As suggested by the literature on the topic, there is a negative relationship since higher levels of education help to prevent child mortality. Finally, the other significant variable is GDP per capita. Since this one shows a negative coefficient, we can infer that better economic conditions impact social variables positively, with an example of this being child survival rate. However, the coefficient in this case is very low.

We also considered a Generalized Method of Moments model with education as dependent variable. The results are shown in Table 5. From this model we identified that child mortality is a relevant variable and has a negative coefficient. We also identified macroeconomic variables as significant to explain education. Foreign Direct Investment has a positive coefficient, implying that many of the financial resources end up improving the conditions of education in the country. Finally, the trade variable is significant to explain education. The coefficient, however, is negative, which implies that higher commercial trade in the country reduces the level of education.

Table 5. Generalized Method of Moments model with education as a dependent variable

Variable	Coefficient	Std. Error	t-Statistic	Prob.	
C	102,561	3,61758	28,35073	0,000	
ATMs	-0,017068	0,01578	-1,081575	0,283	
Branches	-0,019873	0,07855	-0,252994	0,801	
ch_mort	-0,418067	0,046045	-9,079572	0,000	Significant

FDI	0,040019	0,019216	2,08254	0,040	Significant
GDPpc	-0,0000372	3,89E-05	-0,955834	0,342	
Remitt	0,093983	0,245855	0,38227	0,703	
Savings	0,22249	0,117617	1,891655	0,062	
Trade	-0,038859	0,015032	-2,585133	0,012	Significant

Note. ATMs is the number of automated teller machines per 100 000 adults. Branches is the number of commercial bank branches per 100 000 adults. ch_mort is child mortality of children under 5 years old per 1 000 births. FDI is foreign direct investment, net inflows as a % of GDP. GDPpc is GDP per capita in current US$. Remitt is personal remittances, received as a % of GDP. Savings are calculated as gross national income minus total consumption, plus net transfers as a % of GDP. Trade is the sum of exports and imports as a % of GDP. The J-test in this case is 6.82E-29. This table was made using the software EViews.

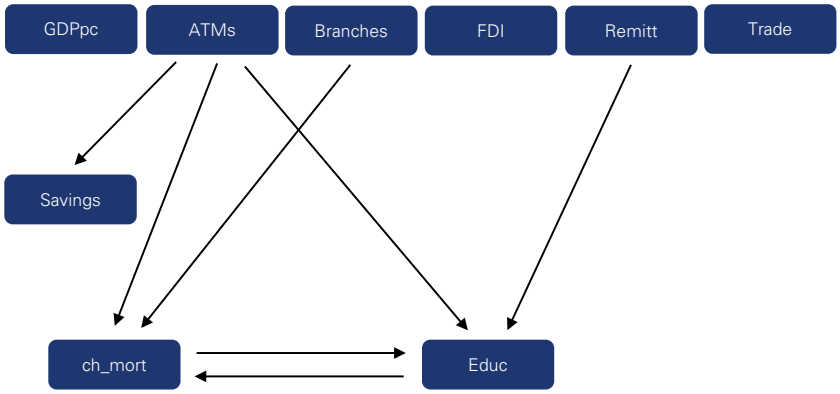
Source: own elaboration.

At the end of the 1990s, Bessler and Akleman (1998) proposed to the economic scientific community the use of inductive causality models. These authors based themselves on the works of Spirtes *et al*. (1993) and Pearl (1995), referring to computational sciences and the use of artificial intelligence. The result of these proposals is the Directed Acyclic Graphs technique. Some examples of the use of this technique with macroeconomic variables are works by Huang and Xiong (2020), Melo-Becerra *et al*. (2015), and Spiegler (2017).

Directed Acyclic Graphs (DAG) offer a convenient way to estimate causality among variables, especially when the literature does not specify a clear relationship between them as in the case of financial inclusion on social variables, studied on this paper. Using the software Tetrad, we were able to estimate a DAG where we forbid latent common causes in order to estimate the direct causal relationship. In addition, the software established a causal order presented in Figure 1. It is worth to mention that other software like Amos and Lisrel are based on least squares and maximum likelihood, and do not estimate causality (Ahmed *et al*., 2017).

From these results we can imply that variables related with financial inclusion such as ATMs and Branches have a direct causal relationship with child mortality. This was only inferred but not proven in literature. The correlation matrix presented above showed that this relationship is negative, from which we can assume that in countries with higher access to ATMs and Branches, which are signs of better financial inclusion, child mortality is reduced. This happens, as mentioned before, because of the rapid access to cash and alternative health services in the country. There is a causal positive relationship between ATMs and savings which is expected as a better financial system helps people handle their finances and allows for the possibility to increase savings.

Figure 1. Results from the Directed Acyclic Graph estimate



Note. GDPpc is GDP per capita in current US$. ATMs is the number of automated teller machines per 100 000 adults. Branches is the number of commercial bank branches per 100 000 adults. FDI is foreign direct investment, net inflows as a % of GDP. Remitt is personal remittances, received as a % of GDP. Trade is the sum of exports and imports as a % of GDP. Savings are calculated as gross national income minus total consumption, plus net transfers as a % of GDP. ch_mort is child mortality of children under 5 year old per 1 000 births. Educ is education level in terms of primary completion rate as a % of relevant age group. This graph was made using the software Tetrad.

Source: own elaboration.

Remittances have been proven to have a direct positive relationship with education. In the countries where remittances are important as a percentage of GDP, people use this money, among other things, to invest in education, which is reflected on a higher percentage of the population having completed primary education. There is an important negative interrelationship between child mortality and education, from which we can infer that countries with better education have a reduced child mortality rate. Also, reduced child mortality allows for a better level of education. The results obtained from the Directed Acyclic Graphs technique showed that ATMs have a causal relationship with education. Although the GMM showed that this relationship has a negative coefficient and is not significant, the DAG and the correlation matrix showed a positive relationship. We can therefore imply that countries with more access to cash can manage to pay for education services, and this is reflected on the general level of education in the population.

It is worth to mention that some other macroeconomic variables like Foreign Direct Investment and trade have no relationship with GDP per capita in this study. This faint result may suggest that we need to remember that GDP is a complex variable and is formed by many other components in each economy. Our general results are in line with those of Unnikrishnan and Jagannathan (2015). However, they differ from Farouq and Sulong (2021), Orazi *et al.* (2020), and Ajefu and Ogebe (2019), though we need to remember that these last studies are specific for some countries and are not a general study of the world.

5. Conclusions

In order to explain the relationship between financial inclusion and social variables, we first estimated two econometric models where the dependent variables were child mortality and education. For this we used the Generalized Method of Moments (GMM) and White

correction error. From these models we were able to prove that variables related with financial inclusion like number of ATMs are relevant to improve social environment. To reach this conclusion we considered the data set of 92 countries for the year 2019.

We identified, for example, that one of the significant variables to explain child mortality in this data set are ATMs. As we expected, there is a negative relationship between the number of ATMs available in a country and its child mortality rate. We can therefore infer that a higher number of ATMs, related with better financial inclusion, helps to prevent child mortality since people have more access to cash. Education is another variable related with child mortality with a negative coefficient. We can infer that higher education in the country implies a smaller number of children and better conditions for each one. The last significant variable is GDP per capita, related to the general economic and financial conditions. With a better economy we can infer better health conditions in the country.

When we considered education as dependent variable, we found that child mortality is a relevant variable with a negative coefficient. We also found significant macroeconomic variables like Foreign Direct Investment, which has a positive coefficient. This implies that many of the financial resources from foreign countries end up improving the conditions of education in the country receiving investment. Finally, while the trade variable is significant to explain education, its coefficient is negative, which could imply that higher commercial trade in a country reduces its level of education. This result signals an opportunity for future analysis.

We also estimated another econometric model to capture the causal relationship among variables using the Directed Acyclic Graphs (DAG) technique. From here we were able to prove that variables related with financial inclusion, like number of ATMs and number of commercial bank branches, are relevant in the causal flow of social variables like child mortality and education.

Using the econometric techniques described above, we found a negative relationship between the number of ATMs available in the country and child mortality. Among other things, child mortality is related to health access and health conditions. If a country has better financial conditions and relatively fast access to cash, it is possible to find relatively fast access to different health services and decrease child mortality. This concept has been inferred on the literature, but to our knowledge it had not been proven until now. This is one of the main theoretical contributions of this research.

We found a positive causal relationship between ATMs and remittances on the level of primary education completion on this data set. These results support our inference on the importance of the level of investment on education from the financial system. However, we recommend further research on this topic, especially considering that we only have data for 2019 and no subsequent years. We believe that the impact on education is reflected over time.

Although there are differences in the conclusions obtained from the GMM and DAG, there are also strong coincidences. It is important to consider these econometric techniques like complements of formal studies. The DAG technique captures the interrelationship between child mortality and education, and that has to be estimated step by step in the GMM.

Our conclusions allow to generate policy recommendations to improve social conditions. These recommendations are directly related to the importance of promoting financial inclusion in each country. In this manner, it is important to remember that although financial inclusion on the supply side is mainly defined by ATMs, branches and account ownership, it is not enough just to open a country to the financial system in general. There should be banks and financial institutions that are willing to work in a competitive environment in order to avoid monopolies and generate benefits for the general population, not just for some firms. Also, we recommend not to just freely give debit cards and bank accounts to the general population. There are some countries in which account ownership is relatively high, even when most of them have zero balance.

The objective in any policy recommendation is not just to create ATMs or branch infrastructure, but to improve financial and social conditions for the population. As it has been proven in this article, this is possible with better financial inclusion.

This study´s limitations include the availability of data for every country. We therefore recommend a panel data analysis where we can incorporate time series analysis for the available data set and other econometric techniques like Vector Autoregressive and Cointegration. Also, we recommend an extension of this study considering another data set to include variables like Human Development Index, Happiness Index and Social Progress Index. Finally, we recommend to estimate these models using data available for any one specific country or region.

references

Abidi, N.A.

2014 Sustainable financial inclusion: A case study of Ranchi District. *CLEAR International Journal of Research in Commerce & Management, 5*(6), 63–67.

Abrigo, M.R.M., & Love, I.

2016 Estimation of Panel Vector Autoregression in Stata. *The Stata Journal*, *16*(3), 778-804. https://doi.org/10.1177/1536867X1601600314

Ajefu, J.B., & Ogebe, J.O.

2019 Migrant remittances and financial inclusion among households in Nigeria. *Oxford Development Studies*, *47*(3), 319-335. https://doi.org/10.1080/13600818.2019.1575349

Ali, N., Fatima, K., & Ahmed, J.

2019 Impact of financial inclusion on economic growth in Pakistan. *Journal of Managerial Sciences*, *13*(3), 166-174.

Balakrishnan, M.

2015 Indian payment systems and financial inclusion: Current status and next steps. *Journal of Payments Strategy & Systems*, *9*(3), 242–293. https://hstalks.com/article/4247/indian-payment-systems-and-financial-inclusion-cur/

Beck, T.H.L., & De la Torre, A.

2007 The basic analytics of access to financial services. *Financial Markets, Institutions and Instruments*, *16*(2), 79-117. https://doi.org/10.1596/1813-9450-4026

Bessler, D.A., & Akleman, D.G.

1998 Farm prices, retail prices, and directed graphs: Results for pork and beef. *American Journal of Agricultural Economics*, *80*(5), 1144-1149. https://doi.org/10.2307/1244220

Bhalli, M.T., & Raghavan, M.

2019 Financial inclusion index: A comprehensive measure. *World Economics Journal*, *21*(4), 139-170. https://www.world-economics-journal.com/Journal/Papers/Financial%20Inclusion%20Index.details?ID=818

Burns, S.

2018 M-Pesa and the "Market-Led" Approach to Financial Inclusion. *Economic Affairs*, *38*(3), 406-421. https://doi.org/10.1111/ecaf.12321

Cabral, K.

2017 Exploiting Latin American microfinance deregulation: One borrower at a time. *Brooklyn Journal of Corporate, Financial & Commercial Law*, *12*(1), 105-131. https://brooklynworks.brooklaw.edu/cgi/viewcontent.cgi?article=1264&context=bjcfcl

Calderón, C., & Liu, L.

2003 The direction of causality between financial development and economic growth. *Journal of Development Economics*, *72*(1), 321-334. https://doi.org/10.1016/S0304-3878(03)00079-8

Christopoulos, D.K., & Tsionas, E.G.

2004 Financial development and economic growth: Evidence from panel unit root and cointegration tests. *Journal of Development Economics*, *73*(1), 55-74. https://doi.org/10.1016/j.jdeveco.2003.03.002

references

Demetriades, P.O., & Luintel, K.B.

1996 Financial development, economic growth and banking sector controls: Evidence from India. *The Economic Journal*, *106*(435), 359-374. https://doi.org/10.2307/2235252

El-Sheikh, A., Abonazel, M.R., & Gamil, N.

2017 A review of software packages for structural equation modeling: A comparative study. *Applied Mathematics and Physics*, *5*(3), 85-94.

Farouq, I.S., & Sulong, Z.

2021 The effects of foreign direct investment uncertainty on financial development in Nigeria: An asymmetric approach. *Iranian Journal of Management Studies*, *14*(2), 383-399.

Finau, G., Rika, N., Samuwai, J., & McGoon, J.

2016 Perceptions of digital financial services in rural Fiji. *Information Technologies & International Development*, *12*(4), 11-21. https://itidjournal.org/index.php/itid/article/view/1566.html

Fowowe, B., & Folarin, E.O.

2019 The effects of fragility and financial inequalities on inclusive growth in African countries. *Review of Development Economics*, *23*(3), 1141-1176. https://doi.org/10.1111/rode.12594

Goyal, C.K.

2008 Financial inclusion in the northeastern region of India with special reference to Assam. *ICFAI Journal of Applied Finance*, *14*(12), 54-64. http://dx.doi.org/10.1108/XJM-09-2020-011

Gupte, R., Venkataramani, B., & Gupta, D.

2012 Computation of financial inclusion index for India. *Procedia – Social and Behavioral Sciences*, *37*, 133-149. https://doi.org/10.1016/j.sbspro.2012.03.281

Hajilee, M., & F.

2018 The impact of interest rate volatility on financial market inclusion: Evidence from emerging markets. *Journal of Economics & Finance*, *42*(2), 352-368. https://doi.org/10.1007/s12197-017-9422-x

Hathroubi, S.

2019 Inclusive finance, growth and socio-economic development in Saudi Arabia: A threshold cointegration approach. *Journal of Economic Development*, *44*(2), 77-111. https://doi.org/10.35866/caujed.2019.44.2.004

Huang, H., & Xiong, T.

2020 Price bubbles and market integration in global sugar futures markets. *Journal of Applied Economics*, *23*(1), 1-20. https://doi.org/10.1080/15140326.2019.1693202

Jain, M., Naz, S. S., & Mathur, T. N.

2017 Financial inclusion: Its impact on Indian banking industry. *CLEAR International Journal of Research in Commerce & Management*, *8*(5), 15-19.

Jalaludeen, N.

2014 Is bank branch expansion driven by demand? - Some evidence from Kerala. *The IUP Journal of Bank Management*, *13*(1), 7-18. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2482266

Kappoor, P.

2013 Study of financial inclusion in banking industries in India. *CLEAR International Journal of Research in Commerce & Management*, *4*(10), 44-48.

references

Kelkar, V.

2010 Financial inclusion for inclusive growth. *ASCI Journal of Management*, *39*(1), 55-68.

Kim, D.W., Yu, J.S., & Hassan, M. K.

2018 Financial inclusion and economic growth in OIC countries. *Research in International Business and Finance*, *43*, 1-14. https://doi.org/10.1016/j.ribaf.2017.07.178

Kim, J.H.

2016 A study on the effect of financial inclusion on the relationship between income inequality and economic growth. *Emerging Markets Finance & Trade*, *52*(2), 498-512. https://doi.org/10.1080/1540496X.2016.1110467

Laghate, K., & Chotaliya, M.

2021 Financial inclusion and inclusive growth in India: An analysis of bank branches, deposits and credits. *IUP Journal of Accounting Research & Audit Practices*, *20*(3), 33-42.

Lenka, S.K., & Sharma, R.

2017 Does financial inclusion spur economic growth in India? *Journal of Developing Areas, 51*(3), 215-228. https://doi.org/10.1353/jda.2017.0069

Lumsden, E.

2018 The future is mobile: financial inclusion and technological innovation in the emerging world. *Stanford Journal of Law, Business & Finance*, *23*(1), 1-44. https://law.stanford.edu/publications/future-mobile-financial-inclusion-technological-innovation-emerging-world/

McKinnon, R.I.

1973 *Money and capital in economic development.* Brookings Institution.

Melo-Becerra, L.A., Ramos-Forero, J.E., & Zárate-Solano, H.

2015 Sovereign bond markets and financial stability in an emerging economy: An application of directed acyclic graphs and SVAR models. *Macroeconomics & Finance in Emerging Market Economies*, *8*(3), 306–319. https://doi.org/10.1080/17520843.2015.1049641

Mialou, A., Amidzic, G., & Massara, A.

2017 Assessing countries' financial inclusion standing: A new composite index. *Journal of Banking & Financial Economics*, *2*(8), 105-126. https://doi.org/10.7172/2353-6845.jbfe.2017.2.5

Mohan, R.

2006 Economic growth, financial deepening and financial inclusion. In *Inclusive Growth – A New Challenge* (pp. 1305-1320). Reserve Bank of India Bulletin.

Nair, M.S.

2015 Financial inclusion vis-à-vis economic efficiency: The case of commercial banks in India. *Productivity*, *55*(4), 338-349. https://www.proquest.com/docview/1701848768

Noronha, M., & Kumar, V.R.

2019 Technology: A tool for achieving inclusive and sustainable growth through financial inclusion. *CLEAR International Journal of Research in Commerce & Management*, *10*(2), 1-5.

Nyoka, C.

2019 Education level and income disparities: Implications for financial inclusion through mobile money adoption in South Africa. *Comparative Economic Research*, *22*(4), 129-142. https://doi.org/10.2478/cer-2019-0036

Odedokun, M.O.

1996 Alternative econometric approaches for analyzing the role of the financial sector in economic growth: Time-series evidence from LDCs. *Journal of Development Economics*, *50*(1), 119-146. https://doi.org/10.1016/0304-3878(96)00006-5

Orazi, S., Martinez, L.B., Vigier, H.P., & Guercio, M.B.

2020 A regional Kohonen map of financial inclusion and related macroeconomic variables. *Economic Computation & Economic Cybernetics Studies & Research*, *54*(3), 179-195. https://ri.conicet.gov.ar/handle/11336/127012

Park, D., & Shin, K.

2017 Economic growth, financial development, and income inequality. *Emerging Markets Finance & Trade*, *53*(12), 2794-2825. http://hdl.handle.net/11540/5099

Pearl, J.

1995 Causal diagrams for empirical research. *Biometrika*, *82*(4), 669-710. https://doi.org/10.2307/2337329

Schumpeter, J.A.

1912 *The theory of economic development*. Harvard University Press.

Sethy, S.K.

2016 Developing a financial inclusion index and inclusive growth in India. *Theoretical & Applied Economics*, *23*(2), 187-206. https://store.ectap.ro/articole/1191.pdf

Shylaja, H.N.

2021 Pradhan Mantri Jan Dhan Yojna and financial inclusivity: An empirical analysis. *SDMIMD Journal of Management*, *12*(1), 41-53. https://doi.org/10.18311/sdmimd/2021/26604

Spiegler, R.

2017 Data monkeys: A procedural model of extrapolation from partial statistics. *Review of Economic Studies*, *84*(4), 1818-1841. https://www.jstor.org/stable/26543873

Spirtes, P., Glymour, C., & Scheines, R.

1993 *Causation, prediction, and search*. Springer-Verlag.

Spirtes, P., Glymour, C., & Scheines, R.

2000 *Causation, prediction, and search* (2nd ed.). MIT Press.

The World Bank

2022a World Bank Data [data base]. https://data.worldbank.org

The World Bank

2022b Financial Inclusion. https://www.worldbank.org/en/topic/financialinclusion

Uddin, A., Ferdous Chowdhury, M.A., & Islam, M.N.

2017 Determinants of financial inclusion in Bangladesh: Dynamic GMM & quantile regression approach. *Journal of Developing Areas*, *51*(2), 221-237. https://muse.jhu.edu/article/657938

references

Unnikrishnan, R., & Jagannathan, L.

2015 Unearthing global financial inclusion levels and analysis of financial inclusion as a mediating factor in global human development. *Serbian Journal of Management*, *10*(1), 19-32. https://doi.org/10.5937/sjm10-5363

Van, L.T.-H., Vo, A.T., Nguyen, N.T., & Vo, D.H.

2021 Financial inclusion and economic growth: An international evidence. *Emerging Markets Finance & Trade*, *57*(1), 239-263.

Varghese, G., & Viswanathan, L.

2018 Normative perspectives on financial inclusion: Facts beyond statistics. *Journal of Public Affairs*, *18*(4). https://doi.org/10.1002/pa.1829

Vera, F.

2021 Social or economic variables? Which one reduces poverty? A causality approach. *London Journal of Research in Humanities and Social Sciences*, *21*(2), 9-22.

Vera-Sánchez, F.

2023 Revisión bibliográfica acerca de la inclusión financiera. In *Finanzas éticas y solidarias en América Latina: diagnósticos, debates y propuestas*. Dirección Editorial del Instituto de Altos Estudios Nacionales.

Wardhono, A., Qori'ah, C.G., & Indrawati, Y.

2016 The determinants of financial inclusion: Evidence from Indonesian districts. *International Journal of Economic Perspectives*, *10*(4), 472-483. https://www.researchgate.net/publication/319304832_The_determinants_of_financial_inclusion_Evidence_from_Indonesian_districts

Werlinger, F., & Cáceres, D.

2018 Aplicación de grafos acíclicos dirigidos en la evaluación de un set mínimo de ajuste de confusores: un complemento al modelamiento estadístico en estudios epidemiológicos. *Revista médica de Chile*, *146*(7), 907-913. http://dx.doi.org/10.4067/s0034-98872018000700907