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EXTENDED ABSTRACT

Title:

A new Financial Inclusion Index: An estimation for Mexican municipalities

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Subject area: *(please, indicate the subject area which corresponds to the paper)*

Regional and municipal analysis of financial inclusion.

Abstract: (*minimum 1500 words*)

Financial inclusion (FI) has long been identified as an element that may spur economic growth (Beck, Demirguc-Kunt, and Martinez Peria (2007) among many others) and may reduce inequality (Demirguc-Kunt, Klapper, & Singer, 2017). FI means that all adults have access to and can effectively use a range of appropriate financial services. FI should be measured in a way that is theoretically grounded, and with an adequate mathematical formulation. This is of utmost importance because it allows identification of the possible obstacles to achieve an adequate level of FI, and to proper diagnosis, analysis and evaluation of policies. To this aim several indices have been proposed by researchers.

Contemporaneous attempts to measure FI dates to Beck et al. (2007), who proposed several indicators as adequate proxys for financial inclusion. Other researchers have considered that instead of using individual indicators, it could be a better approach to construct a multivariate index; recognizing that financial inclusion is a multidimensional phenomenon.

There are several reasons for the importance of building a multivariate indicator. On the one hand it is recognized that financial inclusion is a multidimensional concept, for this reason comprising several variables could be a more adequate approach. On the other hand, it is possible that different indicators when considered alone, yield different conclusions about financial inclusion of the same country or region. For example, the infrastructure indicators on the one hand, and the number of accounts on the other. Or that a single indicator gives only partial information of inclusion. For a more complete view, it is important to construct a multivariate index. The financial inclusion index could be used as a yardstick to measure performance, and also useful to make comparisons across countries or regions.

(Sarma, 2008) and (Chakravarty & Pal, 2013) have proposed indices of financial inclusion using the UNDP approach. (Gupte, Venkataramani, & Gupta, 2012) propose an index of financial inclusion improving the quantity of dimensions and indicators considered by previous indices, by trying to involve all the indicators that other scholars have considered. (Arora, 2014) has calculated the index of financial inclusion using the same reasoning as (Sarma, 2008); including more variables in the outreach dimension, capturing not just the demographic penetration but also geographic penetration. In this way, FI indices proposed by researchers have been constructed by several methodologies that have been refined and made more robust by considering different dimensions, more indicators, and also by choosing different methods of weighting and aggregation.

Some indices have been constructed by using principal component analysis or factor analysis for extraction of weights. This is the case for the two FI indices previously estimated for Mexico, (Zulaica Piñeyro, 2013) and (Citibanamex, 2019). Nevertheless, principal component analysis has several drawbacks for indices construction, as has been stated by some researchers (Greco, Ishizaka, Tasiou, & Torrisi, 2018):

- The standard procedure in using PCA is to use the factor loadings of the first component. However, sometimes the first component alone is not adequate to explain a large portion of the variance of the indicators.
- Low interpretability of principal components.

- Loss of information, when using only one component.
- The weights are always the same for all countries in the sample.

In the case of Citibanamex index, only the loadings of the first component are used for the estimation of the index, and this may not be adequate to explain a large portion of the variance of the indicators.. Furthermore, indices are estimated for several years, but in this case weights are fixed for all the years of the series, using the weights extracted from principal component of one year. Nevertheless, fixing weights limits the intertemporal evaluation, as components, that reflect the underlying relation of variables of FI, could change over time.

We consider that a better methodological proposal to construct a multivariate FI indicator is a geometric index with Benefit of the Doubt weights. We followed the formulation proposed by (Van Puyenbroeck & Rogge, 2017). The index is aggregated as a geometric weighted average. A geometric formulation has been considered as a superior form of aggregation than a linear one, because it reflects substitution rates among indicators, which is more characteristic of variables of financial inclusion. Some researchers have previously used geometric weighted averages, but with equal weights, or weights determined by the researcher. In our case, we are using Benefit of the Doubt derived weights. DEA Benefit of the Doubt is a data driven methodology that has been increasingly used for constructing indices. It is considered that in this way the researcher does not discretionary imposes weights, as this has been a general criticism to composite indices.

For the estimation of our FI index, we conduct carefully a formal methodology as suggested by European Commission and OECD (2008), Nardo et al. (2005), Greco et al. (2019), considering the several steps necessary for constructing a composite indicator: a) conducting a multivariate analysis for establishing the different subdimensions of the indices; b) normalization of variables; c) determination of dimensional sub-indices; d) weighting of sub-indices e) aggregation of sub-indices

We consider very important that the index have dimensions of financial inclusion. Researchers have considered theoretical background for these dimensions. But in addition, we consider that it is important that the data "speaks" for the relevant dimensions to study in the particular case of Mexican municipalities. To this aim, exploratory factor analysis was conducted, showing us that two factors, that is two combination of variables explain the variance of access data. And that four factors of usage are relevant, that is four dimensions to study for usage in Mexican municipalities. Cluster analysis was also conducted confirming factor analysis.

We consider that our investigation has several important contributions:

- We use a robust methodology to construct a FI index for municipalities in Mexico. Conducting multivariate analysis prior to deciding the dimensions of the index, adopting an adequate mathematical formulation to measure financial inclusion, both for weighting and aggregation of the dimensions of the index, and finally conducting robustness analysis.
- Most of the FI indices are for the country or regional level. Few studies construct indices for subnational levels.
- The mathematical formulation of the index is innovative for measuring financial inclusion. We propose a geometric mean index with Benefit of the Doubt (BoD) derived weights. To our knowledge this is the first FI Index constructed this way.

The Benefit-of-the-Doubt (BoD) weighting technique has been chosen because it is a data-driven technique increasingly used in many applications for estimating composite indices in various areas. The principle of weighting ensures the more optimistic weights, because each entity will choose its weights. In the study of financial inclusion, it is adequate not to have a priori established the importance and trade-offs of the variables, but rather let the data decide, via BoD.

The methodological choice for the construction of the financial inclusion index for Mexican Municipalities will be a mean geometric aggregated index, with weights derived from a linear BoD model. This approach follows the formulation of Van Puyenbroeck and Rogge (2017), inspired by the literature on index number theory. This type of index is chosen because it has several desirable mathematical properties for a multivariate indicator, as considered by Van Puyenbroeck and Rogge (2017). The authors also extend the basic formulation of the index to provide transitive indicator orderings that allow to compare entities. Finally, the authors propose a formulation to explain the intertemporal evolution of each entity of the analysis.

We construct multivariate indices with a geometric formulation, weighted by Benefit of the Doubt weights. The results are presented in tables that summarize the first municipalities in the rank, for all Mexican municipalities, and top 10 for each State. From the different dimensions of the index we can observe that financial inclusion, in the case of Mexico means very different things for varying types of municipalities. For some municipalities, financial inclusion is explained more because of the proximity of infrastructure. For other municipalities, usage appears to be important even banking infrastructure is not near. For some others, credits or micro-financial entities, or group and durable goods credits are more important than banking credits. Further, for more detailed analysis of financial inclusion, the indices we are presenting could be very relevant, and for specific policy proposals. It is important for further analysis why some localities rank high or low in the indices. The reasons for high ranking could be that geographically is small, with high population density, other reasons could be economic or turistic importance of the municipality. In other cases, it could be no a priori explanation, and it could motivate a detail study of success cases of financial inclusion, that should be replicated for more municipalities.

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