Land Use Policy 111 (2021) 104761

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

On the link between material deprivation and city size: Ecuador as a case study

Moisés Obaco [a,*], Vicente Royuela [b], Alessia Matano [b]

[a] GIER (Grupo de Investigación en Economía Regional), Facultad de Ciencias Económicas y Administrativas, Universidad de Cuenca, Ecuador
[b] AQR-IREA Research Group, Universitat de Barcelona, Spain

ARTICLE INFO

JEL classification:
R10
R20
I31

Keywords:
Deprivation
Developing economies
Ecuador
Slums

ABSTRACT

The association between city size and productivity has been widely investigated in the academic literature. On the contrary, less is known about the link between city size and material living conditions. Recently, a strong emphasis has been put on the process of urbanization without growth and on the burst of large cities. The creation of slums and large areas with underdeveloped housing characteristics has become a major concern for urban planners. This is especially the case for developing economies. This work analyses the association between city size and material living conditions in Ecuador, a small developing country experiencing rapid urbanization and where slums constitute a relevant part of the urban landscape. Our findings show that living in denser areas is associated with lower levels of deprivation and overcrowding. Nonetheless, we also show evidence of congestion in larger cities.

1. Introduction

The UN's Sustainable Development Goals (SDG) aim to achieve a better and more sustainable future for all. As the world becomes increasingly urban, the spatial dimension of sustainability turns its focus to 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 is a 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 has taken place in developing economies is characterized by extreme poverty and poor quality institutions (Glaeser and Henderson, 2017).

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 (Castells-Quintana and Wenban-Smith, 2019; Pesaresi et al., 2016; Mitchell et al., 2015), 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 living conditions. To this end, we employ a two-stage empirical strategy for studying agglomeration economies, now standard in the literature (Combes et al., 2008). We also take into account individual sorting and endogeneity arising from simultaneity bias by means of instrumental variables estimates. As a case study, we consider Ecuador, a small developing economy in which a fast urbanization process is currently taking place and slums creation is a real concern. We take advantage of micro-household data in Ecuador from 2010 to 2017 and define a battery of composite indices to proxy living conditions and, in particular, material deprivation at the household level. To our knowledge, this is the first paper in the literature investigating the association between city size and material deprivation using individual data and employing a robust estimation strategy.

In relation to the existing literature, this paper is linked to two main streams: the literature on development theories, according to which urbanization is expected to be a consequence and driver of development, and the literature on urban economics, in which cities are the result of agglomeration forces and an endogenous source of economic growth. Nevertheless, the analysis of costs associated with urbanization and recent literature on urbanization without growth drive to a need to investigate the association between urbanization and material living conditions in cities, particularly in the developing world.

The main results of this study show that urbanization is linked with lower levels of deprivation, though at a decreasing pace, thus providing evidence of congestion. The growth of Ecuadorean cities is facing the problem of adequate households and basic services as the size of the cities continue to get larger. Also, the recent urbanization process is

* Corresponding author.
E-mail addresses: moisesl.obaco@ucuenca.edu.ec (M. Obaco), vroyuela@ub.edu (V. Royuela), amatano@ub.edu (A. Matano).

https://doi.org/10.1016/j.landusepol.2020.104761
Received 10 September 2019; Received in revised form 8 April 2020; Accepted 13 May 2020
Available online 13 June 2020

likely to explain territorial differences in key dimensions of deprivation. Besides, household characteristics are an important factor in explaining deprivation.

The paper is structured as follows. Section 2 introduces the literature of reference. Section 3 describes the way we measure deprivation in Ecuador, our case study. Section 4 describes the methodological approach, while Section 5 presents the obtained results. In Section 6, we summarize the main findings and provide a list of policy implications.

2. Literature review

2.1. Urbanization and deprivation

The concept of deprivation refers to the inability of a population access the goods and services necessary to fulfill basic needs that are considered as a standard for society. (Spicker et al., 2009; Townsend, 1987). Deprivation is also associated with bad health conditions and higher disease rates (Lillini and Vercelli, 2018). The process of rapid urbanization in low and middle income countries is accompanied by the development of large slums, characterized by unhealthy environments and overcrowded dwellings. Slums are neighborhoods with very bad infrastructure conditions, and they represent a good indicator of the quality of life in cities and urban areas (UN-Habitat, 2015; 2003). Ensuring that residents have a good quality of life is an important goal of urban planners and urban policies.

According to traditional development theories, cities accommodate rural migrants in informal settlements who later improve their wellbeing. Slums provide cheap transitory housing for cheap labor. Slums necessarily belong to the process of economic growth in developing countries (Frankenhoff, 1967) and are the vehicle for the process of modernization (Turner, 1969). The development of cities linked to economic growth can be the result of agricultural revolutions, resource revolutions, or endogenous agglomeration effects. Nevertheless, since the mid-20th century, academics have noted that urbanization takes place without economic growth. Jedwab and Vollrath (2015) list several factors leading to this reality: improved urban technologies, preferences for urban amenities, urban political bias, rural poverty, or internal urban growth. According to Fox (2014), the proliferation of slums is a consequence of "disjointed modernization," which he characterizes as a consequence of the interaction between rapid urban population growth (usually as a result of an excessive migration from rural to urban areas), urban poverty (as people remain poor, their housing will not be improved), and institutional problems (an inelastic supply of affordable housing as a result of inefficient regulations or lack of incentives). Pavo (2013) suggests using strict rules on land use regulation and flexible enforcement of the quality of urbanization to reduce the proliferation of slums in developing countries. Patel (2016) and Zhang (2018) analyze informal housing in India and the role of formal and informal tenure systems, together with the responsibility of the state in the governance of urban informality.

Ravallion (2002) develops a model showing the conditions under which the poor urbanize more quickly than the non-poor, and Ravallion et al. (2007) show that the poor are urbanizing more quickly than the population as a whole. Nevertheless, according to these authors, the process of urbanization has had a relevant poverty reduction effect by providing opportunities to the new urbanites. This view is shared by other authors. According to Glaeser and Henderson (2017), the creation of slums, together with the informal sector, are the main characteristics of the urbanization process in the countries of the developing world. Glaeser (2011) considers that the urban size of a city might promote quality of life, as larger cities are characterized by higher wages for all workers. UN-Habitat (2015) also recognizes that slum households improve their conditions over time. On the contrary, Marx et al. (2013) claim that the people born in slums can hardly improve their conditions over time, while Castells-Quintana (2017) shows that without proper basic infrastructure, urbanization does not activate the channels of agglomeration economies.

The debate on the role of urbanization as a driver of improved material well-being is connected with the agglomeration economies literature. From the production side, cities are engines of growth, as agglomeration economies boost productivity. There is vast empirical evidence showing that larger cities are more productive (Combes et al., 2008; Combes and Gobillon, 2015) in both developed (2–5%) and developing countries (5–13%). From the consumption side, cities are usually linked with higher rents, congestion, pollution, and crime. Hence, life expectancy is lower due to industrial smoke, polluted water, or unhygienic practices. Nonetheless, several works emphasize a positive link between city size and consumption (Glaeser et al., 2001; Costa and Kahn, 2000; Puga, 2010): density decreases transportation costs and facilitates social contact (better matching for young singles), and large urban markets enjoy substantial scale economies for consumption (football, opera…) and allow for greater diversity of products.

Glaeser and Henderson (2017) recognize that the urbanization in the developing world is different from the old urbanization process, mainly due to extreme poverty and poor governance. They signal that there is a significant knowledge gap on this urbanization process and that the literature examining the association between deprivation and urbanization is not as vast as can be expected. The existing evidence is generally in favor of a positive link between urbanization and material well-being: Jedwab and Vollrath (2015) find a positive relationship between the city size of the world's main cities and their living standards, while Mitra and Nagar (2018) find a negative association between city size and deprivation in Indian cities, although with diminishing returns for larger cities. Finally, Frick and Rodríguez-Pose (2017) use a panel of 113 countries between 1980 and 2010 to show that as population concentration grows the benefits of agglomeration decline.

2.2. Defining deprivation

Deprivation analyses start in the 1980s with the pioneering works of Carstairs and Morris (1989), Jarman (1983), and Townsend (1987). To proxy deprivation, they defined various indices that combine similar attributes such as unemployment rate, levels of overcrowding, no car ownership, and not owner-occupied households. Jarman's index extends these composite measures by using up to eight variables to represent deprivation.

Two main dimensions are being captured by deprivation indices: material deprivation and social deprivation. The former represents material well-being and exploits information on the physical characteristics of dwellings such as quality/material of the roof, walls, floor; accessibility of basic services, including safe water, electricity, and sewerage; and assets, such as having a TV, refrigerator, bicycle, car, etc. The latter focuses on the segmentation of the population in terms of employment status, disabilities, education, ethnicity, etc. (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 technique to build the composite index. The OECD (2008) recommends following a list of steps wherein weighting and aggregating the data along the defined dimensions is a key issue. The guidelines assume that any composite indicator must be defined according to the goal of the analysis and the case under study. Hence, deprivation indices also change in line with the conceptual content of the analysis or the applied case study: Awasthi et al. (2017) build a deprivation index for disabled people in India, Lalloué et al. (2014) construct a deprivation index to analyze health inequalities, while Sánchez-Cantalejo et al. (2008) adapt a standard index of deprivation to the case of Spain. An example of these case study specificities is the definition of overcrowding: while for Spain overcrowded households must have more than one person per room, for Argentina there has to be three or more persons per room (Durán and Condorí, 2017). In Cabrera-Barona et al. (2017), who analyze deprivation in Quito, there must

be four or more people per room.

Sahn and Stifel (2003) analyze deprivation for a set of developing countries[1] and consider the availability of a list of assets to proxy material deprivation: radio, TV, refrigerator, bicycle, car, pipe water, flush toilet, no toilet, low-quality floor, and education of the head of household. Durán and Condorí (2017) develop a small area deprivation index based on material and social characteristics for Argentina, using information on unemployment rate, literacy rate, and single parent households, among others. Other studies 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., 2017), China (Balen et al., 2010), Russia (Podova and Pishniak, 2017), and Vietnam (Thu Le and Booth, 2014). Table A1 in the Appendix provides a synthesis of a list of works using deprivation indexes in Latin American countries. The variables related with housing deprivation are linked with the lack of basic services, including available water, waste disposal, and sewage system; quality of housing materials; and overcrowding and legal status of the occupied dwelling. These items are similar to those used in UN-Habitat's official definition of slums (2003). According to UN-Habitat, a household is in a slum if it does not accomplish one or more of the following conditions: (1) access to safe water: sufficient amount of water (20 L/person/day) at an affordable price (less than 10% of total household income) and available without being subject to extreme effort (less than 1 h a day of walking time); (2) access to improved sanitation: access to an excreta disposal system either in the form of a private toilet or of a public toilet shared with a reasonable number of people; (3) sufficient living area: fewer than three people per habitable room; (4) structural quality/durability of dwellings: a house built on a nonhazardous location and with a permanent structure adequate to protect its inhabitants from the extremes of climatic conditions; and (5) security of tenure: the right to effective protection by the State against arbitrary unlawful evictions.

Several works have studied deprivation in Ecuador. Benvin et al. (2016) study well-being at the national level, considering the principles of distributive justice and distinguishing by household type. Cabrera-Barona et al. (2017) perform a deprivation analysis where the objective is to identify the deprivation areas in Quito, the capital of the country. The deprivation index is built using various social indicators, such as the percentage of the population that works without formal payment, the percentage of the population with a long term disability, the percentage of the population without formal education, and material indicators (percentage of households without public drinking water, distance to the nearest healthcare service, percentage of households without access to a sewage system and/or public electricity, percentage of households with no garbage collection service). Díaz and Romaní (2016) and Royuela et al. (2019) analyze overcrowding measures at the household level and conclude that household characteristics are an important determinant of the dimension of overcrowding.

Given these reference benchmarks, for our empirical analysis we have elaborated a slum index using a list of indicators linked to the described dimensions. The index is computed as a weighted average of deprivation characteristics:

$$I_{dep} = \sum_{k=1}^{K} \omega_k X_k$$

I_{dep} is the deprivation index, X_k is the set of K variables that compose the index, and ω_k is the weight allocated to every variable. For its computation, we use the available data information to proxy the dimensions listed for the slum definition. As for the methodology employed to combine these characteristics, we use a Principal Components Analysis (PCA). This is a data-driven approach that allows us to avoid subjectivity in the final weighting scheme. It is widely used in many disciplines since it relies on statistical techniques; it is easy to apply and solves the problems of selecting adequate variables and weights for the index (Boelhouwer, 2002; Decancq and Lugo, 2013).

PCA is a statistical technique that synthetizes a set of variables highly correlated into a smaller number of indices that are uncorrelated (orthogonal) among them. Once the variables that can capture a socioeconomic phenomenon, deprivation in this case, are selected, the goal is to obtain a small number of indicators that can explain a large share of the data variance. Before the application, variables should be standardized in order to create an index with similar measurement units. Also, the obtained factors are rotated, since the rotation strategy allows us to obtain a clear pattern of high loadings for some variables (Krishnan, 2010), thus easing interpretation. The chosen results are those with an eigenvalue equal to or larger than 1, or with a total accumulated variance equal to or larger than 60%.

3. Measuring deprivation: evidence for Ecuador

Ecuador is a small open economy located on the northwest side of South America, neighboring Colombia to the north, Peru to the east and south, and the Pacific Ocean to west. Ecuador has an area of 283,561 km^2 and is geographically defined by four natural regions: the coastal region, the Andean highland region, the Amazon region, and the Galapagos Islands. The country is divided into 24 provinces, which are our spatial units of analysis. We exclude the provinces of Galapagos and two Amazonian provinces (Morona Santiago and Zamora Chinchipe) because of data availability, thus leaving us with data for 21 provinces. Ecuador currently has around 16 million inhabitants. In terms of ethnicity composition, Ecuador has a variety of self-identified groups such as mestizo (majoritarian), indigenous, white, black, and others. Most of the population is concentrated in the coastal and Andean regions, particularly in Guayaquil and Quito (the capital)—the largest cities.

Ecuador is an interesting case study due to its rapid urbanization process that has taken place over the last half century and that is ongoing. Its urbanization rate has been around 65%, below the average of Latin America, which is close to 70%. More than 50% of the urban population is concentrated in two main urban areas—Guayaquil on the coast (Province of Guayas) and Quito in the Andean region (Province of Pichincha)—with more than 2 million inhabitants each. The next largest city is Cuenca (Province of Azuay) with a population of around 500,000, demonstrating the prominent role of Quito and Guayaquil in the Ecuadorean urban system (Obaco and Díaz-Sánchez, 2018; Royuela and Ordóñez, 2018).[2]

We use the quarterly ENEMDU survey, which captures Ecuador's labor market status, representative at the province level. For our objective, we take advantage of the extension of the survey, which also includes information on the physical characteristics of housing and material living conditions.[3] For our analysis, we use the period of 2010 to 2017. The final sample accounts for around 150,000 households.

In order to capture material deprivation, we consider up to 13 variables that proxy the main dimensions considered in the literature. The identification is done by means of dummy variables, 1 if the household has the deprivation characteristic and 0 otherwise. The indicators are associated with the availability of public services: households without toilets and sewage systems, public water supply, electricity, public garbage collection, fixed telephone, and internet connection. We also consider the quality and durability of the homebuilding materials. Some variables capture the availability of key private assets, e.g. color TVs, computer desks, etc. Finally, we consider social deprivation by

[1] They consider Ghana, Jamaica, Madagascar, Pakistan, Peru, South Africa, Vietnam, and Papua New Guinea.

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

[3] The data do not cover the exact definition of slums, which would require a dummy identifying slum households based on a set of five characteristics that are not fully covered in the ENENMDU surveys (UN-Habitat, 2003). Thus, in this paper we consider slum households and deprivation as synonymous, although we are aware that they are not the same.

Table 1
Descriptive statistics. Average share of households with deprivation characteristics from 2010 to 2017.

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 garbage collection service	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 for walls	6.0	25.1	13.8
7	Bad floor	No durable material for floors	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	0.20	0.12	0.16

Source: ENEMDU, information at household level.

Table 2
Descriptive statistics of the indexes.

Indexes	Mean	Median	Std. Dev.	Min	Max
General Deprivation (PC1)	−0.003	−0.27	1	−0.91	5.8
Deprivation in Assets (PC2)	−0.011	035	1	−2.04	144
Deprivation in Housing (PC3)	0.009	0.16	1	−2.6	2.44
Overcrowding (PC4)	0.004	−0.06	1	−0.31	24.4

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 the urban/rural distinction at the national level.[4] Clearly, rural areas present higher deprivation in almost all dimensions, a result that demonstrates the role of urban areas in providing better material living conditions. Nevertheless, urban areas also present important levels of deprivation in several variables, with particularly high numbers for connectivity, fixed telephone, internet, or the presence of a computer desk. Interestingly, rural areas present lower rates than urban areas in housing non-ownership (renting or illegal occupation is more likely to occur in urban areas) and overcrowding (space is scarcer in urban areas). Finally, all deprivation variables present a slightly decreasing trend over time (statistics not reported for brevity), with the exception of internet connection, which is time invariant during the period of study.

By means of the 13 variables, we perform the PCA analysis.[5] Four components report an eigenvalue higher than 1 and capture around 60% of the total variance. Table A2 and A3 in the Appendix A display the basic PCA results. The first component captures 29% of total variance and is positively associated with 11 of the 13 indicators. Consequently, it can be interpreted as a 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 the presence of a computer. This index is labelled "Deprivation in Assets". The third component (8.3% of total variance) is mainly related to non-home ownership and is labelled "Deprivation in Housing", while the last component (7.7%) is related to the overcrowding rate and is labelled "Overcrowding". Table 2 presents descriptive statistics of the four indicators. Fig. A1 in the appendix displays the box plot of each component.

4. Empirical approach

The main aim of this work is to study the impact of urbanization on household deprivation. In order to perform the empirical analysis, two main issues have to be addressed. First, there could be sorting of population, as more urbanized areas may 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 that control for unobserved individual heterogeneity. However, in many developing countries panel data are generally not available. The better alternative is to use a wide list of individual observable characteristics as control variables in the analysis (Glaeser and Resenger, 2010; Duranton, 2016). Second, there could be a problem of endogeneity due to possible simultaneity in the individual choices concerning housing characteristics and locations. The common solution in the literature is the use of instrumental variable estimations, usually employing lagged values of the agglomeration measures as instruments (Combes et al., 2008; Matano et al., 2020).

We apply a two-step estimation strategy (Combes et al., 2008). In the first step, we regress the index of deprivation on a set of household characteristics and on a set of province-time fixed effects. From this estimation we retrieve the estimates of the location-time fixed effects that capture the (residual) deprivation not explained by household characteristics. In the second step we regress these province-time fixed effects on the density variable, controlling for time and macro-region fixed effects, to gauge the effect of spatial variables on deprivation. Note that in Ecuador there is a limited number of urban centers, most of them linked with a single province (Obaco et al., 2019).[6]

Formally, the proposed empirical model considers the estimation of two equations:

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

$$\widehat{\delta}_{it} = \alpha_2 + \gamma_1 \ln(density_{it}) + \gamma_1 \ln(density_{it})^2 + \theta_1 Region_i + \theta_2 Time_t + e_{it} \quad (2)$$

where $Index_{i,p,t}$ represents the deprivation index of household i, in province p, at time t; X is a vector of household characteristics that includes the following variables: gender, age and age squared of the head of household; household composition (number of children and elderly members); a dummy for informality that indicates the labor condition of the head of household; household socio-economic status captured by the education of the head of household (proxied in the following categories: no literacy, literacy, primary, secondary, technical, university)[7] ; and a dummy indicating if the household lives in a rural area. $Prov_i * Time_t$, are the time-varying province fixed effects. Given the structure of Eq. (1) the parameters for the province-time fixed effects (δ_{it}) capture any variation in deprivation not associated with household characteristics included in X. As stressed, these estimated parameters are used as dependent variables in Eq. (2), which considers an indicator of provincial urbanization as the variable of main interest. We use the log of urban density (urban population per km^2) and its square to deal with possible non-linearity in the relationship analyzed. Eq. (2) also includes macro-region dummies (Coastal, Andean, and Amazon regions) to capture the natural regional

[4] According to the official classification, Ecuadorean urban areas are limited by the borders of capital provinces, together with other highly concentrated parishes. On the other hand, a rural parish is a population of 10,000 or fewer inhabitants.

[5] In detail, the PCA uses the correlation matrix and rotates components with the Varimax (orthogonal) methodology. The PCA is computed for the overall sample, and consequently we consider both cross-section and time series information. Another alternative, not considered here, would have been to compute year-by-year PCA.

[6] According to Obaco et al. (2019), 28 urban centers are identified using satellite imagery of population density of a minimum of 500 inhab./km^2 and 25,000 inhabitants. Practically, the provinces that we use in our sample represent the urban areas.

[7] We exclude family income since it is not significant when education is included in the analysis.

Table 3
Regression of deprivations indexes on individual household characteristics.

	OLS			
	(1) General deprivation	(2) Deprivation in assets	(3) Deprivation in housing	(4) Overcrowding
Female	−0.0476***	−0.00777*	0.00922**	0.000445
	(0.00451)	(0.00441)	(0.00456)	(0.00524)
Age	−0.00947***	−0.0112***	0.00378***	−0.00134**
	(0.000475)	(0.000472)	(0.000474)	(0.000541)
Age^2	0.000107***	8.51e-05***	−2.30e-05***	6.15e-05***
	(5.71e-06)	(4.96e-06)	(5.10e-06)	(7.48e-06)
Elderly	−0.0515***	−0.00724*	0.112***	−0.0310***
	(0.00470)	(0.00413)	(0.00381)	(0.00455)
Children	0.0289***	0.0198***	0.0251***	−0.0211***
	(0.00258)	(0.00197)	(0.00219)	(0.00138)
Literacy	−0.455***	−0.111***	0.0673***	0.0626***
	(0.0139)	(0.00654)	(0.00884)	(0.0109)
Primary	−0.532***	−0.463***	0.0649***	0.128***
	(0.0141)	(0.00837)	(0.0101)	(0.0144)
Secondary	−0.538***	−0.640***	0.113***	0.115***
	(0.0159)	(0.0124)	(0.0134)	(0.0148)
Technical	−0.433***	−0.878***	0.0686**	0.189***
	(0.0212)	(0.0266)	(0.0271)	(0.0487)
University	−0.407***	−1.079***	0.150***	0.154***
	(0.0143)	(0.00995)	(0.0113)	(0.0171)
Informal	0.150***	0.207***	0.0214***	−0.0121*
	(0.00661)	(0.00515)	(0.00582)	(0.00675)
Rural	0.621***	0.457***	0.831***	−0.0399***
	(0.00566)	(0.00483)	(0.00530)	(0.00579)
Province*Year	Yes	Yes	Yes	Yes
Obs.	153,846	153,846	153,846	153,846
R^2	0.217	0.287	0.211	0.010

Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Household characteristics related to the head of household.

differences between provinces, and time dummies. The specification for the second step does not include other covariates and, consequently, our measure of urbanization captures changes in other socio-economic variables, such as provincial GDP or improvements in infrastructure.

To deal with endogeneity, we use an instrumental variable approach. The chosen instrument is the log of urban density in 1975, which is correlated with the current urban size, but is expected not to be directly related with the current deprivation level. There can be some doubts on the fulfilment of the exclusion restriction, since flows of rural migrants might have been historically placed in larger cities. Reassuringly, Royuela and Ordóñez (2018) show that provinces with the greatest influx of migrants are not necessarily the most populated. In any case, we assume that our strategy ameliorates the endogeneity concern.

5. Results

Table 3 displays the coefficient estimates of Eq. (1) for all four components of deprivation. In this first step, we find that household characteristics have a relevant role in household differences in terms of the deprivation indices. The estimates for the General Deprivation index and the Deprivation in Housing index explain around 21% of total variance of the dependent variables, while the Deprivation in Assets index's R squared is 29%. The estimation using the Overcrowding index as dependent variable has low explanatory power. Thus, the significance of the parameters is likely to be associated with the large sample size. Consequently, the results of this model need to be read with some caution.

As for the overall results presented in Table 3, it can be noted that gender arises as a relevant factor, with the exception of the Overcrowding index. When women are the head of household, there is a lower level of General Deprivation and of Deprivation of Assets. On the contrary, female heads of household are more likely to have Deprivation in Housing. A similar pattern is found for the age of the head of the household. Household composition matters in all indices: a stronger presence of elderly household members is significantly associated with a lower level of deprivation, with the exception of the Deprivation in Housing index, which is likely the result of a cohort effect, i.e., younger generations are more concerned with the legal status of their houses. A stronger presence of children is associated with higher levels of deprivation indexes, with the unexpected exception of the Overcrowding index. These results are in line with the fertility hypothesis: as the number of children per family increases, the average capacity for investment decreases (Brueckner, 2013; Barro, 2000).

The dummies capturing education levels of the head of household (the reference category for which is non-literacy) clearly report a strong negative impact of schooling on deprivation, which is higher at the secondary level for the General Deprivation index and at the university level for Asset Deprivation. On the contrary, education is positively associated with Deprivation in Housing and Overcrowding.

Labor market status, proxied by the informal dummy, indicates that not having a formal job is associated with higher deprivation indices (except for Overcrowding). Finally, the rural dummy has a stronger impact on deprivation: in the first three components we find the highest standardized parameter values, indicating that rurality is strongly associated with material deprivation.

The parameters linked to the province-time fixed effects capture the part of the deprivation indices not associated with household characteristics. Fig. A2 in the appendix maps the time-average of these estimates. Higher levels in the General Deprivation index are in the poorest regions of Ecuador (Amazon and Coast), with the exception of Guayas (the province of Guayaquil, the largest city in the country) and Santa

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

	OLS				IV			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VAR	General deprivation	Deprivation in assets	Deprivation in housing	Overcrowding	General deprivation	Deprivation in assets	Deprivation in housing	Overcrowding
Log (Density)	−0.1616***	−0.0411**	−0.0339*	−0.0234***	−0.1731***	0.0209	−0.0215	−0.0348***
	(0.0338)	(0.0184)	(0.0173)	(0.0065)	(0.0565)	(0.0358)	(0.0294)	(0.0109)
Coast	0.2132***	0.2074***	0.1718***	−0.0011	0.2181***	0.1816***	0.1666***	0.0037
	(0.0328)	(0.0269)	(0.0256)	(0.0084)	(0.0376)	(0.0344)	(0.0285)	(0.0094)
Amazon	0.3851***	−0.1421***	−0.1929***	−0.0546**	0.3539**	0.0253	−0.1593**	−0.0855***
	(0.1017)	(0.0508)	(0.0512)	(0.0226)	(0.1685)	(0.0940)	(0.0761)	(0.0290)
Constant	0.6613***	0.3863***	0.1459**	0.1190***	0.7035***	0.1600	0.1005	0.1607***
	(0.1207)	(0.0755)	(0.0658)	(0.0297)	(0.2002)	(0.1291)	(0.1105)	(0.0425)
Years	yes	yes	yes	yes	yes	yes	yes	yes
Obs	167	167	167	167	167	167	167	167
R^2	0.5894	0.3361	0.3887	0.2594	0.5891	0.2907	0.3868	0.2432
F_test					90.19	90.19	90.19	90.19

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

Table 5
Regression of province varying-fixed effects on log of urbanization density.

	OLS				IV			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VAR	General deprivation	Deprivation in assets	Deprivation in housing	Overcrowding	General eprivation	Deprivation in assets	Deprivation in housing	Overcrowding
Ln(Density)	−1.1380***	0.4315***	0.2671***	−0.1077***	−1.4947***	0.7908***	0.2275	−0.1167**
	(0.2567)	(0.0551)	(0.0672)	(0.0239)	(0.2896)	(0.1372)	(0.1580)	(0.0464)
Ln(Density) 2	0.1285***	−0.0622***	−0.0396***	0.0111***	0.1860***	−0.1084***	−0.0350*	0.0115*
	(0.0313)	(0.0067)	(0.0083)	(0.0029)	(0.0369)	(0.0182)	(0.0202)	(0.0062)
Coast	0.1749***	0.2259***	0.1836***	−0.0044	0.1244***	0.2362***	0.1842***	−0.0022
	(0.0305)	(0.0244)	(0.0238)	(0.0087)	(0.0422)	(0.0308)	(0.0273)	(0.0091)
Amazon	−0.5543**	0.3126***	0.0967	−0.1358***	−0.7578***	0.6729***	0.0501	−0.1543***
	(0.2363)	(0.0617)	(0.0822)	(0.0328)	(0.2549)	(0.1381)	(0.1653)	(0.0422)
Constant	2.4342***	−0.4718***	−0.4007***	0.2721***	2.9343***	−1.1397***	−0.3198	0.2989***
	(0.4953)	(0.1178)	(0.1312)	(0.0537)	(0.5445)	(0.2594)	(0.3027)	(0.0872)
Year Dummies	yes	yes	yes	yes	yes	yes	yes	yes
Obs	167	167	167	167	167	167	167	167
R^2	0.7267	0.5062	0.4628	0.3163	0.6848	0.4116	0.4615	0.3122
F_test					18.50	18.50	18.50	18.50

Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Elena. The Deprivation in the private Assets and Housing indices have higher values in the Coastal region. Finally, the Overcrowding index is more evenly distributed between the Coastal and Amazonian regions.

Table 4 shows the results of the second step of the estimation strategy. We first test a linear estimation of Eq. (2) by not including the squared log of density in the regression. The table reports OLS results in the first four columns, while the last four columns display the instrumental variables estimates (IV), where it is possible to check from the F-test that the historical population instrument is not weak.

According to both OLS and IV estimates, provinces with higher urban density show significantly lower levels of Deprivation. These effects are larger for the General Deprivation index (coefficient estimate of -0.17). Nonetheless, the IV estimates related to the Deprivation in Assets and in Housing are not significant. This is an interesting result, as far as these two dimensions are likely to be captured by household characteristics in the first step (private assets) or have a spatial dimension not directly linked with urban density. Finally, as expected, the model for Overcrowding deprivation has the least goodness of fit, but it reports a significant, small, impact of density.[8] This analysis has been replicated using each indicator of deprivation as the dependent variable. The results presented in Tables A5 and A6 in the Appendix show a significant and negative effect of urban density on all dimensions of deprivation in OLS estimates while, when using IV estimates, only water supply, electricity, garbage, bad floor, TV, and overcrowding are significantly affected by urban density.[9]

Next we explore possible city congestion by investigating non-linearity in the relationship between urban size and deprivation. To this end, we introduce the square of the log density into the estimation. Table 5 shows the results. First, it can be noted that generally the goodness of fit is substantially higher in all estimates compared to Table 4, pointing to the need to consider non-linearity in the relationship analyzed. Second, analyzing the parameters of interest, we find evidence of congestion, since as city density increases the levels of General Deprivation and Overcrowding decrease to a lesser extent. On the other hand, density has a significant impact on Deprivation in Assets and in Housing, which is now positive but with decreasing returns, thus showing a concave relationship.[10]

To further check this evidence, we perform an extra analysis where we consider the interaction of two dummies related to the two largest urban centers, Guayas (Guayaquil) and Pichincha (Quito). The results are shown in Table A7 in the Appendix. We can observe that previous results are also confirmed when we consider the two largest cities as compared to the other cities. These results are relevant and reinforce the presence of non-linearity in the impact of urban size on deprivation. It is clear from these outcomes that the decrease in deprivation in larger urban areas is lower than in smaller areas, pointing to evidence of congestion. Nonetheless, the impact on the Deprivation in Assets and in Housing is marginally reduced in larger areas.

6. Discussion and conclusion

This paper analyses the association between urban density and deprivation in material living conditions in Ecuador using data on 21 provinces from 2010 to 2017. We built indicators of deprivation by means of principal components analysis considering 13 basic characteristics related to deprivation. We obtain four deprivation indexes representing: general deprivation, private asset deprivation, home-ownership deprivation, and overcrowding.

The empirical analysis has been carried out in two steps. We first regressed the deprivation indexes on household information (including a set of personal characteristics) to isolate population sorting, and on a set of province-time fixed effects. In the second step, the estimates of the province-time fixed effects 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 and Overcrowding. Insignificant results are found for the other measures of deprivation. When we investigate non-linearity in the relationship analyzed, we find evidence of congestion. Also, there is a positive impact of density in Deprivation in Assets and in Housing, though at a decreasing pace with respect to the increase in urban size. These results are confirmed when we focus on the two largest cities.

Our results demonstrate the role of urbanization as a driver of development and improvements in household living conditions, especially concerning general deprivation. Nonetheless, the risk of congestion has to be considered. From the development point of view, and in line with works such as Brueckner (2013), higher income and education lead to occupancy of dwellings with less slum-like characteristics. This is consistent with Gollin et al. (2016) who report that urbanization driven by economic growth (production cities) is associated with higher living standards than economic growth driven by the discovery of resources (consumption cities). However, the results for Ecuador should be carefully generalized to other cases, as other developing countries may present different results.

[8] As for the region dummies, the Coastal and Amazonian regions present higher levels of Deprivation and Housing with respect to the Andean regions.
[9] Table A4 in the Appendix shows the first step results of these estimates.
[10] Note that the linear coefficient of density is just slightly not significant for the estimation related to Deprivation in Housing.

From a governance point of view, it is clear that urban agglomeration allows for better planning of the provision of basic services, such as clean water, sewage, electricity, and connectivity services. For our case study, the increase in city size is associated with better general living conditions. Nonetheless, it is not that clear that large agglomerations are good in all dimensions of deprivation, as congestion ultimately arises. Also, the results in terms of housing suggest key points to be addressed with policy interventions at the micro level, e.g., lowering housing costs in the largest cities. The evaluation of housing policies in the country, such as the incentive system known as ABC (*ahorro-bono-crédito*), in light of deprivation characteristics, is an aspect to consider in the future agendas of policy makers and academics.

Authorship statement

M. Obaco:Conception and design of study.

M. Obaco: Acquisition of data.

M. Obaco, V. Royuela, A. Matano: Analysis and/or interpretation of data.

M. Obaco, V. Royuela: Drafting the manuscript.

A. Matano, V. Royuela: Revising the manuscript critically for important intellectual content

M. Obaco, V. Royuela, A. Matano: Approval of the version of the manuscript to be published (the names of all authors must be listed)

Acknowledgments

The authors express gratitude for the support received from Spain's Ministerio de Ciencia e Innovación through action ECO2016-75805-R.

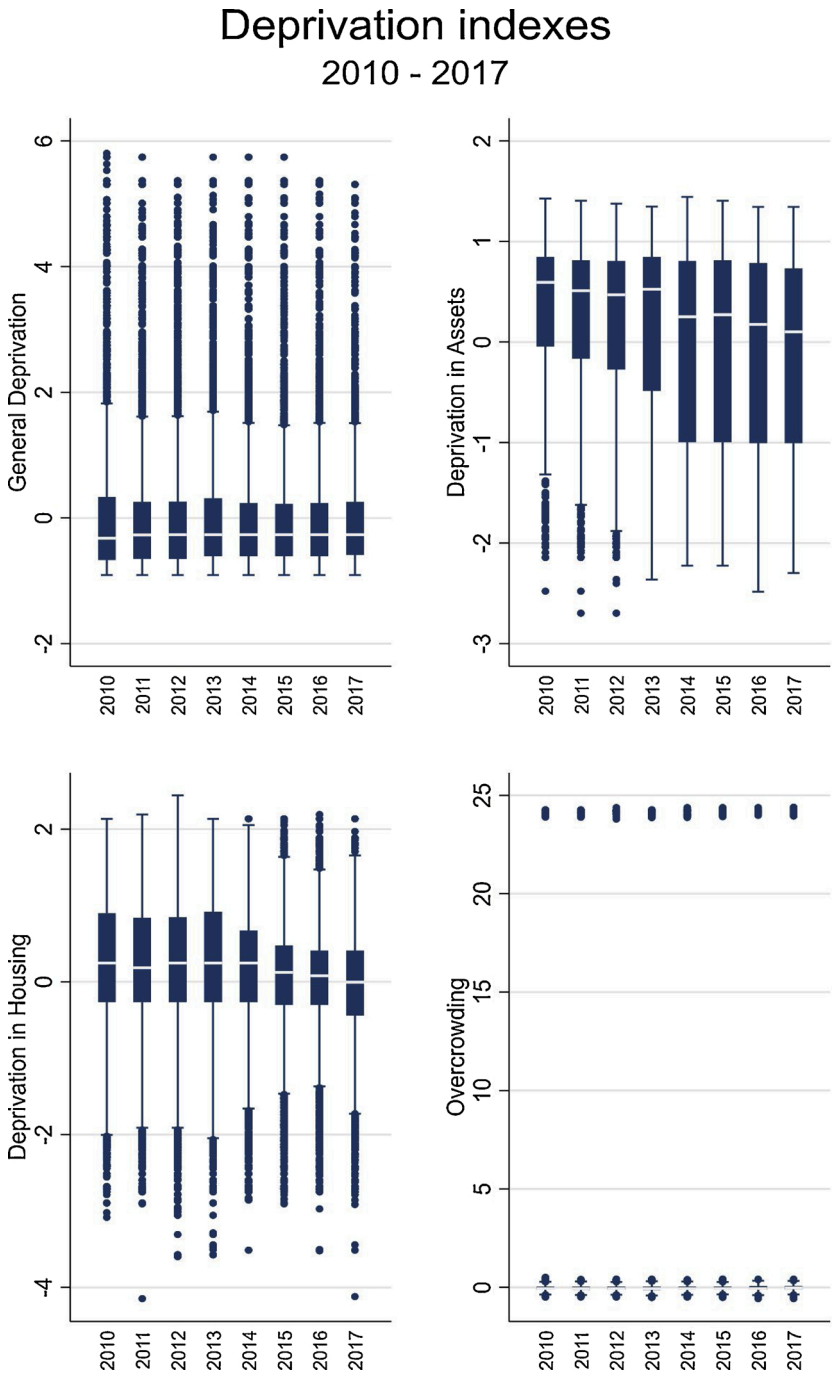

Fig. A1. Deprivation indices at household level.

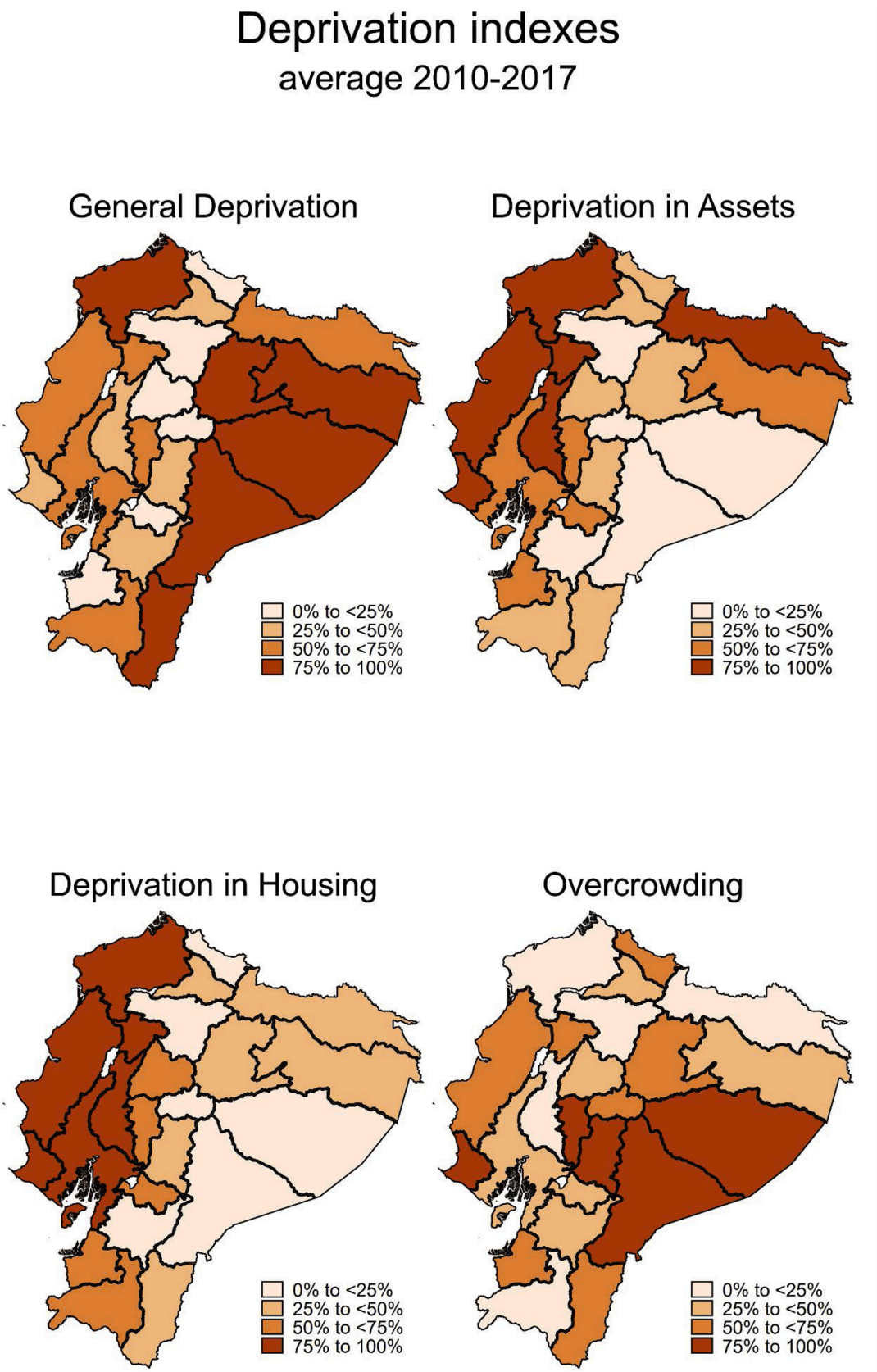

Fig. A2. Deprivation indexes for the Ecuadorean provinces.

Table A1
Description of empirical works using deprivation indexes in Latin America.

Author(s)	Country	Level	Variables used to proxy deprivation
Cabrera-Barona et al. (2017)	Ecuador	Neighbors of one municipality (Quito)	**Housing**: garbage collection service, electricity, sewage system, water, overcrowding **Health**: disabled people, distance to healthcare service **Education**: illiteracy **Labor market**: works without payment, no public social insurance
Duque et al. (2012)	Colombia	Neighbors of one municipality (Medellín)	**Housing**: sewage system, water, risk location, assets, overcrowding **Health**: violence, nutrition, birth control methods **Education**: illiteracy **Labor market**: benefits of social programs
Duran and Condorí (2017)	Argentina	Municipalities	**Housing**: quality of the construction, lack of basic services, overcrowding, no ownership **Health**: people living alone, single parent household **Education**: Illiteracy rate **Labor market**: benefits of social programs, unemployed
Machado et al. (2014)	Brazil	Households	**Housing**: sanitation and sewage systems, water, waste disposal, type of fuel used for cooking, assets, homebuilding materials, overcrowding **Health**: health status, number of live born who have died **Education**: illiteracy, school attendance **Labour market**: child labor, unemployed adults

Table A2
PCA results. Correlation between the variables and the 4 main factors.

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 A3
PCA results. Description of all factors resulting from PCA.

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

Table A4
First stage results for single indicators of deprivation.

	(1) Sewage system	(2) Water supply	(3) Electricity	(4) Garbage	(5) Access	(6) Bad walls	(7) Bad floor	(8) Telephone	(9) Internet	(10) Computer	(11) TV	(12) Owner house	(13) Overcrowding
Female	−0.0073***	−0.014***	−0.005***	−0.009***	−0.007***	−0.012***	−0.005***	−0.020***	−0.0014	0.0047**	−0.007***	−0.005***	−0.0001
	(0.0012)	(0.0017)	(0.0007)	(0.002)	(0.0021)	(0.0015)	(0.0019)	(0.0022)	(0.002)	(0.002)	(0.002)	(0.0018)	(0.0002)
Age	−0.0019***	−0.001***	−0.001***	−0.002***	−0.003***	−0.002***	−0.003***	−0.006***	−0.004***	−0.003***	−0.005***	−0.001***	−0.0001**
	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0000)
Age2	2.2e-5***	1.1e-5***	9.5e-6***	2.1e-5***	9.9e-6***	1.4e-5***	4.0e-5***	3.8e-5***	4.3e-5***	3.9e-5***	6.e-5***	−1e-5***	2.00e-6***
	(1.57e-6)	(2.1e-6)	(9.64e-7)	(2.07e-6)	(2.50e-6)	(1.81e-6)	(2.42e-6)	(2.55e-6)	(2.21e-6)	(2.25e-6)	(2.42e-6)	(1.91e-6)	(3.08e-7)
Elderly	−0.0043***	0.0002	−0.005***	0.0076***	−0.016***	−0.005***	0.0156***	−0.055***	0.0234***	0.0277***	−0.009***	−0.052***	−0.0020***
	(0.0013)	(0.0018)	(0.0008)	(0.0018)	(0.0021)	(0.0015)	(0.0021)	(0.0022)	(0.0019)	(0.0020)	(0.0021)	(0.0013)	(0.0002)
Children	0.0103***	0.0141***	0.0027***	0.0080***	0.0239***	0.0116***	0.0089***	0.0182***	0.0080***	−0.0003	−0.006***	−0.0019**	−0.0007***
	(0.0007)	(0.0009)	(0.0005)	(0.0009)	(0.0010)	(0.0008)	(0.0010)	(0.0009)	(0.0009)	(0.0009)	(0.0010)	(0.0008)	(0.0001)
Literacy	−0.1038***	−0.083***	−0.032***	−0.089***	−0.123***	−0.034***	−0.100***	−0.160***	−0.007***	−0.023***	−0.188***	−0.023***	0.0022***
	(0.0041)	(0.0045)	(0.0026)	(0.0045)	(0.0047)	(0.0040)	(0.0051)	(0.0039)	(0.0026)	(0.0026)	(0.0052)	(0.0026)	(0.0004)
Primary	−0.1239***	−0.128***	−0.041***	−0.128***	−0.232***	−0.074***	−0.149***	−0.317***	−0.129***	−0.143***	−0.219***	−0.032***	0.0048***
	(0.0041)	(0.0048)	(0.0026)	(0.0047)	(0.0052)	(0.0042)	(0.0053)	(0.0046)	(0.0036)	(0.0036)	(0.0054)	(0.0034)	(0.0006)
Secondary	−0.1370***	−0.136***	−0.042***	−0.141***	−0.241***	−0.089***	−0.165***	−0.351***	−0.206***	−0.222***	−0.216***	−0.051***	0.0045***
	(0.0046)	(0.0057)	(0.0028)	(0.0056)	(0.0066)	(0.0049)	(0.0064)	(0.0063)	(0.0054)	(0.0055)	(0.0065)	(0.0048)	(0.0006)
Technical	−0.1251***	−0.126***	−0.040***	−0.125***	−0.289***	−0.086***	−0.168***	−0.445***	−0.33***	−0.273***	−0.202***	−0.0182	0.0078***
	(0.0054)	(0.0086)	(0.0031)	(0.0085)	(0.0108)	(0.0064)	(0.0096)	(0.0123)	(0.0125)	(0.0132)	(0.0109)	(0.0112)	(0.0020)
University	−0.1232***	−0.137***	−0.036***	−0.124***	−0.32***	−0.089***	−0.178***	−0.500***	−0.397***	−0.349***	−0.197***	−0.063***	0.0062***
	(0.0041)	(0.0049)	(0.0026)	(0.0049)	(0.0055)	(0.0042)	(0.0055)	(0.0051)	(0.0044)	(0.0046)	(0.0058)	(0.0040)	(0.0007)
Elderly	0.0358***	0.0451***	0.0130***	0.0699***	0.0678***	0.0259***	0.0613***	0.0935***	0.0848***	0.0736***	0.0552***	−0.0031	−0.0006**
	(0.0019)	(0.0025)	(0.0011)	(0.0024)	(0.0029)	(0.0021)	(0.0027)	(0.0027)	(0.0023)	(0.0023)	(0.0027)	(0.0021)	(0.0003)
Rural	0.1246***	0.4057***	0.0375***	0.4062***	0.4126***	0.1535***	0.2361***	0.2522***	0.1658***	0.1565***	0.1433***	−0.174***	0.0001
	(0.0016)	(0.0024)	(0.0009)	(0.0023)	(0.0027)	(0.0020)	(0.0025)	(0.0025)	(0.0021)	(0.0022)	(0.0024)	(0.0019)	(0.0002)
Constant	0.1502***	0.1824***	0.0351***	0.1694***	0.5195***	0.0691***	0.2772***	0.7257***	0.9276***	0.7769***	0.3785***	0.3639***	−0.0049***
	(0.0089)	(0.0120)	(0.0040)	(0.0118)	(0.0132)	(0.0087)	(0.0138)	(0.0154)	(0.0121)	(0.0142)	(0.0131)	(0.0127)	(0.0007)
Obs	153,846	153,846	153,846	153,846	153,846	153,846	153,846	153,846	153,846	153,846	153,846	153,846	153,846
R^2	0.1314	0.3733	0.0650	0.3400	0.3100	0.2163	0.1924	0.2704	0.2690	0.1861	0.1115	0.1061	0.0061

Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Households' characteristics related to the head of the households. Province*Time fixed effects included in all estimates.

Table A5
Second stage results for single indicators of deprivation. OLS estimates.

VAR	(1) Sewage system	(2) Water supply	(3) Electricity	(4) Garbage	(5) Access	(6) Bad walls	(7) Bad floor	(8) Telephone	(9) Internet	(10) Computer	(11) TV	(12) Owner house	(13) Overcrowding
Log(density)	−0.0210***	−0.0287**	−0.021***	−0.039***	−0.033***	−0.028***	−0.08***	−0.0216**	−0.03***	−0.023***	−0.035***	0.020***	−0.0006**
	(0.0049)	(0.0111)	(0.0063)	(0.0077)	(0.0108)	(0.0073)	(0.0072)	(0.0084)	(0.0054)	(0.0057)	(0.0078)	(0.0044)	(0.0003)
Coast	0.0242***	0.1130***	0.021***	0.0567***	0.0497***	0.147***	0.07***	0.1491***	0.068***	0.089***	0.0084	−0.08***	−0.0001
	(0.0051)	(0.0196)	(0.0047)	(0.0125)	(0.0156)	(0.0137)	(0.0106)	(0.0146)	(0.0099)	(0.0087)	(0.0082)	(0.0077)	(0.0003)
Amazon	0.0416**	0.0879***	0.0261*	−0.083***	−0.0653*	0.289***	−0.0142	−0.0071	−0.06***	−0.0268*	−0.0048	0.060***	−0.0020**
	(0.0207)	(0.0317)	(0.0156)	(0.0282)	(0.0337)	(0.0294)	(0.0282)	(0.0227)	(0.0158)	(0.0145)	(0.0239)	(0.0121)	(0.0009)
Const	0.0912***	0.1476***	0.088***	0.1918***	0.1188***	0.133***	0.32***	0.2957***	0.150***	0.163***	0.126***	−0.14***	0.0040***
	(0.0206)	(0.0430)	(0.0221)	(0.0338)	(0.0438)	(0.0319)	(0.0319)	(0.0331)	(0.0237)	(0.0253)	(0.0319)	(0.0160)	(0.0012)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	yes
Obs	167	167	167	167	167	167	167	167	167	167	167	167	167
R^2	0.4167	0.5252	0.3563	0.3260	0.1308	0.7861	0.6676	0.3513	0.6912	0.3684	0.4316	0.3639	0.1523

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

Table A6
Second stage results for single indicators of deprivation. IV estimates.

VAR	(1) Sewage system	(2) Water supply	(3) Electricity	(4) Garbage	(5) Access	(6) Bad walls	(7) Bad floor	(8) Telephone	(9) Internet	(10) Computer	(11) TV	(12) Owner house	(13) Overcrowding
Log(density)	−0.0178	−0.0390**	−0.0186**	−0.0770***	0.0224	−0.0180	−0.0823***	0.0223	−0.0187	−0.0051	−0.0218*	0.0035	−0.0012***
	(0.0111)	(0.0181)	(0.0093)	(0.0187)	(0.0221)	(0.0167)	(0.0145)	(0.0217)	(0.0117)	(0.0125)	(0.0115)	(0.0133)	(0.0004)
Coast	0.0229***	0.1173***	0.0198***	0.0725***	0.0265	0.1433***	0.0804***	0.1309***	0.0626***	0.0823***	0.0031	−0.0685***	0.0001
	(0.0069)	(0.0212)	(0.0054)	(0.0175)	(0.0215)	(0.0153)	(0.0118)	(0.0210)	(0.0122)	(0.0115)	(0.0092)	(0.0114)	(0.0004)
Amazon	0.0502	0.0599	0.0325	−0.1867***	0.0856	0.3165***	−0.0318	0.1114**	−0.0182	0.0220	0.0299	0.0154	−0.0035***
	(0.0308)	(0.0457)	(0.0261)	(0.0429)	(0.0553)	(0.0534)	(0.0463)	(0.0507)	(0.0301)	(0.0308)	(0.0303)	(0.0317)	(0.0011)
Const	0.0796*	0.1854***	0.0799**	0.3313***	−0.0852	0.0971	0.3433***	0.1355*	0.1006**	0.0967**	0.0778*	−0.0452	0.0061***
	(0.0410)	(0.0648)	(0.0335)	(0.0653)	(0.0876)	(0.0617)	(0.0553)	(0.0730)	(0.0439)	(0.0450)	(0.0446)	(0.0457)	(0.0016)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	167	167	167	167	167	167	167	167	167	167	167	167	167
R2	0.4157	0.5229	0.3557	0.2577		0.7844	0.6662	0.2684	0.6824	0.3297	0.4222	0.3245	0.1225

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

Table A7
Regression of province varying-fixed effects on log of urbanization density and interaction of log of urban density and dummy for Guayas and Pichincha.

	OLS				IV			
VAR	(1) General deprivation	(2) Deprivation in assets	(3) Deprivation in housing	(4) Overcrowding	(5) General deprivation	(6) Deprivation in assets	(7) Deprivation in Housing	(8) Overcrowding
Ln(density)	−0.2695***	0.0416	0.0349	−0.0263**	−0.2485***	0.1145**	0.0344	−0.0395**
	(0.0570)	(0.0261)	(0.0260)	(0.0105)	(0.0817)	(0.0452)	(0.0410)	(0.0164)
Ln(density) * Guayas	0.0570***	−0.0354***	−0.0294***	0.0066*	0.0509**	−0.0560***	−0.0291**	0.0104**
	(0.0186)	(0.0096)	(0.0111)	(0.0039)	(0.0247)	(0.0143)	(0.0138)	(0.0053)
Ln(density) * Pichincha	0.0763***	−0.0650***	−0.0542***	−0.0021	0.0694**	−0.0883***	−0.0541***	0.0022
	(0.0208)	(0.0108)	(0.0108)	(0.0041)	(0.0277)	(0.0165)	(0.0148)	(0.0058)
Coast	0.2307***	0.1821***	0.1506***	−0.0080	0.2255***	0.1637***	0.1506***	−0.0046
	(0.0340)	(0.0279)	(0.0271)	(0.0094)	(0.0358)	(0.0325)	(0.0284)	(0.0102)
Amazon	0.1274	0.0523	−0.0310	−0.0633**	0.1811	0.2388**	−0.0323	−0.0971**
	(0.1260)	(0.0619)	(0.0673)	(0.0307)	(0.2119)	(0.1122)	(0.1003)	(0.0401)
Constant	1.0205***	0.1143	−0.0806	0.1304***	0.9469***	−0.1411	−0.0789	0.1768***
	(0.1899)	(0.0988)	(0.0881)	(0.0416)	(0.2780)	(0.1601)	(0.1452)	(0.0589)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	167	167	167	167	167	167	167	167
R-squared	0.6175	0.4308	0.4593	0.2735	0.6170	0.3984	0.4593	0.2622
F test					32.02	32.02	32.02	32.02

Robust standard errors in parentheses: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Appendix A

References

Awasthi, A., Pandey, C., Dubey, M., Rastogi, S., 2017. Trends, prospects and deprivation index of disability in India: evidences from census 2001 and 2011. Disabil. Health J. 10, 247–256.

Balen, J., McManus, D.P., Li, Y., Zhao, Z., Yuan, L., Utzinger, J., Williams, G.M., Li, Y., Ren, M., Liu, Z., Zhou, J., Raso, G., 2010. Comparison of two approaches for measuring household wealth via an asset-based index in rural and peri-urban settings of Hunan province, China. Emerg. Themes Epidemiol. 7, 7.

Barro, R.J., 2000. Inequality and growth in a panel of countries. J. Econ. Growth 5, 5–32.

Benvin, E., Rivera, E., Tromben, V., 2016. A multidimensional time use and well-being index: a proposal for Colombia, Ecuador, Mexico and Uruguay. CEPAL Rev. 118, 115–137.

Boelhouwer, J., 2002. Quality of life and living conditions in the Netherlands. Soc. Indic. Res. 59 (115), -140.

Booysen, F., Van der Berg, S., Burger, R., 2008. Using an asset index to assess trends in poverty in seven sub-saharan african countries. World Dev. 36, 1113–1130.

Brueckner, J., 2013. Slums in developing countries: new evidence for Indonesia. J. Hous. Econ. 22 (4), 178–290.

Cabrera-Barona, P., Wei, C., Hagenlocher, M., 2017. Multiscale evaluation of an urban deprivation index: implications for quality of life and healthcare accessibility planning. Appl. Geogr. 70, 1–10.

Carstairs, V., Morris, R., 1989. Deprivation and mortality: an alternative to social class? J. Public Health (Bangkok) 11, 210–219.

Castells-Quintana, D., 2017. Malthus living in a slum: urban concentration, infrastructure and economic growth. J. Urban Econ. 98, 158–173.

Castells-Quintana, D., Wenban-Smith, H., 2019. Population dynamics, urbanisation without growth and the rise of megacities. J. Dev. Stud. (forthcoming).

Combes, P.P., Gobillon, L., 2015. The empirics of agglomeration economies. In: Henderson, J.V., Thisse, J.-F. (Eds.), Handbook of Regional and Urban Economics, 5 ed. Amsterdam: Elsevier-North-Holland), pp. 247–348.

Combes, P.P., Duranton, G., Gobillon, L., 2008. Spatial wage disparities: sorting matters! J. Urban Econ. 63 (1), 723–742.

Costas, D., Hahn, M., 2000. Power couple: changes in the locational choice of the college educated: 1940-1990. Q. J. Econ. 115 (5), 1287–1315.

Decancq, K., Lugo, M.A., 2013. Weights in multidimensional indices of well-being: and overview. Econ. Rev. 32 (1), 7–34.

Díaz, J.P., Romaní, J., 2016. An approximation to household overcrowding: evidence from Ecuador. Rev. Polit. 37 (2), 1–8.

Duque, J.C., Royuela, V., Noreña, M., 2012. A stepwise procedure to determinate a suitable scale for the spatial delimitation of urban slums. In: fernández, Esteban, rubiera, Fernando (Eds.), Defining the Spatial Scale in Modern Regional Analysis: New Challenges From Data at the Local Level. Springer, pp. 237–254. ISBN 978-3-642-31994-31998.

Durán, R.J., Condorí, M.Á., 2017. Deprivation index for small areas based on census data in Argentina. Soc. Indic. Res. 89, 1–33.

Duranton, G., 2016. Agglomeration effects in Colombia. J. Reg. Sci. 56 (2), 210–238.

Fox, S., 2014. The political economy of slums: theory and evidence from Sub-Saharan Africa. World Dev. 54, 191–203.

Frankenhoff, C., 1967. Elements of an economic model for slums in a developing economy. Econ. Dev. Cult. Change 16 (1), 27–36.

Frick, S., Rodríguez-Pose, A., 2017. Big or Small Cities? On city size and economic growth. Growth Change 49 (1), 4–32.

Glaeser, E.L., 2011.). Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier. Penguin Press., London, UK.

Glaeser, E.L., Henderson, J.V., 2017. Urban economics for the developing world: an introduction. J. Urban Econ. 98 (1), 1–5.

Glaeser, E.L., Resenger, M.G., 2010. The complementarity between cities and skills. J. Reg. Sci. 95 (1), 17–59.

Glaeser, E.L., Kolko, J., Saiz, A., 2001. Consumer city. J. Econ. Geogr. 1, 27–50.

Gollin, D., Jedwab, R., Vollrath, D., 2016. Urbanization with and without industrialization. J. Econ. Growth 21, 35–70.

Gómez-Salcedo, M., Galvis-Aponte, L., Royuela, V., 2017. Quality of work life in Colombia: a multidimensional fuzzy Indicator. Soc. Indic. Res. 130, 911–936. https://doi.org/10.1007/s11205-015-1226-9.

Jarman, B., 1983. Identification of underprivileged areas. Br. Med. J. 286, 1705–1709.

Jedwab, R., Vollrath, D., 2015. Urbanization without growth in historical perspective. Explor. Econ. Hist. 58, 1–21.

Khadr, Z., Nour, M., Hamed, R., 2010. Using GIS in constructing are-based physical deprivation index in Cairo Governorate. Ehypt. Habitat International 34 (2), 264–272.

Krishnan, V., 2010. Constructing an Area-based Socioeconomic Index: A Principal Components Analysis Approach. Every Day in Every Way: creating Learning Experiences for Every Child. National Convention Centre, Canberra, Australia, pp. 20–22.

Lalloué, B., Monnez, J.M., Padilla, C., Kihal, W., Le Meur, N., Zmirou-Navier, D., 2014. A statistical procedure to create a neighborhood socioeconomic index for health inequalities analysis. Int. J. Equity Health 12 (21), 1–11.

Lillini, R., Vercelli, M., 2018. The local socio-economic health deprivation index: methods and results. J. Prev. Med. Hyg. 59 (2), 3–10.

Machado, A.F., Golgher, A.B., Antigo, M.F., 2014. Deprivation viewed from a multidimensional perspective: the case of Brazil. Cepal Rev. 112, 125–146.

Marx, B..Stoker, Stoker, T., Suri, T., 2013. The economics of slums in the developing world. J. Econ. Perspect. 27 (4), 187–210.

Matano, A., Obaco, M., Royuela, V., 2020. Agglomeration economies and informality: the case of Ecuador. J. Reg. Sci. https://doi.org/10.1111/jors.12486.

Mitchell, D., Enamark, S., Van der Molen, P., 2015. Climate Resilient Urban Development: Why Responsible Land Governance is Important.

Mitra, A., Nagar, J., 2018. City size, deprivation and other indicators of development: evidence from India. World Dev. 106, 273–283.

Obaco, M., Díaz-Sánchez, J.P., 2018. Urbanization in Ecuador: an overview using the FUAs definition. Region 5 (3). https://doi.org/10.18335/region.v5i3.235.

Obaco, M., Royuela, V., Xavier, V., 2019. Identifying Functional Urban Areas in Ecuador using a varying travel time approach. Geogr. Anal. https://doi.org/10.1111/gean.12190 in press.

OECD, 2008. Handbook on Constructing Composite Indicators: Methodology and User Guide. ISBN 978-92-64-04345-9. OECD Publishing., Paris.

Patel, K., 2016. Encountering the state through legal tenure security: perspectives from a low income resettlement scheme in urban India. Lan Use Policy 58, 102–113.

Pavo, M., 2013. Urban land-use regulations and housing markets in developing countries: evidence from Indonesia on the importance of enforcement. Land Use Policy 34, 255–264.

Pesaresi, M., Melchiorri, M., Siragusa, A., Kemper, T., 2016. Atlas of the human planet 2016: mapping human presence on earth, with the global human settlement layer. European Commission, EUR - Scientific and Technical Research Reports.

Podova, D., Pishniak, A., 2017. Measuring individual material well-being using multidimensional indices: an application using the gender and generation survey for Russia. Soc. Indic. Res. 130, 883–910.
Puga, D., 2010. The magnitude and causes of agglomeration economies. J. Reg. Sci. 50 (1), 203–230.
Ravallion, M., 2002. On the urbanization of poverty. J. Dev. Econ. 68 (2), 435–442.
Ravallion, M., Chen, S., Sangraula, P., 2007. New evidence on the urbanization of global poverty. Popul. Dev. Rev. 33 (4), 667–701.
Royuela, V., Ordóñez, J., 2018. Internal migration in a developing country: a panel data analysis of Ecuador (1982-2010). Pap. Regional Sci. 1–23.
Royuela, V., Díaz-Sánchez, J.P., Romaní, J., 2019. Migration effects on living standards of the left behind. The case of overcrowding levels in Ecuadorian households. Habitat Int. https://doi.org/10.1016/j.habitatint.2019.102030 forthcoming.
Sahn, D.E., Stifel, D., 2003. Exploring alternative measures of welfare in the absence of expenditure data. Rev. Income Wealth 49 (4), 463–489.
Sánchez-Cantalejo, C., Ocana-Riola, R., Fernández-Ajuria, A., 2008. Deprivation index for small areas in Spain. Soc. Indic. Res. 89, 259–273.
Spicker, P., Álvarez Leguizamón, S., Gordon, D., 2009. Pobreza: un glosario internacional. In: Aires, Buenos (Ed.), Comparative Research Programme on Poverty, 1. ed. en español). Consejo Latinoamericano de Ciencias Sociales (CLACSO).
Thu Le, H., Booth, A., 2014. Inequality in Vietnamese urban-rural living standards, 1993-2006. Rev. Income Wealth 60 (4), 862–886. https://doi.org/10.1111/roiw.12051.
Townsend, P., 1987. Deprivation. J. Soc. Policy 16, 125–146.
Turner, J.F., 1969. Uncontrolled urban settlement: problems and policies. Urbanization: development policies and planning. Int. Soc. Dev. Rev. 1. UN, New York.
UN-Habitat, 2003. The Challenge of Slums. United Nations Human Settlements Program. Earthscan Publications on behalf of UN-Habitat.
UN-Habitat, 2015. Slum Almanac 2015 - 2016, UNON, Publishing Services Section. Nairobi. ISO 14001:2004-certified.
Vandemoortele, M., 2014. Measuring household wealth with latent trait modelling: an application to malawian DHS data. Soc. Indic. Res. 118, 877–891. https://doi.org/10.1007/s11205-013-0447-z.
Zhang, Y., 2018. The credibility of slums: informal housing and urban governance in India. Land Use Policy 79, 876–890.