On the link between material deprivation and city size in developing countries

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Abstract:

The association between urban size and productivity has been vastly studied in the academic literature. On the contrary, less is known on the link between city size and material living conditions. In particular, a strong emphasis has been made on the negative effect of large cities in developing countries experiencing an urbanization process. The creation of slums and large areas with underdeveloped housing characteristics has been a major concern for urban planners. This work analyses this association in Ecuador, a small developing country experiencing a rapid urbanization process. Our findings show that living in more dense areas is associated with lower levels of deprivation.

Keywords: Deprivation, Developing Economies, Ecuador, Multilevel

JEL: R10, R20, I31

1.- Introduction

UN's Sustainable Development Goals (SDG) aim to achieve a better and more sustainable future for all. As the world becomes more and more urban, the spatial dimension of sustainability turns its focus into dense areas. As argued by SDG Target 11, rapid urbanization comes with a list of challenges: while density is a major driver of concentration of talent and booster of productivity, it is also accompanied by inadequate housing and public services, as well as slums (UN-Habitat, 2015). Urbanization is a synonym of development and better living conditions. Nevertheless, the rapid urbanization process that took place in developing economies is characterized by extreme poverty and bad quality of institutions (Glaeser and Henderson, 2017). In this line, Fox (2014) compiles three conditions to the creation of urban slums: fast urban growth, poverty and institutions, with a strong role of urban planning and anti-urban policies. Hamman (2013) considers the persistence of fast migration with an inelastic supply of affordable housing is the results of policy failures. The creation of slums not only reflects an incapacity of the city to cope with a diverse demand for social-economic needs. It also directly affects the overall quality of life of living in cities due to the lack of planning and management of the urban areas, and of course, the coverage of basic infrastructure offered by the cities. Although agglomeration effects exist for all urbanites, the urban wage premium for new migrants living in slums, usually informal workers, will be significantly lower (Matano et al., 2018) and might not compensate urban costs to improve housing conditions.

This alleged puzzle results in an interesting question about the role of urbanization in offering adequate living conditions. Even though bad housing and lack of public services is present in rural areas as well, the growth of major urban poles, a major driver of urbanization in developing countries (Pesaresi et al., 2016), represents a significant challenge for local governance, land use planners and policy makers in the developing world. The objective of this work is to provide new empirical evidence on the association between urbanization and household's living conditions.

Defining living conditions is not an easy task. Deprivation indexes measure the lack of basic needs of a group with respect to the total society (Townsend,1979), and have become an important tool for identifying, analyzing and monitoring social-economic disadvantages at the local level (Sánchez-Cantalejo et al., 2008; Durán and Condorí, 2017; Zadnik et al., 2018). Nowadays, deprivation indexes increasingly include different measures of household's well-being (OECD, 2008). These indicators have been used in Patel et al. (2014) to show the living conditions in two large Indian cities and can be also of great help to analyze and compare deprivation across areas, and the role of urbanization in living conditions. This is fact the main aim of this work: we propose the use of deprivation indices to study the role of urbanization in the living conditions. As case of study we consider Ecuador, which offers a list of interesting characteristics: it started a rapid urbanization process in the 1960's, and still presents an urbanization rate below the average of Latin America countries (Jaitman, 2015; Obaco & Diaz-Sanchez, 2018); and living standards are still representing a challenge: according to UN-Habitat (2015), Ecuador shows an increase in the percentage of people living in slums, from 22% in 2005 to 36% in 2014,[1] although there is no official national statistic on that matter and the international figure is not locally disaggregated.

This paper takes advantage of micro-household data over the period 2010-2017 and develops a hierarchical analysis of the link between deprivation and city size. The analysis is developed at two levels, combining a joint micro and macro approach. By using Principal Component Analysis

[1] See https://data.worldbank.org/indicator/EN.POP.SLUM.UR.ZS?view=chart

(PCA), we define a deprivation indexes by means of thirteen variables covering aspects such as access to public infrastructure, use of housing durable materials, and the social dimension, proxied the overcrowding. The reported results ameliorate endogeneity concerns by considering instrumental variables (IV) estimates.

The results show that the average deprivation in Ecuador displays a value of 14% and that it is likely that any Ecuadorean households would have some of the deprivation-controlled characteristics. We also find that household's education is an important factor to reduce actual deprivation levels at the micro level. Other controls with a significant effect include labor characteristics, rurality and demographic characteristics. At the province level, Coastal and Amazon regions present higher levels than provinces in the Andean region. Finally, we find a significant effect of urbanization as a reducing factor of households' deprivation indices. Consequently, in the considered period, the growth of Ecuadorean cities has helped to the reduction of deprivation.

The paper is structured as following. The section 2 introduces the literature. The section 3 presents the structure of the indexes. The section 4 the case study, while the section 6 introduces the methodology. The section 6 shows the results, and the section 7 presents the conclusion and policy implications.

2.- Literature

The concept of deprivation is associated to the lack of basic needs that are considered as a standard for a group(s) with respect their total society. These disadvantages should be observable and demonstrable (Spicker, 2009; Townsend 1987). Deprivation is also associated to bad health conditions and higher diseases rate (Lillini & Vercelli, 2018). Deprivation analysis starts in the 1980s with the pioneering works of Carstairs (1981), Jarman (1983) and Townsend (1987). These indices present similarities such as the use of unemployment rate, levels of overcrowding, no car ownership and not owner-occupied households, while Jarman's index extend the composite measure by using up to eight variables representing deprivation.

Generally, there are two main dimensions being captured by deprivation indexes: material deprivation and social deprivation. The former capture material well-being and uses physical characteristics of dwellings such as quality/material of the roof, walls, floor; and accessibility to basic services, including to safe water, electricity, and sewerage; and assets belongings, such as having TV, refrigerator, bicycle, car, etc. The latter focusses on the segmentation of the population such as unemployment rate, proportion of people with disabilities, literacy rate, ethnicity, among others (Cabrera-Barona et al., 2017; Durán and Condorí, 2017).

Besides the definition of the structure and amplitude of the index, a key aspect is the considered technique to build the composite index. The OECD (2008) recommends following a list of steps wherein weighting and aggregating the data on the dimensions arise as a key issue. It is assumed that any composite indicator must be defined according the goal of the analysis and the case of study. In this line, deprivation indexes change from the conceptual contents and their methodologies (Morris and Carstains, 1991; Durán and Condorí, 2017); Awasthi et al. (2017) buils a deprivation index for disabled people in India; Lalloué et al. (2014) study health inequalities and exclude the proportion of families without a car because they consider that it could depend on the availability of the public transport and the contrast between urban and rural needs; Sánchez-Cantalejo et al. (2008) study the Spanish case and adapts the standard index to the case of study. An example of these case-study specificities is the definition of overcrowding: while for Spain household's overcrowding is fixed at more than one person per

room, for Argentina, overcrowding is fixed to three or more persons per room (Durán and Condorí, 2017), and Cabrera-Barona et al. (2017) consider four or more people per room to analyze deprivation in Quito.

Consequently, the case of study conditions the use of alternative different definitions. In for the developing world, Sahn and Stifel (2003) analyzed deprivation for a set of developing countries, including Ghana, Jamaica, Madagascar, Pakistan, Peru, South Africa, Vietnam, Papua New Guinea.[2] The set of assets to evaluate deprivation were radio, TV, refrigerator, bicycle, car, pipe water, flush toilet, no toilet, low-quality floor, and education of the head of the household. Durán and Condorí (2017) develops a small area deprivation index based on material and social dimensions for Argentina for the year 2010, proxying deprivation by using the unemployment rate, literacy rate and single parent households, among others. Other examples analyze African countries (Booysen et al., 2008), Brazil (Machado et al., 2014), Malawi (Vandemoortele, 2014), Egypt (Khadr et al., 2010), Colombia (Gómez-Salcedo et al., 2016), China (Balen et al., 2010), Russia (Popova and Pishniak, 2016) or Vietnam (Thu Le and Booth, 2014).

As for Ecuador, Benvin et al. (2016) study well-being of Ecuadoreans being guided by the principles of distributive justice and distinguishing by household type at the country level. Cabrera-Barona et al. (2015, 2016) and Cabrera-Barona and Ghorbanzadeh (2018) perform a deprivation analysis where the objective is to identify the deprivation areas in Quito, the capital of the country. The deprivation is built using social indicators, such as percentage of population that works without formal payment, percentage of population with a long term disability, percentage of population without formal education, and material indicators including percentage of households without public drinking water, distance to the nearest healthcare service, percentage of households without access to sewerage system, public electricity, percentage of households with no garbage collection service, among others. As in other works, the main aim the identification of deprived areas in a particular point of time. Díaz and Romaní (2016) and Royuela et al. (2019) analyze overcrowded measures at the household level and conclude that households' characteristics are an important determinant of this dimension of overcrowding.

The literature examining the association between deprivation and urbanization is not as vast. Glaeser and Henderson (2017) analyze living conditions and urbanization in developed and developing countries and find higher levels of poverty and slums in more urbanized developing countries. Patel et al. (2014) suggest the importance of a minimum standard of living conditions in urban areas. Castells (2017) analyzes the role of urban concentration and quality of life which seem not to be straightforward. He also mentions the importance of basic public services and infrastructure to generate agglomeration benefits, which might be affected by the lack of them. Mitra and Nagar (2018) find that the largest urbanized areas present higher levels of deprivation when these urbanized areas reach a very large size. As for individual households, Brueckner (2013) considers that higher income and education lead to occupancy of dwellings with less slum's characteristics. Moreover, the lower number of children in the household tends to reinforce this effect. Galiani et al. (2017) show that improving housing conditions increase the well-being of extremely poor people.

3.- The deprivation index

[2]As for developed countries, it is founded for Canada (Pampalon & Raymond, 2000), England and Wales (Morgan and Baker, 2006), Europe (Alkire et al., 2015) or OECD countries (Boarini and Mira d'Ercole, 2006), Spain (Sánchez-Cantalejo et al., 2008), France (Havard et al. 2008), among others.

In this work we define a material deprivation index, by means of using a list of socio-economic characteristics. An index is usually presented as the following:[3]

$$I_{dep} = \sum_{k=1}^{K} \omega_k X_{ik} \quad (1)$$

where I_{dep} is the deprivation index, X_{ik} is the set of K variables that compose the index, and ω_k is the weight allocated for group of variables. The weight is important as it defines the importance of every indicator. If $\omega_k = 1$, all variables would have the same importance, while this can be not advisable, as having access to piped water can be more important than having a. Hence, building a final index can be a difficult task, as there can be a large variety of dimensions proxying deprivation.

The process of building a deprivation index depends on two main decisions (do Carvalhal Monteiro et al., 2017; Athanassoglou, 2015): the definition of the list of indicators of deprivation, and the way that these indicators are combined. A common method to combine the basic indicators is Principal Components Analysis (PCA). This is a data-driven approach that allows avoiding subjectivity in the final weighting scheme. The first application of PCA is founded in Pearson and Hotelling (See OECD, 2008) and it is vastly used in many disciplines. While PCA relies on statistical methods, it is easy to apply, and it solves the problems of selecting the adequate variables and the weights for the index (Boelhouwer, 2002; Decancq & Lugo, 2013).

PCA summarizes a set of variables that are highly correlated into a smaller number of indices that are uncorrelated (orthogonal) among them. Thus, once selected the variables that can capture a socio-economic phenomenon, deprivation in this case, the goal is to capture a small number of indicators containing a large share of common variance. It is recommended that before the application the variables are standardized, and to rotate the obtained factors to create an index with similar measurement units (OECD, 2008). The rotation strategy allows to obtain a clear pattern of high loadings for some variables (Krishnan, 2010). The chosen results are those with an eigenvalue equal or larger than 1, or with a total accumulated variance equal or larger than 60%. Finally, PCA can be also transformed linearly into an index between 0 and 1, allowing for easier comparisons.

4.- The Case of study

Ecuador is a small open economy located in the Northwest side of South America, neighboring Colombia at the North, Peru at the East and South, and the Pacific Ocean at West. Ecuador has an area of 283,561 km^2 and geographically, is defined by four natural regions: Coastal region, Andean highland region, Amazon region and Galapagos Islands.[4]

Nowadays Ecuador has some 16 million inhabitants. In terms of ethnicity composition, Ecuador has a variety self-identification such as mestizo (majoritarian), indigenous, white, black, and others.[5] Most population is concentrated in the Coastal and Andean regions, being Guayaquil and Quito (the capital) the largest cities. The administrative division of Ecuador is based on three levels: provinces (24), cantons (224), and parishes (1,024). Provinces are the most aggregated

[3] Decancq and Lugo (2013) present an overview of most used techniques to identify weights in multidimensional indexes. OECD (2008) also presents a comprehensive guide to build composite indicators.

[4] Galapagos is out of our analysis because of the data availability.

[5] Mixed between white and native indigenous.

administrative division; meanwhile parishes are the closest to the conceptualization of municipality.

Ecuador is an interesting case of study due to its rapid urbanization process over the last half century. Ecuador had an urbanization rate of around 65%, below the average of Latin America, which is close to 70%.[6] Two main urban areas concentrate more than the 50% of the urban population, Guayaquil in the Coast (Province of Guayas), and Quito in the Andean region (Province of Pichincha) with more than 2 million of inhabitants in their metropolitan areas. The next large city is Cuenca (Province of Azuay) with a population of around 300 thousand inhabitants, what demonstrates the primal role of Quito and Guayaquil in the Ecuadorean urban system (Obaco & Díaz-Sánchez, 2018; Royuela and Ordoñez, 2018).[7]

To cover the idea of material deprivation, we us the ENEMDU survey.[8] These surveys are devoted to capture the Ecuadorean labor market status and are taken quarterly. For our objective, we take advantage of the extension of the survey, which also include information on housing physical characteristics and material living conditions. Every year's fourth quarter of the surveys is designed to be representative at the national, regional, provincial level, and also distinguishing nationally between urban and rural areas. Moreover, the survey is representative for the main five cities: Guayaquil, Quito, Cuenca, Ambato and Machala. For our analysis use the period 2010 to 2017.[9] The final sample account for around 150 thousand households.

In order to capture material deprivation, we consider up to thirteen variables. Some of them are associated with public services availability: households without toilet and sewage system, public water supply, electricity, public garbage collection, fixed telephone, and internet connection. We also consider houses made of non-durable materials, and two variables capturing the availability of some key private assets, including non-TV color and computer desk. Finally, we consider social deprivation by considering if the house is owned by the dweller, and if it is overcrowded (defined as four people or more per bedroom).

Table 1 shows descriptive statistics of the variables used to measure deprivation, including an urban/rural distinction. Clearly, rural areas present higher deprivation in almost all dimensions. Still, urban areas also present important level of deprivation in many variables, being particularly high for connectivity, fixed telephone, internet, or having a computer desk. As for public services, there are still urbanized areas with some level of deprivation, for rural areas the percentage are higher, especially for water supply and garbage collection. Finally, all deprivation variables present a slightly decreasing trend over time (statistics not reported for brevity), with the exception of internet connection that seems time invariant during the period of study.

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[6] According to Ecuadorian authorities, urban areas are the ones limited by the borders of capital provinces, together with other highly concentrated parishes. On the other hand, a rural parish is that with a population of ten thousand or less inhabitants.

[7] Here, Guayaquil and Quito are referred to metropolitan areas.

[8] The data does not allow to cover the idea of slums with requires the dummy identification of being or not being a slum household based on a set of five given characteristics that are not fully covered in the ENENMDU surveys (UN-Habitat, 2003). Thus, it is used slums households and deprivation as synonymous although they are not the same.

[9] In order to work with the whole period, some corrections were needed, as two new provinces were created, and the questionnaires were not fully identical. After 2017, the ENEMDU survey changed to a difference methodology that does not allow representativeness at the provincial level.

Table 1. Descriptive statistics. Share of households with deprivation characteristics

N.-	Variable	Concept	Urban	Rural	Total
1	Sewage system	No toilet and no public sewage system	1.4	16.8	7.6
2	Water supply	No public water supply	7.1	51.7	25.2
3	Electricity	No electricity	0.3	5.3	2.3
4	Garbage	No service of garbage collection	3.9	47.5	21.7
5	Access	No good access to the house	25.2	73.2	44.2
6	Bad walls	No durable material of walls	6.0	25.1	13.8
7	Bad floor	No durable material of floor	12.1	41.4	24
8	Telephone	No fixed telephone	50.1	83.3	63.6
9	Internet	No internet connection	63.2	90.7	74.4
10	Computer	No computer	66.4	90	76
11	TV	No color TV	14.3	31.4	21.3
12	Owner house	No owner of an occupied household	22.2	4.9	15.1
13	Overcrowding	Four or more people per bedroom	0.2	0.12	0.16

Source: ENEMDU, information at household level Elaboration Autors

By means of the thirteen variables, we perform the PCA analysis.[10] Four components report an eigenvalue higher than 1 and capture around 60% of the total variance. Appendix 1 displays the basic PCA results. The four indicators are linearized between 0 and 1 to make the interpretations easier, where to be closer to one can be interpreted as higher deprivation. The first index captures 29% of total variance and is positively associated with eleven of the thirteen indicators. Consequently, we interpret that it can be interpreted as the general indicator of deprivation. The second component captures 11.5% of the total variance, and is mostly associated with private assets, including telephone and internet connection, or having a computer. The third component (8.3% of total variance) is mainly related to no being owner of an occupied house, while the last component (7.7%) is related to overcrowding rate.

Table 2 presents some descriptive statistics of the four indicators. The mean of deprivation index (PC1) is around 0.14 and the median is 0.10, what can be interpreted as a low deprivation average. On the contrary, the second and third components, those linked to private assets (PC2) and housing ownership (PC3), clearly show higher levels of deprivation. Finally, deprivation associated with overcrowding (PC4) is reporting a quite low value, in line with the single indicator described in Table 1. Figure A1 in the appendix displays the box plot of each component. The general deprivation index (PC1) concentrates most of the frequency in low values and displays a long tail to the right. The second and third components are less skewed, while the last one displays a low variability.

Table 2. Descriptive statistics of the indexes

Indexes	Obs	Mean	Median	Std. Dev.	Min	Max
Deprivation index (PC1)	148,899	0.139	0.098	0.150	0	1
Assets (PC2)	148,899	0.649	0.745	0.244	0	1
Housing ownership (PC3)	148,899	0.626	0.648	0.153	0	1
Overcrowding (PC4)	148,899	0.022	0.020	0.042	0	1

Source: ENEMDU, information at household level Elaboration Autors.

[10] In detail, the PCA use the correlation matrix and rotate components with the varimax (orthogonal) metodology.

5.- Methodological framework

The main aim of this work is the study of the impact of urbanization on household's deprivation. In order to perform an empirical analysis, the empirical literature has found two main methodological problems, both resulting in potential endogeneity, and consequently with biased estimates. The first one is that of sorting of population: it can be the case that more urbanized areas attract people with specific characteristics that are connected with deprivation. The empirical literature on agglomeration economies has addressed this issue by using individual panel data and performing fixed effects estimations, what controls for any unobserved individual heterogeneity. However, in many developing countries it is not possible to find such suitable data set. The better alternative has been the use of a wide list of individual controls (as in Glaeser and Resseger, 2010, and Duranton, 2016). The second methodological aspect to be considered is the possible simultaneity in the individual choices concerning housing characteristics and locations. The common solution in the literature is the use of instrumental variables estimations, considering lagged values of the agglomeration measures and geological attributes (Combes et al., 2008, Matano et al. 2018).

The present study addresses these two challenges by considering a hierarchical model, as proposed by Combes et al. (2011) and Combes et al. (2008). The model considers in a first level microdata with households' characteristics and a second level with city information, in our case, provincial data, including location fixed effects that capture whatever location specific factor not explained by household's characteristics. Following Obaco et al. (2019), there is a limited number of urban centers in Ecuador, and most of them are linked with a single province, that capture more than 90% of the urbanization of the province.[11]

Thus, the proposed empirical model considers two equations to be estimated:

$$Index_{i,p,t} = \alpha_1 + \sum_{i=1}^{k} \beta_i X + \delta_{it} * Prov_i * Time_t + u_{i,p,t} \quad (1)$$

&

$$\delta_{it} = \alpha_2 + \gamma\ urban_{\ it} + \theta_1 Region_i + \theta_2 Time_t + e_{it} \quad (2)$$

where $Index_{i,p,t}$ represents the deprivation index of household *i*, in province *p*, at time *t*; α, β, δ and θ are vectors of parameters, being γ the interest parameter capturing the effect of urbanization on deprivation; X is a vector of household's characteristics and includes the following variables household composition (number of children and elderly members), age and gender of the head of the household;; a dummy for informality that indicates the labor's conditions; in order to capture the socio economic status of the household we include education categories of the head of the household rather than total income[12] ; and we finally included a dummy indicating if the household lives in a rural area. $Prov_i * Time_t$, are time-varying province fixed effects. Given the structure of equation (1) the parameters for these fixed effects, δ_{it}, capture any variation in deprivation that is not associated with personal characteristics

[11] According Obaco et al. (2019), 28 urban centers are identified using satellite imagery of population density of a minimum of 500 inhab./km^2 and 25 thousand inhabitants. Practically, one per province (24 provinces).

[12] Income family is not significant when education is included in the analysis.

included in X. These estimated parameters are used as dependent variable in equation (2), which considers urbanization provincial rate as main interest variable. We use the log of urban density (urban population per km^2). The expected result is that denser provinces must be associated to a lower level of deprivation due to the benefits of agglomeration. Equation (2) also included region dummies (Coastal, Andean and Amazon) to capture the natural regional differences, between provinces and time dummies. Our specification does not include extra covariates, and consequently our measure of urbanization captures also changes in other socio-economic variables, such as province GDP, or improvements in infrastructure. Finally, in order to deal with endogeneity, we use an instrumental variable estimate. The instruments proposed in this paper are the log of urban density in 1975 and the number of urban centers in each province, which would be correlated with the urban size, but not directly related with the current deprivation level.

Finally, as robustness check, we use information for the five largest cities in the country, for which we have a representative sample in the survey. Because of the limited data availability, we consider a dummy for the role played by the two largest cities (Guayaquil and Quito), which will capture the differential against small and medium cities, with the advantage that the frequencies of the observations are representative at city level and not only at the provincial level.

6.- Results

6.1.- First step

Table 3 displays the standardized coefficient estimates of equation (1) for all four components of deprivation. In this first step, we find that household's characteristics have a relevant role in households' differences in terms of the deprivation indices. Gender arises as a relevant factor only in the general dimension of deprivation, being insignificant in the other three. We find that when the head of the household is a woman, there is a lower level of deprivation. The age of the head of the household and stronger presence of elderly in the household are significantly associated to a lower level of deprivation, although at a decreasing rate. The only index with positive effects is PC3, the one linked with no-homeownership. This can be the result of a cohort effect, i.e. younger generations are more concerned with legal status of their houses, as well as with spatial differences linked with both dimensions. A stronger presence of children is associated to higher levels of deprivation indexes, with the exception of PC4. These results are in line with the fertility hypothesis according to which as the number of children per family increases the average capacity for investment decreases (Barro, 2000). The dummies capturing education levels (being the reference category non-literacy) clearly report a strong impact of schooling on deprivation, which is higher at the secondary level for the general deprivation index (PC1) and at the university level for the assets deprivation (PC2). It is not clear the effect of education on the last two components of deprivation. In both cases non-homeownership and overcrowding, higher levels of education are associated with more deprivation. This puzzling result can only be explained by the small absolute values of the parameters and the fact that they are conditional on other variables. Labour market status, proxied by the informal dummy, indicates that not having a formal job is associated with higher deprivation indices. Finally, the rural dummy is the one with a stronger impact on deprivation: in the first three components we find the highest standardized parameter value, indicating that rurality is strongly associated with material deprivation.

The first three components are somehow explained by the considered variables. While the general deprivation index (PC1) and the non-homeownership index (PC3) estimates capture around 21% of total variance, the assets deprivation index's R squared is 27%. As could be expected by the small variability of the overcrowding index (PC4), the adjustment is very low, and the significance of the parameters can be associated with the large sample size. Consequently, it is very likely that the results of this model are not reporting as good results as the other ones.

As for the results of the province-time, figure A2 in the appendix shows the average of the estimates. There is clear the concentration of the general deprivation index (PC1) is the poorest regions of Ecuador, the Amazon and Coast, with the exception de Guayas (a province holding Guayaquil, the largest city in the country) and Santa Elena. The assets deprivation index (PC2) shows a concentration in the Coastal region. The non-homeownership deprivation index (PC3) is also reporting higher values in Coastal region. Finally, overcrowding deprivation index (PC4) is evenly distributed between Coastal and Amazon regions. Regional dummies in equation (2) are expected to capture any permanent heterogeneity due to regional characteristics.

Table 3. Regression of deprivations indexes on individual households' characteristics (beta standardized coefficients)

	(1)	(2)	(3)	(4)
VARIABLES	PCA1	PCA2	PCA3	PCA4
Female	-0.0075***	0.0005	0.0008	0.0000
	(0.0007)	(0.0011)	(0.0007)	(0.0002)
Age	-0.0015***	-0.0024***	0.0005***	-0.0001***
	(0.0001)	(0.0001)	(0.0001)	(0.0000)
Age2	9.72e-05***	9.72e-05***	9.72e-05***	9.72e-05***
	(5.54e-06)	(5.54e-06)	(5.54e-06)	(5.54e-06)
Elderly	-0.0079***	-0.0016	0.0171***	-0.0011***
	(0.0007)	(0.0010)	(0.0006)	(0.0002)
Children	0.0056***	0.0051***	0.0045***	-0.0009***
	(0.0004)	(0.0005)	(0.0003)	(0.0001)
Literacy	-0.0693***	-0.0285***	0.0068***	0.0027***
	(0.0021)	(0.0016)	(0.0014)	(0.0004)
Primary	-0.0819***	-0.1111***	0.0045***	0.0053***
	(0.0022)	(0.0020)	(0.0016)	(0.0006)
Secundary	-0.0834***	-0.1486***	0.0105***	0.0047***
	(0.0024)	(0.0030)	(0.0022)	(0.0006)
Technical	-0.0651***	-0.2535***	0.0137***	0.0063***
	(0.0022)	(0.0025)	(0.0018)	(0.0007)
University	-0.0437***	-0.3356***	0.0304***	0.0116***
	(0.0030)	(0.0055)	(0.0040)	(0.0028)
Informal	0.0236***	0.0487***	0.0034***	-0.0005*
	(0.0010)	(0.0012)	(0.0009)	(0.0003)
Rural	0.0933***	0.1100***	0.1355***	-0.0016***
	(0.0009)	(0.0012)	(0.0008)	(0.0002)
Province*Year	yes	yes	yes	yes
Observations	148,899	148,899	148,899	148,899
R-squared	0.2071	0.2738	0.2156	0.0110

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Households characteristics related to the head of the households

6.2.- Second step

Table 4 shows the results of the second step of the estimation strategy. The table reports OLS results in the first four columns, while the last four display the instrumental variables IV estimates, which show the Underidentification, Weak identification and Overidentification tests for the instruments. The Instruments are good for these tests in the estimates of deprivation index (PC1) and deprivation index of no-homeownership (PC3). On the contrary, for the assets (PC2) and overcrowding (PC4) deprivation indices, there is a significant association between the instruments and the estimation residuals, and consequently the IV is not successful in ameliorating the potential endogeneity concerns.

According to both OLS and IV estimates, provinces with higher urban density are significantly presenting lower levels of deprivation. These effects are larger for the general deprivation index (PC1). For this index, doubling urban density implies a decrease in the deprivation index of 2.4%,

a result that holds when instrumenting the agglomeration measure for the assets deprivation index (PC2) we find a marginally significant (OLS) or not significant (IV) association with the urbanization measure. As for no-homeownership deprivation index (PC3), the effect of urbanization is still negative and significant even when instrumenting for urbanization, although at a marginal significance level. In this case we find that doubling urban density imply a decrease between 0.5% and 0.4% of deprivation. Finally, as expected, the model for overcrowding deprivation is the one with the lowest adjustment and reporting the lowest impact.

Table 4. Regression of province varying-fixed effects on log of urbanization density.

	OLS estimate				**IV estimate**			
	(1)	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
VAR.	**PCA1**	**PCA2**	**PCA3**	**PCA4**	**PCA1**	**PCA2**	**PCA3**	**PCA4**
L(density)	-0.024***	-0.010**	-0.004*	-0.001***	-0.024***	-0.003	-0.005*	-0.001**
	(0.004)	(0.004)	(0.002)	(0.001)	(0.006)	(0.006)	(0.003)	(0.001)
Years	yes	yes	yes	yes	yes	yes	yes	yes
Region	yes	yes	yes	yes	yes	yes	yes	yes
Obs.	167	167	167	167	167	167	167	167
R-squared	0.597	0.344	0.376	0.264	0.597	0.335	0.375	0.261
Underidentification test					0.00	0.00	0.00	0.00
Weak identification test					81.24	81.24	81.24	81.24
Overidentification test					0.630	0.023	0.160	0.001

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

6.3.- Robustness check

The ENEMDU survey is representative at for cities in the country: Guayaquil, Quito, Cuenca, Ambato y Machala. The first two are the largest metropolitan areas, both over the 2 million, while the others are small and medium size cities, all with less than 500 thousand inhabitants. The forthcoming analysis contrasts the differences in deprivation of people living in the two largest cities against those living in less crowded urban areas, once we control for household' characteristics. The question here has to see with the role of urbanization in large urban cores as a driver of benefits or as a pole of deprivation and slums, as has taken place in other countries. In other words, if agglomeration is good for lowering deprivation, should everyone be concentrating in few large cities? Or, on the contrary, is it enough to live in a small or medium city to enjoy the benefits of urbanization? We try to answer this question by expanding the former equation (1) including a dummy for those individuals living in Quito and Guayaquil. Given the small number of spatial units, the alternative of expanding equation (1) is preferred to the use of a two-equations strategy, as we performed above.

The results of the estimates for the four deprivation indices are reported in table 5. In line with the former results, the first three models are the ones with higher adjustments. In this case, though, the R-squared are always lower than in the previous estimates, what clarifies that differences between the five top-cities in the country are lower than what we find with the rest of the country. For these three models the dummies capturing living in Quito and Guayaquil report a significant parameter. As for deprivation index (PC1), the dummy is significant and negative. Thus, the two largest cities tend to offer lower levels of deprivation compared with the other three cities, once we account for households' characteristics. As for the assets

deprivation index (PC2), the dummy of big cities reports a positive effect, indicating more inequality in assets is present in the two largest cities. It is likely to be the case that higher housing costs in larger cities allow for lower investments in private assets. The dummy for big city is associated to lower levels of non-homeownership deprivation index (PC3, and finally, we find a non-significant parameter for the deprivation index (PC4).

Table 5. Results of deprivation indexes for the five representative cities.

	(1)	(2)	(3)	(4)
VARIABLES	PCA1	PCA2	PCA3	PCA4
Female	-0.0013*	-0.0045*	0.0002	-0.0005
	(0.0007)	(0.0026)	(0.0016)	(0.0004)
Age	0.0000	-0.0020***	0.0006***	-0.0001**
	(0.0001)	(0.0003)	(0.0002)	(0.0000)
Age2	-0.0000***	0.0000***	0.0000	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Olderly	-0.0107***	-0.0093***	0.0269***	-0.0003
	(0.0007)	(0.0025)	(0.0012)	(0.0003)
Children	0.0004	0.0058***	0.0014	-0.0010***
	(0.0004)	(0.0014)	(0.0009)	(0.0001)
Literacy	-0.0109***	-0.0616***	0.0022	0.0018***
	(0.0036)	(0.0072)	(0.0050)	(0.0005)
Primary	-0.0068*	-0.1586***	0.0038	0.0037***
	(0.0035)	(0.0074)	(0.0050)	(0.0008)
Secundary	-0.0020	-0.2177***	0.0185***	0.0029***
	(0.0038)	(0.0091)	(0.0059)	(0.0009)
Technical	0.0076*	-0.2650***	0.0067	0.0060*
	(0.0045)	(0.0133)	(0.0086)	(0.0031)
University	0.0094***	-0.3044***	0.0233***	0.0053***
	(0.0035)	(0.0076)	(0.0051)	(0.0011)
Informal	-0.0041***	0.0942***	-0.0090***	0.0006
	(0.0012)	(0.0036)	(0.0024)	(0.0006)
Big Cities	-0.0037***	0.0083***	-0.0068***	-0.0002
	(0.0007)	(0.0025)	(0.0016)	(0.0004)
Constant	0.0894***	0.7948***	0.5395***	0.0194***
	(0.0041)	(0.0100)	(0.0064)	(0.0009)
Year	yes	yes	yes	yes
Observations	34,403	34,403	34,403	34,403
R-squared	0.0766	0.1641	0.0365	0.0068

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Households characteristics related to the head of the households

7.- Discussion and conclusion

This paper presents a multilevel analysis of the association between deprivation and urbanization in Ecuador. We perform our analysis by building an indicator of deprivation by means of principal components analysis considering thirteen indicators of deprivation. Four deprivation indexes are obtained from the analysis: a first component defined as the general concept of deprivation; a second component labelled as assets deprivation; a third component

related to non-homeownership deprivation; and a fourth factor defined as overcrowding deprivation.

The multilevel analysis is composed by two equations; first we use household information including a set of personal characteristics to explain deprivation indexes, and a fixed effects structure capturing specific provincial effects over time. At the second level, the varying provinces fixed effects parameters are regressed on a measure of urbanization, i.e. urban density. Our IV estimates show that more urbanized provinces tend to have lower levels of general deprivation as well as lower indices of non-homeownership deprivation. Inconclusive results are found for the other two measures of deprivation, although we also find a negative association in the basic OLS estimates. We have performed an additional analysis inspecting the role of major cities in declining deprivation. We find that living in one of the two largest cities in the country, Quito and Guayaquil, compares to three medium cities, and significantly improves households' position by lowering the general level and the non-homeownership deprivation. On the contrary, these two cities report a worse result in the assets deprivation index, what we hypothesize as a result of higher housing costs and consequently lower purchasing power for enjoying additional assets.

Our results demonstrate the role of urbanization as a driver of development and improvement of households' living conditions. From a governance point of view, it is clear that urban agglomerations allow for better planning of provision of basic services, such as clean water, sewerage, electricity and connectivity services. For our case of study, bigger means smarter and more efficient in providing better living conditions. Nevertheless, it is not that clear that large agglomerations are good in all dimensions of deprivation. While our findings are robust for the general deprivation index and for non-homeownership deprivation dimension, not conclusive results are found for the assets and overcrowding deprivation indices. Both aspects are clearly linked with policy intervention at the microlevel, by lowering housing costs and improving crowded conditions of urban dwellings. The evaluation of housing policies in the country, such as the incentive system labelled ABC (*ahorro-bono-crédito*), at the light of deprivation characteristics is an aspect to consider in the future agenda of policy makers and academics.

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Appendix 1. PCA results

Table A1. PCA result.

N.-	Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
1	Sewage system	**0.566**	-0.302	**0.162**	0.013	0.563
2	Water supply	**0.677**	-0.135	-0.214	-0.051	0.476
3	Electricity	**0.402**	-0.339	**0.366**	0.068	0.586
4	Garbage	**0.674**	-0.178	-0.182	-0.044	0.479
5	Access	**0.625**	0.016	-0.332	-0.074	0.493
6	Bad walls	**0.608**	-0.276	**0.156**	0.013	0.529
7	Bad floor	**0.645**	-0.238	**0.141**	0.023	0.507
8	Fixed Telephone	**0.594**	**0.478**	**0.121**	-0.023	0.404
9	Internet	**0.574**	**0.622**	-0.026	0.035	0.282
10	Computer	**0.541**	**0.606**	0.017	0.064	0.337
11	Tv	**0.399**	-0.192	**0.357**	0.089	0.669
12	Owner house	-0.218	**0.286**	**0.730**	0.010	0.338
13	Overcrowding	-0.021	-0.013	-0.114	**0.986**	0.014

Table A1. PCA result.

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	3.753	2.263	0.289	0.289
Factor2	1.490	0.409	0.115	0.403
Factor3	1.081	0.079	0.083	0.486
Factor4	1.002	0.027	0.077	0.564
Factor5	0.975	0.139	0.075	0.639
Factor6	0.836	0.059	0.064	0.703
Factor7	0.777	0.097	0.060	0.763
Factor8	0.679	0.060	0.052	0.815
Factor9	0.620	0.093	0.048	0.862
Factor10	0.527	0.042	0.041	0.903
Factor11	0.485	0.085	0.037	0.940
Factor12	0.400	0.023	0.031	0.971
Factor13	0.376	.	0.029	1.000

Figure A1. Deprivation indices at household level

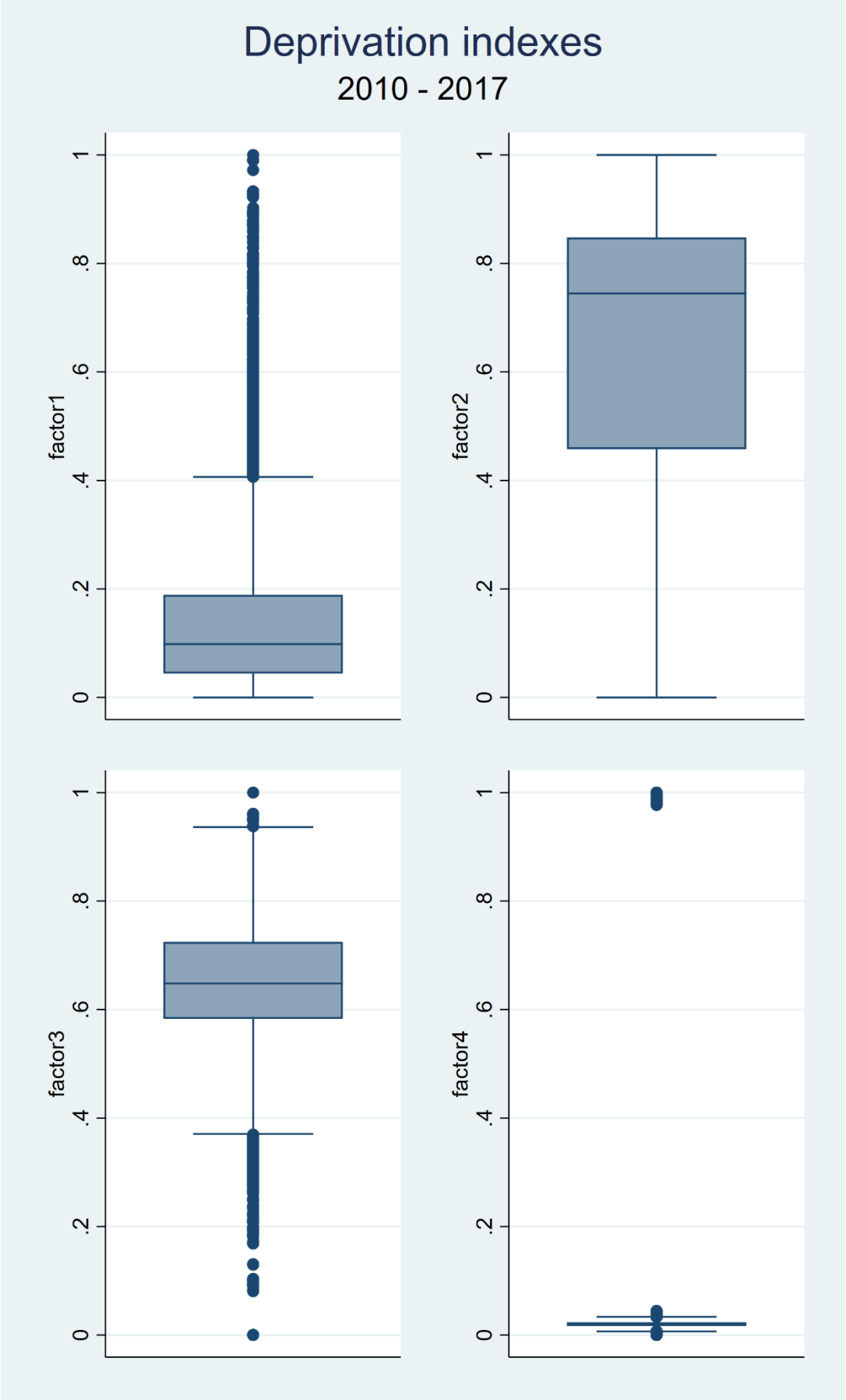

Figure A2. Deprivation indexes for the Ecuadorean provinces – include the labels (topics) of every index in the maps