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Noelia Cámara
David Tuesta

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Abstract

We rely on demand and supply-side information to measure the extent of financial inclusion at country level for eighty-two developed and less-developed countries. We postulate that the degree of financial inclusion is determined by three dimensions: usage, barriers and access to financial inclusion. Weights assigned to the dimensions are determined endogenously by employing a two-stage Principal Component Analysis. Our composite index others a comprehensive measure of the degree of financial inclusion, easy to understand and compute.

Keywords: Financial inclusion, Principal Component Analysis, inclusion barriers.

JEL: C43, G21, O16.

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1 Introduction

Issues relating to financial inclusion are a subject of growing interest and one of the major socioeconomic challenges on the agendas of international institutions, policymakers, central banks, financial institutions and governments. The World Bank's declared objective of achieving universal financial access by 2020 is another example of financial inclusion being recognised as fundamental for economic growth and poverty alleviation. [1] The World Bank's latest estimates state that half the adult population in the world does not have a bank account in a formal financial institution. However, the concept of financial inclusion goes beyond single indicators, such as percentage of bank accounts and loans and number of automated teller machines (ATMs) and branches. The attempts to measure financial inclusion through multidimensional indices are scarce and incomplete. To the best of our knowledge, literature lacks a comprehensive indicator that can bring together information on financial inclusion by using a statistically sound weighting methodology and takes into account both demand- and supply-side information. Our study aims to fill this gap.

The major contribution of this paper is the construction of a multidimensional financial inclusion index covering eighty-two countries for the year 2011. The weights of the index are obtained from a two-stage Principal Component Analysis (PCA) for the estimation of a latent variable. First, we apply PCA to estimate a group of three sub-indices representative of financial inclusion. Second, we apply again PCA to estimate the overall financial inclusion index by using the previous sub-indices as causal variables. Our index improves existing financial inclusion indices in several ways. First, we use a parametric method that

[1] The Global Financial Development report for 2014, by the World Bank (2013), is the second report that focuses on the relevance of financial inclusion. It offers an overview of financial inclusion status and problems based on new evidence about financial sector policy. The Maya Declaration is another example that evidences the importance of financial inclusion. It consists of a set of measurable commitments by developing countries' governments to enhance financial inclusion. There are more than 90 countries in the agreement and they represent more than 75 per cent of the unbanked population. Finally, the G20 also express its interest in promoting financial inclusion in non-G20 countries through the Global Partnership for Financial Inclusion (GPFI). This platform, officially launched in Seoul in 2010, recognizes financial inclusion as one of the main pillars of the global development agenda endorsed in its Financial Inclusion Action Plan.

avoids the problem of weight assignment. Second, we offer a harmonized measure of financial inclusion for a larger set of countries, 82 developed and less-developed countries, that allows comparisons across countries and over time. Finally, we provide a comprehensive definition of financial inclusion combining information from a large set of indicators from both demand and supply-side data sets, and from two perspectives: banked and unbanked population. It is the first time that a composite index uses a demand-side data set at individual level to measure the level of financial inclusion across countries. We identify two problems in the current financial inclusion indices. First, existing attempts to build financial inclusion indices rely only on supply-side country level data and come up with inaccurate readings of financial inclusion due to the existence of measurement errors in the usage indicators. Supply-side indicators, particularly the number of accounts or loans, can overestimate the inclusiveness of financial systems since one person can have more than one account or loan. It is a very common practice in developed countries. Second, assigning exogenous weights to indicators is often criticized for lack of scientific rigour because exogenous information is imposed.

The lack of a harmonized measure that collects multidimensional information to define financial inclusion is a pitfall that complicates the understanding of several related problems. The multidimensional measurement of financial inclusion is important in several aspects. First, a measure that aggregates several indicators into a single index aids in summarizing the complex nature of financial inclusion and helps to monitor its evolution. A good index is better at extracting information. Second, a better measure of financial inclusion may allow us to study the relationship between financial inclusion and other macroeconomic variables of interest. Third, information by dimension helps to better understand the problem of financial inclusion. It can be a useful tool for policy making and policy evaluation.

There are two commonly used approaches to constructing composite indices: non-parametric and parametric methods. Non-parametric methods assign the importance of

indicators by choosing the weighs exogenously, based on researchers' intuition. There is evidence that indices are sensitive to subjective weight assignment, since a slight change in weights can alter the results dramatically (Lockwood, 2004). [2] Sarma (2008, 2012) and Chakravarty and Pal (2010) are examples of financial inclusion indices that apply this methodology to usage and access indicators from supply-side country level data sets. Parametric methods sustain that there exists a latent structure behind the variation of a set of correlated indicators so that the importance of indicators (weights) in the overall index can be determined endogenously through the covariation between the indicators on each dimension of the structure. In brief, weights are determined by the information of sample indicators. There are two parametric analyses commonly used for indexing: PCA and Common Factor Analysis. Amidžić *et al.* (2014) attempt to measure financial inclusion based on a Common Factor Analysis. However, the indicators used to define financial inclusion only include limited supply-side information at country level. What is more, from an empirical point of view, PCA is preferred over Common Factor Analysis as an indexing strategy because it is not necessary to make assumptions on the raw data, such as selecting the underlying number of common factors (Steiger, 1979).

The rest of the paper is organized as follows. In section 2, we describe the data and the rationale for our chosen indicators as well as for the use of sub-indices that measure financial inclusion dimensions. Section 3 describes the methodology for constructing our composite index from multi-dimensional data. Section 4 discusses the results of the sub-indices as well as the composite financial inclusion index. Section 5 analyses the robustness of our index. Finally, Section 6 concludes.

[2] There is also a problem with weight reassignment when new indicators are included into an existing index.

2 Financial Inclusion Dimensions and Data Sources

How to measure financial inclusion is a topic of concern among researchers, governments and policy makers. To date, financial inclusion measurement has been mainly approached by the usage and access to the formal financial services by using supply-side aggregate data (e.g. Honohan (2007); Sarma (2008, 2012); Chakravarty and Pal (2010) and Amidžić *et al.* (2014)). The only work that relies on demand-side data, at individual level, focuses on several usage- and barriers-related indicators individually (Demirgüç-Kunt and Klapper, 2013). However, monitoring different indicators individually, although useful, does not offer a comprehensive understanding of the level of financial inclusion across countries. On the other hand, as we mentioned, the few attempts to measure financial inclusion through composite indices are incomplete and subject to methodological problems and measurement errors.

High usage levels of formal financial services or a broad availability of points of access do not mean necessarily that a system is inclusive *per se*. The usage of formal financial services can be conditioned by other socio-economic factors such as GDP *per capita*, human capital, legal framework, cultural habits or development status that make individuals use these kinds of services in a particular manner. We consider the use of formal financial services as an output of financial inclusion rather than a measure of the inclusiveness of a financial system in itself. Likewise, the availability of infrastructure, ATMs and bank branches, captures the extent of accessibility to the formal financial system only partially. Since we do not have information about location or concentration of these points of service, it is not accurate to assert that higher measured levels of these indicators represent a more inclusive financial system. This paper considers that access and usage are both necessary but not sufficient conditions for measuring the inclusiveness of a financial system. Our hypothesis is that focusing only on usage and access leads to limited measurement of financial inclusion. In this context, demand-side individual surveys that gather information on the perceived reasons why people fail to use formal financial services add significant information about

the degree of inclusiveness of a financial system.

We define an inclusive financial system as one that maximizes usage and access, while minimizing involuntary financial exclusion. [3] Involuntary financial exclusion is measured by a set of barriers perceived by those individuals who do not participate in the formal financial system. Thus, we postulate that the degree of financial inclusion is determined by three dimensions: usage, barriers and access. These dimensions are, at the same time, determined by several demand-side individual level indicators for the cases of usage and barrier, and supply-side country level indicators for access. Regarding demand-side information, we approach financial inclusion measurement from a double perspective. On the one hand, we account for the inclusiveness, from the banked side, by measuring the actual use of formal financial services , namely, inclusion output of financial systems. On the other hand, we also include information from the unbanked side to assess the barriers to financial inclusion through the obstacles perceived by people prevented from using formal financial services.

To compute the index, we take advantage of the largest demand-side harmonized data set ever collected at individual level, the World Bank's Global Findex (2011). It is the first public database of indicators to offer a homogeneous measure for individuals' use of financial products across economies for 2011. This survey collects information about 150,000 nationally representative and randomly selected adults from 148 countries around the world. Data available at individual, rather than household, level is also an asset that improves accuracy and comparability of the analyses. This database fills an important gap in the financial inclusion data landscape. We also use supply-side aggregate data on access from the International Monetary Fund's Financial Access Survey (2013). This is a source of supply-side data that offers information on an unbalanced panel of 189 countries, covering the period 2004-2012.

[3] For the CGAP financial inclusion means that all working age adults have effective access to credit, savings, payments and insurance from formal service providers. 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.

2.1 Usage

To assess the extent of usage of the formal financial service by individuals, we consider the utility of these services in three different indicators: holding at least one financial product, keeping savings and having a loan in a formal financial institution. Taking advantage of the information in the Global Findex data set, we can measure the usage dimension of formal financial services.

We built the indicator to account for people using at least one formal financial service by adding information from several questions in the Global Findex. We consider as formal financial service users: people who have a bank account, people who use mobile banking services but do not have an account, and people who have a credit or debit card but do not have an account. [4] Also, we consider as banked those individuals who reported not having a bank account because someone else in the family already has one. This reason identifies individuals who use financial services indirectly. [5] The savings and loan indicators represent the percentage of adult population that saves and has a loan in a formal financial institution respectively. The upper panel in Table 1 shows descriptive statistics of the indicators that we use to measure usage dimension. Data is aggregated at country level by computing the proportion of individuals in each category and then applying the weight corresponding to the population in each country.

2.2 Barriers

The barriers to financial inclusion, perceived by unbanked individuals, provide information about the obstacles that prevent them from using formal financial services. This information is useful to assess the extent of financial inclusion since it offers a perception of why

[4] Since we want to compute and index including both developed and less-developed countries we cannot take into account the usage of financial services for enterprises due to the lack of harmonized information for developed countries. This information is only available for less-developed countries in the World Bank's Enterprise Survey.

[5] We do not consider people with insurance since this information is only available for less-developed countries.

some individuals are excluded from the formal financial system. There are two types of financial exclusion: voluntary or self-exclusion and involuntary. If we treat financial inclusion as a behavioural issue, individuals need to decide whether to participate in the formal financial system given their budget constraints. One possibility is that some individuals do not have a demand for formal financial services, leading them to self-exclusion because of cultural reasons, lack of money or just because they are not aware of the benefits of these types of services. This choice can be shaped by imperfect information about the utility of financial services for managing risk, savings for the future and affordability of different investments such as education or buying a house. However, exclusion can also be due to other market imperfections such as the lack of access to financial services or an inappropriate product range that does not satisfy needs. The latter obstacles that hinder financial inclusion may be associated with a sort of involuntary exclusion. This means that people cannot satisfy their demand.

In order to measure the degree of inclusiveness of financial systems, from the unbanked perspective, we take into account only the information about barriers that represent involuntary exclusion such as distance, lack of the necessary documentation, affordability and lack of trust in the formal financial system. The question about perceived barriers is formulated in the Global Findex questionnaire in such a way that individuals can choose multiple reasons for their not having a bank account.

As we mentioned, according to the Global Findex data set, almost 20 per cent of the unbanked population cites distance as one of the reasons that prevents them from having an account. This reason is observed more frequently in developing countries where access points are remote (Demirgüç-Kunt and Klapper, 2013). Documentation requirements are also cited as a perceived barrier for financial inclusion by almost 20 per cent of the unbanked. Affordability is the second most cited obstacle for financial inclusion, after only lack of money, and prevents 25 per cent of the unbanked from using formal financial services. Finally, the lack of trust in the financial system is cited by 13 per cent of adults.

All these variables are introduced in our analysis in their negative form so that the fewer people reporting the barrier, the greater the inclusiveness of the financial system.

2.3 Access

Access to formal financial services represents the possibility for individuals to use them. However, greater access does not necessarily imply a higher level of financial inclusion. We believe that there is a threshold for access since, when it reaches a certain level, a marginal increase does not necessarily generate a financial inclusion increase by our definition. It may enhance frequency in the use of financial services, by improving intensive margin of usage but does not necessarily increase extensive margin, in terms of higher percentages of accounts held or any other financial service. However, greater access is expected to foster financial inclusion when access levels are below the threshold, via greater availability, if financial services meet the needs of the population. Also, when increasing access is generated from different financial companies, more intense competition may increase the consumption of financial services via prices too, even above the threshold.

We construct the access dimension with supply-side data at country level from four basic indicators: automated teller machines (ATMs) (per 100,000 adults), commercial bank branches (per 100,000 adults), ATMs (per 1,000Km2) and commercial bank branches (per 1,000Km2). They account for the physical point of services offered by commercial banks, credit unions, saving and credit cooperatives, deposit-taking microfinance and other deposit takers (savings and loan associations, building societies, rural banks and agricultural banks, post office giro institutions, post office savings banks, savings banks, and money market funds). This information is collected by financial services providers though the International Monetary Fund's Financial Access Survey (FAS). [6]

The traditional indicators used to measure access are currently incomplete. New technology adopted by the financial sector goes beyond the traditional banking access measured

[6]Data on adult population and land mass come from the World Development Indicators provided by the World Bank.

by number of branches and ATMs. New mobile banking developments and the use of financial services on the internet open up new channels for accessing formal financial services that, under certain circumstances, overcome the distance as a barrier for access. Banking correspondents play an important role, too, in enhancing the problem of access. Nevertheless, distance is still one of the reasons why people do not participate in the formal financial system. While nearly 20 per cent of the unbanked in the world state that financial access points are too far away, this problem involves mainly less-developed countries. In developed countries, the proportion of the unbanked who perceive distance as a problem is only 10 per cent. Both technology and banking correspondents are greatly broadening access in terms of availability of physical access. However, measuring these aspects is not straightforward. The lack of homogeneous measures for a wide range of countries makes it difficult to assess the impact of these new channels on financial inclusion. [7] Although we cannot get an accurate proxy to take into account the new access channels, we do include information on mobile and internet banking in the usage dimension.

3 Principal Component Analysis as an Indexing Strategy

Financial inclusion is an abstract concept which cannot be measured quantitatively in a straightforward way. However this variable is supposed to be determined by the interaction of a number of causal variables. We assume that behind a set of correlated variables we can find an underlying latent structure that can be identified with a latent variable as is the case of financial inclusion. Two important issues arise in the estimate of any latent variable: the selection of relevant variables and the estimation of parameters (weights).

[7] The bias introduced for omitting this information might be different for developed countries and less-developed countries. We cannot quantify this bias but we have some intuitive information about its direction. Although the lack of data to measure financial service access via internet and smart phone underestimates access more for developed countries than for less-developed countries, the effect on financial inclusion may be larger for less-developed countries than for developed countries. The latter have greater access levels and, as such, increases in access may have a larger effect on less-developed countries that start from lower levels. Likewise, less-developed countries benefit more from banking correspondents as well as from basic mobile phones.

Regarding the first issue, it is not possible to rely on standard reduction of information criterion approaches for the selection of variables. For the second, since financial inclusion is unobserved, standard regression techniques are also unfeasible to estimate the parameters. The weight assignment to the indicators or sub-indices is critical to maximize the information from a data set included in an index. A good composite index should comprise important information from all the indicators, but not be strongly biased towards one or more of these indicators. We apply two-stage principal components methodology to estimate the degree of financial inclusion as an indexing strategy.

Our dataset contains causal variables which summarize the information for financial inclusion. As explained in the previous section, each causal variable relates to different dimensions that define financial inclusion. The purpose of dividing the overall set of indicators into three sub-indices is twofold. On the one hand, the three sub-indices have a meaning so, we get additional disaggregated information that is also useful for policy making. On the other hand, for methodological purposes, since the sub-indices contain highly inter-correlated indicators, we estimate the sub-indices first, rather than estimating the overall index directly by picking all the indicators at the same time. This is a preferred strategy because empirical evidence supports that PCA is biased towards the weights of indicators which are highly correlated with each other (Mishra, 2007). We minimize this problem by applying two-stage PCA (Nagar and Basu, 2004). In the first stage, we estimate the three sub-indices: usage, barriers and access, which defined financial inclusion. In the second stage, we estimate the dimension weights and the overall financial inclusion index by using the dimensions as explanatory variables.

Let us postulate that the latent variable financial inclusion is linearly determined as follows:

$$FI_i = \omega_1 Y_i^u + \omega_2 Y_i^b + \omega_3 Y_i^a + e_i, \tag{1}$$

where subscript i denotes the country, and (Y_i^u, Y_i^b, Y_i^a) capture the usage, barriers and

access dimension respectively. Thus, the total variation in financial inclusion is represented by two orthogonal parts: variation due to causal variables and variation due to error (e_i). If the model is well specified, including an adequate number of explanatory variables, we can reasonably assume that the total variation in financial inclusion can be largely explained by the variation in the causal variables. [8]

3.1 First Stage PCA

The first stage aims to estimate the dimensions, that is, the three unobserved endogenous variables Y_i^u, Y_i^b, Y_i^a and the parameters in the following system of equations:

$$Y_i^u = \beta_1 account_i + \beta_2 savings_i + \beta_3 loan_i + u_i \quad (2)$$

$$Y_i^b = \theta_1 distance_i + \theta_2 affordability_i + \theta_3 documents_i + \theta_4 trust_i + \epsilon_i \quad (3)$$

$$Y_i^a = \gamma_1 ATM_{popi} + \gamma_2 branch_{popi} + \gamma_3 ATM_{km^2 i} + \gamma_4 branch_{km^2 i} + v_i \quad (4)$$

$$(5)$$

where *account* is a variable that represents the individuals who have at least one of the financial products described in section 2.1, and *savings* and *loan* represent individuals who save and have a loan in the formal financial system. Hence, the three dimensions are also indices that we estimate by principal components as linear functions of the explanatory variables described in Table 1. Note that the endogenous variables are unobserved so we need to estimated them jointly with the unknown parameters: β, θ and γ. Let $R_p, (pxp)$ define the correlation matrix of the p standardize indicators for each dimension. We denote $\lambda_j (j = 1, \ldots, p)$ as the *j-th* eigenvalue, subscript j refers to the number of principal components that also coincides with the number of indicators or sub-indices, p. $\phi_j(px1)$ is the eigenvector of the correlation matrix. We assume that $\lambda_1 > \lambda_2 > \ldots > \lambda_p$ and denote

[8] If the model is well specified, $E(e) = 0$ and the variance of the error term is relatively small compared to the variance of the latent variable, financial inclusion.

$P_k(k = 1, \ldots, p)$ as the *k-th* principal component. We get the corresponding estimator of each dimension according to the following weighted averages:

$$Y_i^u = \frac{\sum_{j,k=1}^{p} \lambda_j^u P_{ki}^u}{\sum_{j=1}^{p} \lambda_j^u} \tag{6}$$

$$Y_i^b = \frac{\sum_{j,k=1}^{p} \lambda_j^b P_{ki}^b}{\sum_{j=1}^{p} \lambda_j^b} \tag{7}$$

$$Y_i^a = \frac{\sum_{j,k=1}^{p} \lambda_j^a P_{ki}^a}{\sum_{j=1}^{p} \lambda_j^a} \tag{8}$$

where $P_k = X\lambda_j$. λ_j represents the variance of the kth principal component (weights) and X is the indicators matrix. The weights given to each component are decreasing, so that the larger proportion of the variation in each dimension is explained by the first principal component and so on. Following this order, the pth principal component is a linear combination of the indicators that accounts for the smallest variance. In brief, this method represents a p-dimensional dataset of correlated variables by p orthogonal principal components, with the first principal component explaining the largest amount of information from the initial data. One issue using principal component analysis is to decide how many components to retain. Although a common practice is to replace the whole set of causal variables by only the first few principal components, which account for a substantial proportion of the total variation in all the sample variables, we consider as many components as the number of explanatory variables. Our concern is to estimate accurately financial inclusion rather than reducing the data dimensionality so, in order to avoid discarding information that could affect our estimates, we account for 100 per cent of the total variation in our database.

3.2 Second Stage PCA

The second stage of the principal component analysis computes the overall financial inclusion index by replacing Y_i^u, Y_i^b and Y_i^a in Eq. (1) and applying a similar procedure to that described in the first stage (to estimate the vectors of parameters λ). This produces the following estimator of the financial inclusion index:

$$FI_i = \frac{\sum_{j=1}^{p} \lambda_j P_{ki}}{\sum_{j=1}^{p} \lambda_j} \tag{9}$$

The highest weight, λ_1, is attached to the first principal component because it accounts for the largest proportion of the total variation in all causal variables. Similarly, the second highest weight, λ_2, is attached to the second principal component and so on. After some algebra, we can write each component, P_{ki} of (9) as a linear combination of the three sub-indices ($p = 3$) and the eigenvectors of the respective correlation matrices represented by ϕ:

$$P_{1i} = \phi_{11} Y_i^u + \phi_{12} Y_i^b + \phi_{13} Y_i^a \tag{10}$$

$$P_{2i} = \phi_{21} Y_i^u + \phi_{22} Y_i^b + \phi_{23} Y_i^a \tag{11}$$

$$P_{3i} = \phi_{31} Y_i^u + \phi_{32} Y_i^b + \phi_{33} Y_i^a \tag{12}$$

so that the financial inclusion index can be expressed as:

$$FI_i = \frac{\sum_{j=1}^{3} \lambda_j (\phi_{j1} Y_i^u + \phi_{j2} Y_i^b + \phi_{j3} Y_i^a)}{\sum_{j=1}^{3} \lambda_j} \tag{13}$$

Rearranging terms, we can express the overall financial inclusion index as a weighted

average of the dimensions as in Eq. (1):

$$FI_i = \omega_1 Y_i^u + \omega_2 Y_i^b + \omega_3 Y_i^a + e_i$$

where the relative weights (importance) of each dimension, ω_k, in the final index are computed as:[9]

$$\omega_k = \frac{\sum_{j=1}^{3} \lambda_j \phi_{jk}}{\sum_{j=1}^{3} \lambda_j}, k = 1, 2, 3. \quad (14)$$

4 Results

In this section we present the estimated financial inclusion indices for 82 developed and less-developed countries by two-stage PCA for the year 2011. [10] The correlation matrix for the causal variables used to measure financial inclusion is reported in Table 2.

4.1 First Stage Empirical Results

In the first stage, we compute the weights for the causal variables for each sub-index and estimate the latent variables: *usage*, *barriers* and *access* that represent the dimensions of financial inclusion. Since we construct the sub-indices as weighted averages of the principal components, it is possible to gather the coefficients for each causal variable. These weights are derived by Eqs. (2-4) and normalized such that their sum is 1.

With regard to the weighting scheme, for the usage dimension, the indicator for loans has the highest weight (0.42), followed by having an account and savings, at 0.30 and 0.28 respectively, (see upper panel of Table 3). It is important to notice that although the

[9] In general the sum of the weights expressed by the formula above does not necessarily have to equal 1 due to the fact that principal component methodology normalizes the mode of each eigenvector to 1. The weights therefore could be very close to but not always equal to 1.

[10] Although the Global Findex reports reliable data for 123 countries, the lack of data to measure access in some of these countries and the tax haven status of others require us to reduce our sample size to 82 countries.

weights are not evenly distributed, none of the indicators is dominant; this is a desirable condition for an index. For the access dimension, the ratios of ATMs and branches per adult population have higher weights than these ratios per square kilometre. The weights for the latter are half of the former (see middle panel of Table 3). This means that the indicators relative to population contain more information than the ones relative to area for exploring the access dimension. Finally, the lower panel of Table 3 shows the weights for the indicators in the barriers dimension. For the first three indicators (*distance*, *affordability* and *documentation*), the weights are very similar, at 0.23, 0.24 and 0.24 respectively. *Lack of trust* is the most important indicator in defining the barriers dimension, with a weight of 0.29.

Since weights are obtained from the information in the principal components and the corresponding eigenvalues, it is worth studying the composition of these components to understand the structure of our estimated indices. Table 4 shows, in a cumulative way and by dimensions, the amount of the total variance explained by the different components. For the usage dimension, we observe that the first component, which contains 75% of the total information in this dimension (see Table 4) has an even contribution of the three indicators: *account*, *loan* and *savings*. This suggests that these three indicators measure the same latent structure. However, only the indicator referring to loans adds extra information through the second component. It might indicate that having a loan also represents a stage of greater financial inclusion since most people who have a loan already have another financial product, such as a bank account or pay-roll account. [11] As a result, having a loan may be an accurate indicator to identify more consolidated stages of financial inclusion. When defining the access dimension, as shown in the middle panel of Table 3, we again find an even contribution of the four indicators to the first principal component since the coefficients in the eigenvector for this component are similar. However, variables related to population are more powerful in measuring access since they add information in the

[11] People who start to use formal financial services by having a loan, although they might exist, are a very small minority.

second and third component as well. Finally, for the barriers dimension, we also find that the four indicators contribute evenly to the first component, which accounts for almost 80 per cent of the total variation in the data. *Distance*, *affordability* and *documentation* have their highest loadings in the first component. Although *lack of trust* contributes to the first component, it has its highest weighting in the second component, which indicates that this variable also adds extra information in a different structure from the first component. *Lack of trust* is a structural variable that can be related to not only idiosyncratic financial system issues (efficiency of financial institutions, financial stability, episodes of bank failures, etc.) but also to broader issues beyond the financial markets, such as governance, cultural norms, economic crises or macroeconomic variables such as inflation.

Table 5 shows the list of countries ranked by the degree of *usage*, *access* and *barriers*. [12] For a more intuitive interpretation, the sub-indices are normalized to be between 0 and 1, where 1 indicates the highest degree of financial inclusion and 0 the lowest. The computation of the sub-indices to estimate the dimensions can be useful information for policy-makers and governments when designing financial inclusion strategies. The idea is that policies to foster financial inclusion should focus on the dimension in which the country ranks worse by comparison.

4.2 Second Stage Empirical Results

In the second stage, we apply PCA on the three sub-indices (*usage*, *access* and *barriers*) to compute their weights in the overall index. Table 6 presents the composition of the principal components and the normalized weights for each dimension or sub-index. The last column shows that PCA assigns the highest weight to *access* (0.42), followed by *usage* with a weight of 0.29 and *barriers* at 0.28. Thus, this information reveals that access is the most important dimension for explaining the degree of financial inclusion. Supply of formal financial services contributes more than number of users to explain the latent

[12] Using two-stage PCA, we can compute indices by countries as well as aggregated by regions. Due to space limitations, we report the county-based analysis only.

structure behind our pool of indicators, ie. the degree of financial inclusion. Access is key since it represents a necessary but not sufficient condition for using formal financial services.

In terms of the principal component structure, we observe that the first and most important component, accounting for 76 per cent of the total variation in the data (see Table 7), has an even contribution of the three dimensions. This indicates that the three dimensions measure the same latent structure which is interpreted as the degree of financial inclusion. [13] Moreover, unlike *usage* and *barriers*, *access* allocates part of its information in the second component, so this dimension not only contributes to the overall index through the first principal component, but also adds extra information through the second component and gains importance in explaining the overall index.

Table 8 shows the ranking of countries in the sample according to the value of our financial inclusion index. As expected, developed countries have the most inclusive financial systems. The first quarter of the ranking corresponds to developed countries with only two exceptions: Mongolia and Thailand. These two low-income Asian countries outperform other low-to-middle income countries, their East Asian neighbours and even some high-income countries. For Mongolia, the high level of financial inclusion may be due in large part to universal cash hand-outs from the government's Human Development Fund as well as pensions, health insurance and student tuition payments. [14] The degree of financial inclusion in this country is higher than developed countries such as Sweden, Ireland or Austria. In the case of Thailand, its high position in the ranking is mainly due to the large number of bank accounts and the insurance schemes, particularly for healthcare, offered by the Government. Thailand's financial inclusion level is higher than that of Greece. The second quarter of the ranking, down to the position 42, is made up mostly of the Eastern

[13] Tables 4 and 7 show that, in most of the cases, only the first component explains more than 75 per cent of the causal variables' total variation (except for the access dimension that explains 62 per cent). Thus, the strategy of taking only the first principal component may be a good approximation for estimating the dimensions and the degree of financial inclusion as well.

[14] Around 50% of all bank account holders over the age of 15 cite receiving government payments as the most common use for a bank account, according to the Global Findex database.

European middle-income countries. Three Latin American countries (Brazil, Costa Rica and Dominican Rep.) and Malaysia are the exceptions. Brazil exhibits the best performance, in terms of financial inclusion, among Latin American countries. Its success can be seen in the existence of social support programs sponsored by the government through the formal financial system. [15] This way of facilitating money transfers is analogous to the one followed in Mongolia and Thailand.

After these two groups, the second half of the ranking is a heterogeneous group that includes countries from Latin America, Asia, a few Eastern European and all the African countries in the sample. The last ten countries, at the bottom of the ranking, are low-income African countries. Most African countries in our sample perform poorly in financial inclusion terms, with the only exceptions being South Africa, which is in 45^{th} position, Kenya and Mozambique in the 54^{th} and 58^{th} position respectively. Given the relevance of the access dimension in the financial inclusion index, the low levels of financial inclusion in some African countries should improve by including data on e-money outlets since this business model is widespread in the region. This also applies to some Latin American countries which use a banking correspondent business model.

4.3 Preliminary Stylized Facts

In this section, we show some correlations between our index and some variables of interest. We compare our index with GDP *per capita*. Figure 1 shows a high correlation (0.69) between these two variables. This result supports the theoretical literature linking financial inclusion and economic growth. [16] Another variable that may determine the level of financial inclusion is the efficiency of the financial system. More efficient financial systems are more likely to provide services at a more competitive price, so this may minimize the

[15] Brazil has a huge banking correspondent network, pioneering in the region. Brazil's ranking position would improve if data on this access channel were considered in our index.

[16] Similarly, Allen *et al.* (2012) find a high correlation when regressing the percentage of adults with a formal account and GDP per capita. These authors show R-square equals 0.73 based on a country-level OLS regression of account penetration on the log of GDP per capita.

barriers perceived by individuals in terms of the affordability of formal financial services. Figure 2 shows a high negative correlation (-0.65) between the net interest margin, a measure of the inefficiency of the banking system, and our financial inclusion index. Our index is also negatively correlated with the instability of the financial system, measured as the aggregate volatility of the credit gap over GDP, in the last 15 years (Figure 3). Financial inclusion is very much related to education, so we also correlate our index with different education-related metrics. It exhibits a positive correlation with the average years of schooling (0.66) and a negative (-0.50) correlation with the illiteracy rate. We find similar positive correlations if we consider different education levels completed (0.53, 0.58 and 0.57 for people who have completed primary, secondary and tertiary education, respectively).

If we look at the correlations by dimensions, we find that for the first three variables (GDP per capita, inefficiency and instability), the correlations between different dimensions and the total financial inclusion index are quite similar. However, education-related variables exhibit much higher correlation with the usage dimension than with any other dimension. We find high correlations, 0.65 for the average years of schooling and -0.50 for the population with no formal education, when correlating these variables with the usage dimension. Moreover, we find that completed secondary and tertiary education have almost the same correlation (0.57 and 0.55 respectively) with usage, but that it is slightly lower for the case of completed primary education (0.50). [17]

5 Conclusions and policy recommendations

Financial inclusion is an essential ingredient of economic development and poverty reduction and it can also be a way of preventing social exclusion. A person's right to use formal

[17] Our index also exhibits high correlations when comparing with other financial inclusion indices and indicators in the literature. The percentage of people with an account at a formal financial institution, proposed by Demirgüç-Kunt and Klapper (2013), as a proxy for financial inclusion, exhibits a correlation of 0.92 with our index. Existing Financial Inclusion composite indices, such as the ones developed by Honohan (2007), Sarma (2008) and Amidžić *et al.* (2014), have a correlation coefficient of 0.79, 0.84 and 0.90, respectively, with our index.

financial services, as a way of preventing social exclusion, must be a priority. However, efforts to measure financial inclusion are scarce and incomplete. Financial inclusion is a multidimensional concept that cannot be captured accurately by single indicators on their own, but is determined by a much larger set of indicators than the few considered so far. The nature of the financial systems is complex and heterogeneous. An inclusive financial system needs particularly to encourage usage of its services on the part of society's most vulnerable groups; that is, those most affected by obstacles to financial inclusion.

Existing composite indices to measure financial inclusion, taking arbitrary weights, are questionable. This paper proposes a two-stage PCA to measure the extent of financial inclusion for a country or region. This methodology is statistically sound for index construction and robust to high dimensional data. We measure financial inclusion through composite indices for 82 countries by using 11 causal variables as financial inclusion determinants for 2011. Specifically, our index assumes that the degree of financial inclusion is determined by the maximization of usage and access to formal financial services, on the one hand, as well as by the minimization of obstacles causing involuntary exclusion. Demand-side information to assess the usage and barriers dimensions is key in determining the degree of financial inclusion. The dimension of usage measures financial inclusion from the banked perspective, and barriers do so from the perspective of the unbanked. Information from excluded people helps to reveal a comprehensive picture of the extent to which a financial system is inclusive. Our major contribution is twofold. First, we use a parametric method to determine the contribution of each indicator in our financial inclusion index. It has the advantage of not employing any exogenous, subjective information. Second, we build a comprehensive index that includes both demand- and supply-side information.

As shown by our estimates, access is the most important dimension for measuring the level of financial inclusion. This result suggests that supply of formal financial services is more important than number of users in explaining our index. Access represents a necessary but not sufficient condition for using formal financial services.

We find that the degree of financial inclusion is highly correlated with some macroeconomic variables such as GDP *per capita*, education, efficiency of a financial system and financial stability. The creation of such an index is useful to shed some light on the determinants of financial inclusion as well as its contribution to economic growth and development. Also, we believe that desegregated information on the different dimensions will be useful for policy recommendations. Efforts in such direction yield relevant improvements on the analysis of financial inclusion's causes and consequences.

Appendices

A Countries

TABLE A1
Countries

Developed countries	l ess-developed countries	
Australia	Albania	Hungary
Austria	Angola	India
Belgium	Argentina	Indonesia
Canada	Armenia	Kazakhstan
Chile	Azerbaijan	Kenya
Czech Rep.	Belarus	Latvia
Denmark	Bolivia	Lesotho
Estonia	Bosnia and Herzegovina	Lithuania
Finland	Botswana	Macedonia, FYR
France	Brazil	Madagascar
Greece	Bulgaria	Malaysia
Ireland	Burundi	Mexico
Italy	Cameroon	Moldova
Japan	Chad	Mongolia
Korea, Rep.	Colombia	Mozambique
Netherlands	Congo, Dem. Rep.	Nepal
New Zealand	Costa Rica	Nicaragua
Poland	Croatia	Pakistan
Portugal	Dominican Rep.	Paraguay
Slovak Rep.	El Salvador	Peru
Slovenia	Gabon	Philippines
Spain	Georgia	Romania
Sweden	Ghana	
United States	Honduras	

Notes: Countries classified according to World Bank criteria.

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Tables

TABLE 1

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Usage					
Account	82	57.00	28.00	6.00	100
Loan	82	10.60	5.75	1.52	26.83
Savings	82	20.46	17.85	0.82	65.84
Access					
ATMs/100,000 pop.	82	56.18	52.46	0.49	270.13
Branches/100,000 pop.	82	20.82	17.91	0.66	89.73
ATMs/1,000 Km2	82	53.38	136.73	0.03	1136.25
Branches/1,000 Km2	82	17.38	26.51	0.03	131.74
Barriers					
Distance	82	17.06	11.65	0.00	49.16
Affordability	82	26.32	14.59	0.00	59.81
Documentation	82	18.60	11.98	0.00	49.47
Lack of trust	82	18.83	12.10	0.00	57.45

TABLE 2

Correlation Matrix											
Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
Account	1	-	-	-	-	-	-	-	-	-	-
Loan	0.53	1	-	-	-	-	-	-	-	-	-
Savings	0.81	0.57	1	-	-	-	-	-	-	-	-
ATMs/100,000 pop.	0.68	0.33	0.54	1	-	-	-	-	-	-	-
Branches/100,000 pop.	0.55	0.25	0.31	0.56	1	-	-	-	-	-	-
ATMs/1,000 Km2	0.35	0.11	0.34	0.60	0.20	1	-	-	-	-	-
Branches/1,000 Km2	0.44	0.00	0.35	0.45	0.56	0.64	1	-	-	-	-
Distance	-0.45	-0.25	-0.27	-0.39	-0.43	-0.21	-0.40	1	-	-	-
High cost	-0.43	-0.29	-0.28	-0.34	-0.26	-0.26	-0.30	0.55	1	-	-
Documentaion	-0.31	-0.23	-0.16	-0.31	-0.28	-0.05	-0.13	0.49	0.39	1	-
Lack of trust	-0.18	-0.05	-0.30	0.01	0.08	-0.21	-0.26	0.03	0.31	-0.07	1

Notes:

TABLE 3

Principal Components Estimates					
Usage					
Variable	PC_1	PC_2	PC_3	PC_4	norm. weight
Account	0.5968	-0.4551	0.6608	-	0.30
Loan	0.5126	0.8499	0.1223	-	0.42
Savings	0.6172	-0.2658	-0.7041	-	0.28
Eigenvalues	2.2617	0.5579	0.1804	-	
Access					
Variable	PC_1	PC_2	PC_3	PC_4	norm. weight
ATMs per 100,000 pop.	0.5204	0.0368	0.7283	-0.4443	0.33
Branches per 100,000 pop.	0.4546	0.7461	-0.0687	0.4816	0.35
ATMs per 1000 Km^2	0.4907	-0.6618	0.0282	0.5661	0.16
Branches per 1000 Km^2	0.5308	-0.0633	-0.6812	-0.5002	0.16
Eigenvalues	2.5050	0.8044	0.5530	0.1377	
Barriers					
Variable	PC_1	PC_2	PC_3	PC_4	norm. weight
Distance	0.5198	-0.3481	-0.2594	0.7358	0.23
Affordability	0.5357	-0.0126	-0.5986	-0.5955	0.24
Documentation	0.5184	-0.3407	0.7373	-0.2676	0.24
Trust	0.4172	0.8733	0.1757	0.1803	0.29
Eigenvalues	3.12863	0.585401	0.150115	0.135852	

Notes: The weights are normalised add up to 1

TABLE 4

Cumulative Variance Explained by Components	
Components	*Cumulative variance*
Usage	
PC_1	0.7539
PC_2	0.9399
PC_3	1
Access	
PC_1	0.6262
PC_2	0.8273
PC_3	0.9656
PC_4	1
Barriers	
PC_1	0.7822
PC_2	0.9285
PC_3	0.9660
PC_4	1

TABLE 5

Ranking of Countries by Dimension

Usage		Access		Barriers	
Country	rank	Country	rank	Country	rank
New Zealand	1	Korea, Rep.	1	Australia	1
Sweden	2	Spain	2	Finland	2
Finland	3	Portugal	3	Netherlands	3
Canada	4	Italy	4	Denmark	4
Denmark	5	Belgium	5	Austria	5
Australia	6	Japan	6	Belgium	6
United States	7	Bulgaria	7	New Zealand	7
France	8	United States	8	Sweden	8
Mongolia	9	France	9	Japan	9
Ireland	10	Canada	10	France	10
Korea, Rep.	11	Brazil	11	Slovenia	11
Netherlands	12	Russian Federation	12	Estonia	12
Thailand	13	Slovenia	13	Canada	13
Belgium	14	Australia	14	Korea, Rep.	14
Austria	15	Croatia	15	Ireland	15
Slovenia	16	Netherlands	16	Latvia	16
Spain	17	Mongolia	17	Portugal	17
Japan	18	Denmark	18	Croatia	18
Slovak Republic	19	Greece	19	Spain	19
Croatia	20	Peru	20	Thailand	20
Malaysia	21	Ireland	21	Mongolia	21
Czech Republic	22	Poland	22	Italy	22
Estonia	23	Romania	23	Greece	23
Belarus	24	Austria	24	United States	24
Portugal	25	New Zealand	25	Lithuania	25
Bolivia	26	Latvia	26	Slovak Republic	26
Kenya	27	Slovak Republic	27	Macedonia, FYR	27
Vietnam	28	Bosnia and Herzegovina	28	Czech Republic	28
Poland	29	Estonia	29	Poland	29
Macedonia, FYR	30	Czech Republic	30	Hungary	30
Hungary	31	Macedonia, FYR	31	Malaysia	31
Greece	32	Lithuania	32	Venezuela, RB	32
Dominican Republic	33	Costa Rica	33	Dominican Republic	33
Latvia	34	Thailand	34	Bosnia and Herzegovina	34
Bosnia and Herzegovina	35	El Salvador	35	Bulgaria	35
Armenia	36	Turkey	36	Costa Rica	36
Costa Rica	37	Hungary	37	Belarus	37
Uruguay	38	Albania	38	Georgia	38
Azerbaijan	39	Chile	39	Albania	39
Kazakhstan	40	Armenia	40	Vietnam	40
South Africa	41	Moldova	41	Romania	41
Lithuania	42	Sweden	42	Turkey	42
Swaziland	43	Georgia	43	Mozambique	43
Angola	44	Honduras	44	Kazakhstan	44

Notes: Countries are ranked according to their scores in each dimension

TABLE 5 ***Cont***

Ranking of Countries by Dimension					
Usage		Access		Barriers	
Country	rank	Country	rank	Country	rank
Philippines	45	Mexico	45	Uruguay	45
Colombia	46	Malaysia	46	Paraguay	46
Italy	47	Venezuela, RB	47	Brazil	47
Paraguay	48	Ukraine	48	Nepal	48
Peru	49	South Africa	49	India	49
Russian Federation	50	Argentina	50	Pakistan	50
Romania	51	Dominican Republic	51	Russian Federation	51
Chile	52	Finland	52	South Africa	52
Uganda	53	Uruguay	53	Burundi	53
Brazil	54	Colombia	54	Argentina	54
Albania	55	Kazakhstan	55	Kenya	55
Bulgaria	56	India	56	Ghana	56
Georgia	57	Azerbaijan	57	Azerbaijan	57
Nepal	58	Philippines	58	Armenia	58
Ukraine	59	Bolivia	59	Chile	59
India	60	Botswana	60	Angola	60
Mozambique	61	Indonesia	61	Honduras	61
Indonesia	62	Swaziland	62	Moldova	62
Turkey	63	Belarus	63	Colombia	63
Mexico	64	Paraguay	64	Gabon	64
Botswana	65	Angola	65	El Salvador	65
Ghana	66	Vietnam	66	Ukraine	66
Tanzania	67	Pakistan	67	Nicaragua	67
Argentina	68	Nepal	68	Swaziland	68
Honduras	69	Nicaragua	69	Zambia	69
Gabon	70	Gabon	70	Cameroon	70
Nicaragua	71	Kenya	71	Indonesia	71
Zambia	72	Ghana	72	Mexico	72
Venezuela, RB	73	Zambia	73	Botswana	73
Chad	74	Lesotho	74	Bolivia	74
Moldova	75	Mozambique	75	Philippines	75
El Salvador	76	Uganda	76	Madagascar	76
Cameroon	77	Burundi	77	Tanzania	77
Lesotho	78	Tanzania	78	Lesotho	78
Burundi	79	Cameroon	79	Peru	79
Pakistan	80	Madagascar	80	Congo, Dem. Rep.	80
Madagascar	81	Chad	81	Uganda	81
Congo, Dem. Rep.	82	Congo, Dem. Rep.	82	Chad	82

Notes: Countries are listed according to the scores in each dimension

TABLE 6

Principal Component Estimates				
Financial Inclusion Index				
Variable	PC_1	PC_2	PC_3	norm. weight
Usage	0.5775	-0.5758	0.5787	0.29
Access	0.5437	0.8001	0.2535	0.42
Barriers	0.609	-0.1682	-0.7752	0.28
Eigenvalues	2.28051	0.485501	0.233989	

Notes: The weights are normalised add up to 1

TABLE 7

Cumulative Variance Explained by Components	
Components	*Cumulative variance*
Financial Inclusion Index	
PC_1	0.7602
PC_2	0.9220
PC_3	1

TABLE 8

Financial Inclusion Index Country Ranking

Country	rank	Country	rank
Korea, Rep.	1	South Africa	45
Spain	2	Armenia	46
Portugal	3	Vietnam	47
Belgium	4	Venezuela, RB	48
Japan	5	Chile	49
Canada	6	Peru	50
France	7	India	51
United States	8	Paraguay	52
Australia	9	Azerbaijan	53
New Zealand	10	Kenya	54
Denmark	11	Nepal	55
Italy	12	Argentina	56
Netherlands	13	Colombia	57
Mongolia	14	Mozambique	58
Slovenia	15	Ukraine	59
Sweden	16	Angola	60
Ireland	17	El Salvador	61
Croatia	18	Honduras	62
Finland	19	Moldova	63
Austria	20	Bolivia	64
Thailand	21	Swaziland	65
Greece	22	Mexico	66
Estonia	23	Philippines	67
Bulgaria	24	Ghana	68
Slovak Rep.	25	Indonesia	69
Latvia	26	Pakistan	70
Poland	27	Nicaragua	71
Czech Rep.	28	Gabon	72
Brazil	29	Botswana	73
Russian Federation	30	Zambia	74
Macedonia, FYR	31	Burundi	75
Lithuania	32	Cameroon	76
Bosnia and Herzegovina	33	Uganda	77
Malaysia	34	Tanzania	78
Hungary	35	Lesotho	79
Romania	36	Madagascar	80
Costa Rica	37	Chad	81
Dominican Rep.	38	Congo, Dem. Rep.	82
Belarus	39		
Albania	40		
Georgia	41		
Turkey	42		
Uruguay	43		
Kazakhstan	44		

Notes: Countries are listed according to their scores the Financial Inclusion Index

Figures

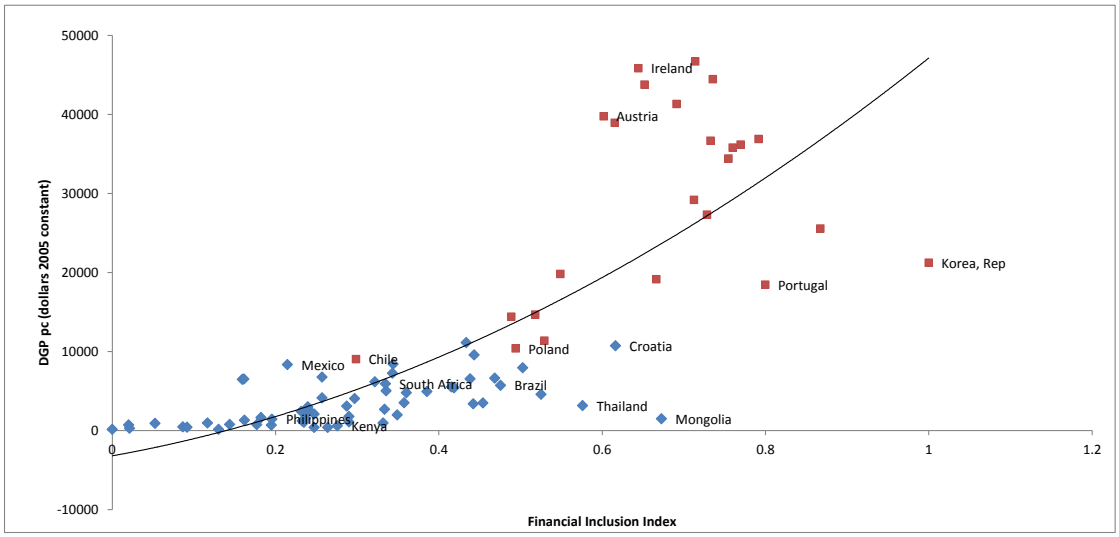

Figure 1: Financial inclusion and income

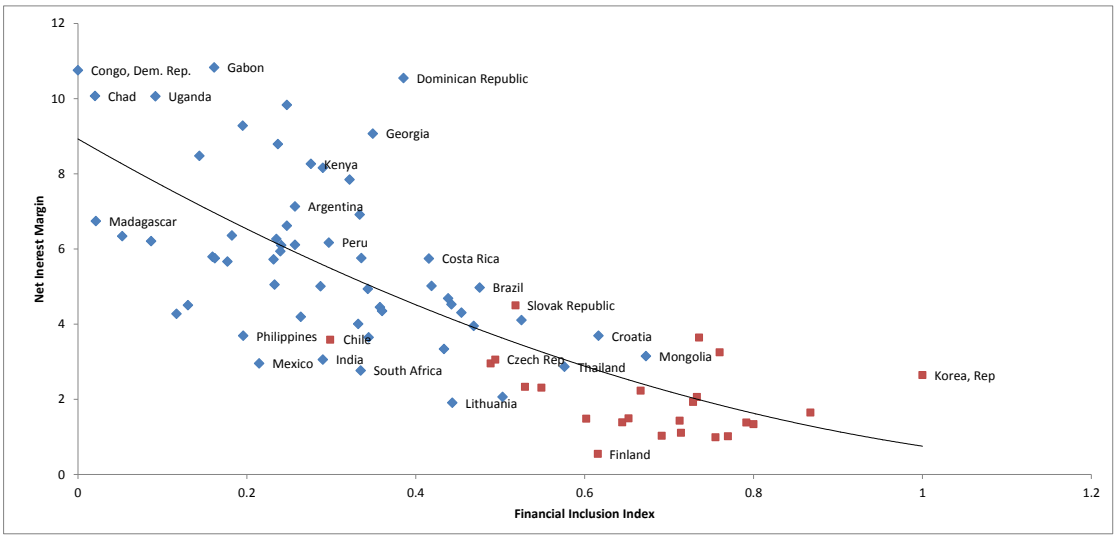

Figure 2: Financial inclusion and inefficiency of financial system

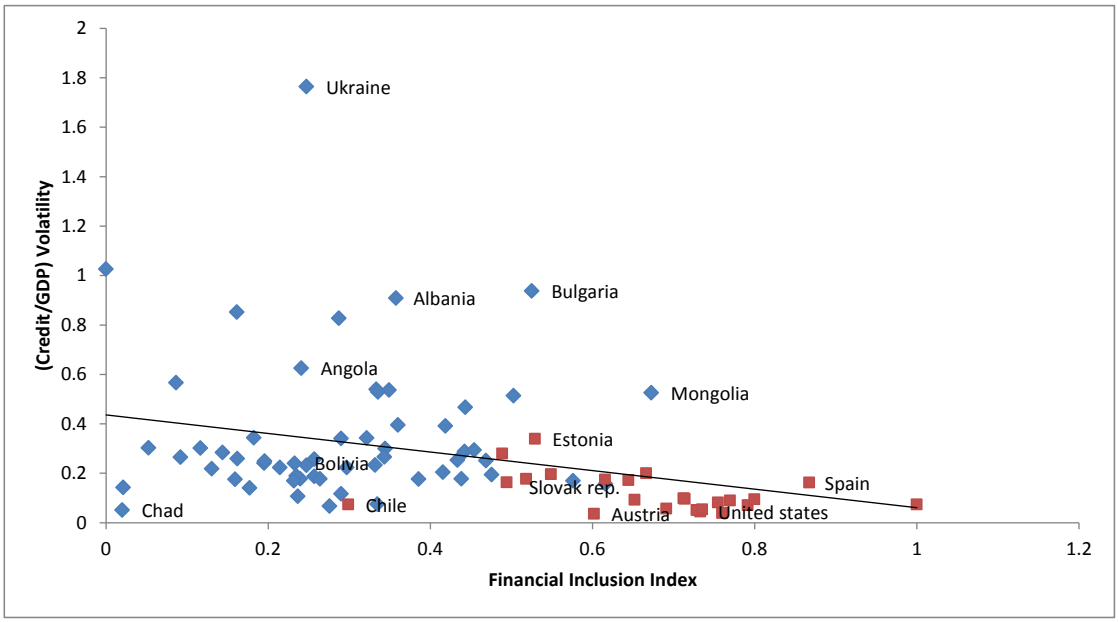

Figure 3: Financial inclusion and instability

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Contact Details:
BBVA Research
Paseo Castellana, 81 – 7º floor
28046 Madrid (Spain)
Tel.: +34 91 374 60 00 y +34 91 537 70 00
Fax: +34 91 374 30 25
bbvaresearch@bbva.com
www.bbvaresearch.com