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Deprivation Index for Small Areas Based on Census Data in Argentina

Rodrigo Javier Durán[1] · Miguel Ángel Condorí[1]

Abstract This paper presents the construction and estimation of a deprivation index based on Principal Factors Analysis for the 2010 Argentina Population and Housing Census in a census tract level. From the application of PFA were estimated two factors, one related to material and the other to social deprivation aspects. Based on the material deprivation factor, a synthetic General Deprivation Index (GDI) has been calculated. In addition, a Deprivation Emergency General Index (DEGI) was defined and measured. The DEGI prioritize the implementation of local development policies over small rural or urban areas according to the greater number of inhabitants in relation to the urban or rural total for a Department of Argentina. The factors and the GDI indicator has been validated the Kaiser–Meyer–Olkin scores were greater than 0.7 for urban, rural, and total tracts, the Cronbach's alpha coefficient for the material factor was 0.811 and the Pearson's correlation coefficient between GDI and the Unsatisfied Basic Needs index was 0.659. The index estimates were mapped on QGIS, a Geographic Information System. The intensity and composition of the deprivation were different according to the geographic areas of Argentina; the lowest values of deprivation correspond to the central zone of the country and its urban areas, which is related to inequalities in the economic growth between urban and rural spaces. Finally, it is expected that this new index will be useful for the formulation and evaluation of public development policies for urban and rural areas in Argentina.

Keywords Deprivation index · Principal factors · Small areas · Inequality · Urban and rural deprivation

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1 Introduction

1.1 The Deprivation Concept

The deprivation concept has broadened the studies of poverty and inequality fields fostering new areas to discuss about the processes of social and material inequality and their effects. Deprivation conveys the lack of something that is considered as desirable (income, good health, etc.). Roughly speaking, any shortage is associated with a certain degree of suffering (Madge and Brown 1982). Thus, it is necessary to understand the standard that determines the shortage of a given person or social group (Spicker 2009).

According to Townsend (1987) "Deprivation may be defined as a state of observable and demonstrable disadvantage in relation to the local community or the wider society or nation to which an individual, family or group belongs. The idea has come to be applied to conditions (that is, physical, environmental and social states or circumstances) rather than resources and to specific and not only general circumstances, and therefore can be distinguished from the concept of poverty". Those characteristics define the comparative framework, which underpins the concept of shortage.

There are two common ways to define the elements that compose the deprivation concept (Fahey 2010; Julkunen 2002; Morris and Carstairs 1991; Philibert et al. 2007) The first one takes into account, at least initially, the social actor as a subject and seeks to define those aspects that constitute the shortage considering his or her subjective expressions. The papers based on a socio-psychological approach arise from asking the social actors about their own daily life deprivation state (Bernstein and Crosby 1980; Bhatty 1998; Mabughi and Selim 2006). The second one is based on a social and economic approach, and it defines the same elements taking into account the study of the economic and social structure (Gradín et al. 2014; Havard et al. 2008, 1998).

Given the temporary specificity of the economic, cultural and social configurations of different population groups and the relativity of the deprivation concept, it is difficult to develop a measurement tool that defines a single and universal system of indicators. However, considering the pioneering publications of Townsend and Cartairs (Carstairs 1981; Townsend 1987); it is common to divide the deprivation concept into two dimensions: social and material (Morris and Carstairs 1991). Generally, the material dimension of the deprivation concept takes into account income, housing, services, education, and work as variables (Philibert et al. 2007; Treanor 2014). Moreover, the social dimension is expressed by social cohesion, disaggregation, and social capital of the population group (Bellani and D'Ambrosio 2011; Mabughi and Selim 2006). Both dimensions determine complementarily the relative deprivation state in a temporary social environment.

Though the social and material aspects of the deprivation concept are considered as social processes, the index values are just defined for a specific time. Therefore, the results of these papers do not show the dynamic of the social processes of deprivation.

1.2 Deprivation Indices

During the last 30 years, different deprivation indicators have been proposed in the fields of health, well-being and development studies; as well as their relationship with problems of inequality and poverty (Domínguez-Berjón et al. 2008; Fu et al. 2015; Gradín et al. 2014; Havard et al. 2008; Salmond et al. 1998). These indicators not only differ from each other

by their conceptual contents but also by the methodology used to define them (Morris and Carstairs 1991).

Nowadays, deprivation indices stand out as useful tools to define health, development and welfare policies; consequently, many countries adopt them as instruments of monitoring (Domínguez-Berjón et al. 2008; Fusco et al. 2013; Pampalon et al. 2010; Salmond et al. 1998; Yuan and Wu 2014). It is common that these indices adapt Townsend's relative deprivation concept, although this definition considers only the material dimension of the deprivation concept. As in other papers, we seek to enrich it by adding social factors for a better description of the relative shortage situation. Thus, deprivation indices are generally obtained from dimensional approaches such as educational level, housing, employment, income, disaggregation and isolation. Currently, deprivation indices are deduced using either two of the most common methods to weigh variables (Gordon 1995), applying statistical methods or conventionally determined by consulting experts. In this paper, we have calculated weighting factors applying Principal Factors Analysis (PFA) (Havard et al. 2008; Krishnan 2010; Salmond et al. 1998).

As a study of local specificity, different authors (Gordon 1995; Messer et al. 2006; Pampalon et al. 2010) consider it valuable to have estimates of deprivation based on the smallest and the most homogeneous geographical units according to social and economic characteristics. In consequence, it can be obtained a stronger definition of correlation among variables; it also helps the resources distribution and the definition of local-oriented welfare and development policies (Pampalon et al. 2010). National censuses are data source used for many national deprivation indices. Their geographical range, temporary immediacy, and minimum census level units allow delimiting small geographical units as well as more homogenous social and economic characteristics (Schuurman et al. 2007; Wong 1997). In addition, working with census allows the geographic reference of information expressed through GIS-based applications. This facilitates the problem identification and its territorial contextualization, while it allows thinking on extension and influence areas of the analysed phenomenon.

1.3 Deprivation Indices for Argentina

The National Institute of Census and Statistics (INDEC: Spanish Acronym) has developed a Household Material Deprivation Index (IPMH: Spanish Acronym) using National Census 2001 (INDEC 2003) data sources. This index is an alternative to the Unsatisfied Basic Needs (UBN) index and it recognizes two dimensions of poverty, one that firmly expresses its structural aspects and other more sensitive to economic cyclic fluctuations. Both are conceptually and operationally integrated into an overall deprivation measure (Meichtry and Fantin 2004). For its formulation, IPMH cannot be replicated with the National Census 2010 data; it is necessary to have access to the census micro-data, and this information is not available to the public.

Argentina's rural population occupies wide geographical areas; their access to basic rights (such as education, appropriate housing, work, and others) is different from urban population (Haimovich and Winkler 2005). To estimate in an overall index how rural and urban populations vary is a topic of current debate in the formulation of deprivation indices (Bertin et al. 2014). However, to obtain this index we have taken into account variables that allow us to figure out the deprivation state of rural and urban environments. In practice, the construction and content of a deprivation index depends on the access to local information that enable us to estimate the dimensions in question. Sometimes the decision of which

indicator is best to construct a dimension depends on its availability. For example, Argentine Census 2010 results do neither provide information about the number of manual workers nor indicate households' or people income or the income related to the poverty line. Thus, it is difficult to estimate the concept of social class based on economic and labour stability aspects, which could be used to construct a deprivation index.

1.4 Objectives and Paper Organization

The aim of this paper is to elaborate a deprivation index based on the National Census of Households and Homes in Argentina 2010 (CNHPV 2010: Spanish acronym) data at the census tracts level in Argentina. This index has been constructed applying PFA to a set of variables related to the concept of deprivation. As a result, two factors have been defined associated with material and social aspects of the deprivation concept in Argentina. These factors were studied from the combination of matrix quintiles and they gave an overall result expressed in a GDI as the one proposed by Langlois and Kitchen (2001). Finally, we propose a General Emergency Deprivation Index (GEDI) that provides information for public policies design comparing rural and urban tracts at Department political level in Argentina. This index is a useful tool to characterize and implement development and welfare policies in local terms. There are numerous reference papers about the concept of poverty and inequality and their measurement in Argentina (Beccaria and Groisman 2008; ASC Bolsi and Paolasso 2009; Kessler 2015; Paz and Piselli 2000). However, no results regarding the measurement of the deprivation concept obtained from 2010 Census data have been published yet.

2 Method

2.1 General Background

2.1.1 Economic Crisis and Effects on Poverty Levels

The structural adjustment models applied to the economies of the region led to the fall of the real wages of a large segment of the Argentine population, also to the increase of the unemployment rate and varied forms of precarization of labour conditions, which generated processes of downward mobility (Kessler and Di Virgilio 2008). The situation of the country at the end of the decade of 1980 (hyperinflation, privatization of the national State) favoured the application of the proposals of the Washington consensus (Duarte 2002). The liberalization of the market was carried out without an adequate regulatory framework, creating conditions of instability. Likewise, the privatization of state service companies, regardless of the system of corruption that accompanied them and the multiplying effect on unemployment, in many cases led to higher prices due to the lack of competition policies or adequate supervision allowing the appropriation of service companies by monopolies (Kozulj 2005; Salvia 2015). Finally, fiscal austerity policies, accompanied by the continued taking of debt, became an end in themselves. These aspects helped unleash a deep institutional, political and economic crisis in the late 1990s that would end the convertibility model (parity between the Argentine peso and the US dollar) and the resignation of the elected president.

Between 1980 and 1990, workers as a whole lost around 40% of the value of their income, and after some recovery in 1991 due to stability; they lost around 20% again

between 1998 and 2001. This process of pauperization of work, in a context of increased unemployment, led to various researchers to conceive the concept of new urban poverty (Kessler and Di Virgilio 2008; Minujin and López 1994; Rodó 2003). This concept describes the descending movement of middle class households and the cultural aspects crisis that characterized it as well as the definition of new strategies of reproduction of their material life; among them, the creation of "barter clubs" where goods and services were exchanged which implied an approach to the popular classes. At the turn of the century, the phenomenon deepened and with the convertibility crisis (2001–2002), poverty reached more than 40% of the country's population. Despite the recovery of GDP and the reduction of poverty levels from 2002 to the present, when comparing the salaries received by workers it is observed that the average labour income of the 10% with higher wages is 30 times higher than the of 10% with lower salaries (Ángel Varesi 2016). Likewise, the last official poverty measures in the country place it at 28.6% (first quarter 2017) for the urban population.

2.1.2 Geographic and Demographic Aspects of Poverty

The latest measures of poverty that include the rural population, based on census data, allow us to observe a strong difference between the regions of the country. Thus, the metropolitan and central area describes the minimum, with 7% less than the national average. In contrast, the Northwest and Northeast regions boast the highest proportion of households, 25% higher than the national average, together with the highest intensity values.

Because of the enormous inequality that characterizes the Northwest and Northeast of Argentina with respect to the rest of the country, the local governments have made diverse agreements of economic cooperation nucleated in what has been denominated the "Norte Grande". The 62% of households in this region have characteristics that can be considered as critical in comparison with the most favoured regions of the country, besides, households with 50% or more of material deprivation are distributed in 98.9% of the regional area. The districts defined by the distribution of the highest levels of deprivation have been called "hard core" of regional poverty. These regions have a common denominator; they are mainly aboriginal or peasant population (Bolsi et al. 2005).

The deregulation of the agricultural public sector, during the 90′s, associated with the redefinition and privatization of public companies, implied the annulment of the state organisms that intervened in the regulation of the markets of goods and services. The rural world was affected mainly in its most fragile spaces. In this way, changes in labour relations and the growing precariousness of workers dependent on agriculture, led to the expulsion of rural workers to the urban margins and the disappearance of more than 30% of the total of small farm units (minors to 5 hectares) (Haimovich and Winkler 2005). This process was accompanied by the consolidation of the model based on the exploitation of large-scale monocultures, such as soy, whose effects on the expulsion of the original rural population tend to eliminate the farmer as a social subject.

Several authors demographically characterized the population living in poverty, noting that the number of household members is higher, fertility is higher and life expectancy is lower since there are higher rates of morbidity and mortality, particularly in the first years (Livi-Bacci 1995).

The demographic transition in Argentina is ending; however, it can be differentiated within the regional groups according to their socio-economic level. The transition for the medium and high socioeconomic levels has ended, while the low sectors exhibit a high growth that decreases proportionally to the improvement of their living conditions. This

has led some authors to state that mainly certain social and regional groups, are sustaining the growth of the Argentine population due to the precariousness of their living conditions (Álvarez et al. 2007).

2.2 Data Sources

In this paper, we have used information belonging to the CNHPV 2010; and the minimum geographical organization unit information, a census tract, that has been defined considering a strictly logistic and order criterion. This has been done by the INDEC to facilitate the census application, as its limits do not necessarily match with the political definition of the territory. At the end of 2015 the National Institute of Census and Statistics (INDEC) allowed public access to 2010 census data-base at the census tract level (INDEC 2015a). At the end of the same year, the GIS layer at the census tract level (INDEC 2015b) was available. This allow us to relate census tract measurements with other territorial aspects. There are 52,384 census tracts defined for the whole country, but the number of households and people surveyed is not constant. In this way, 29.5% of all the tracts contain up to 500 people; 41.3% contain 500–1000; 22.3% contain 1000–1500; and 6.8% contain over 1500. The urban and rural population definitions (CEPAL 2000) discern census tracts where there are more than 2000 inhabitants from those where there are less than 2000 inhabitants. There is a higher population density in urban areas in contrast to rural areas; the 80.2% of rural tracts contain up to 500 people, while the 51.2% of urban tracts contain 500–1000 and the 28.7% contain 1000–1500 people. The uneven population density, is related to Argentina's great geographic extension, the historical development of its populated centres since the formation of regional economies (Ferrer and Rougier 2008), the historical processes of migration (Esteban 2003) as well as the processes of political and economic development in an agro-export matrix (Míguez 2012; Rapoport et al. 2006).

The last Argentine census, carried out in 2010, involved two questionnaires: a basic one, aiming at the whole population and an expanded one, aiming at a population sample. This paper is based on the basic questionnaire results at the census tract level (INDEC 2015a) and the total census tracts GIS map (INDEC 2015b) that have been published by INDEC in November 2015. Thus, it is possible to work and graphically display the census information using census tracts as an analysis unit.

There are some limitations to use this map since in some cases the boundaries of the tracts do not fit completely, leaving empty areas. This hampers the extrapolation of geographic data from other sources and mounting them as GIS layers over the results based on census data analysis. Considering other limitations, there are 125 census tracts without information for any variable that has been used in the construction of this deprivation index. Given the total tracts for Argentina is 52,382, these gaps do not affect indicators measurement significantly. Likewise, after 2015 presidential election, INDEC's new administration published in 2016 a press release denouncing 400,000 duplicate values in 40,117,096 cases. Even though, the low proportion between total cases and his duplicates (0.99%) does not affect the index statistical constitution. However, some rural census tracts may be affected by this omission, due to their relatively low population density. To visualize the deprivation index results in maps, we have used the census tracts GIS layer, published by INDEC and the Departments layer (second order political-geographical subdivision) published by the Instituto Geográfico Nacional (IGN).

Both the theoretical perspective and the data sources characteristics used in the elaboration of deprivation indices are not guided by a single criterion. However, in different

deprivation indexes some dimensions are reiterated: employment, education, social class, health and home. Likewise, some papers include aspects that refer to the dimension of cohesion or social capital (Drukker et al. 2003; Van der Linden et al. 2003). In order to define a deprivation index for Argentina, we considered two issues: the country geographic and population distribution, and the available source data. For the first issue, it is worth noting that Argentina has large rural extensions and high urban population density. Considering these characteristics and the debates about rural deprivation measurement with census data sources (Bertin et al. 2014); we have included indicators to integrate rural and urban environments in the peculiar geographical configuration of Argentina. These indicators are: Housing Quality Construction (HQC), Basic Service Connection Quality (BSCQ) and Illiteracy Rate. HQC and BSCQ are defined by INDEC and have been implemented in the IMPH 2001. HQC measures the house floor and roof quality construction materials, while BSCQ observes whether the house has water and network connection to drains or septic tanks.

2.3 Indicators

Indicators used in the deprivation index formulation are described in Table 1. Illiteracy rates, percentages of unemployment and percentages of people living alone have been standardized according to the structure of population by sex and age. Due to the data source characteristics, some dimensions that are usually considered in deprivation indices development for a European context cannot be defined in Argentina. The definition of labour structure indicators, perceived income (either through poverty lines or total income in households) and those related to health state are not taken into account in the basic form of the Census 2010 in Argentina. Other deprivation indices have been obtained under similar constraints without impediment to their development. In addition, considering the contribution of Fu et al. (2015), the implicit Euro-centrism in some non-European definition of deprivation indices could cause difficulties to measure local aspects of the problem. Hence, it is valuable to define a deprivation index for Argentina to integrate local research papers on poverty and local deprivation; as well as the progress made measuring other national indicators.

Three indicators have been considered in order to survey household dimension: percentage of Insufficient Housing Quality Construction (IHQC), percentage of Insufficient Basic Services Connection Quality (IBSCQ) and Overcrowding (Overc). IHQC and IBSCQ were defined by INDEC and have been used in the evaluation of the IMPH 2001; both are useful indices to define specific aspects of rural areas deprivation in Argentina.

The employment dimension consider the percentage of people over 14 years old who worked (formally or not) in the two weeks before the census and were paid with money or goods. Formally, the INDEC defines the economically active population as of 14 years, while the unemployed population is the economically active population that during the four weeks prior to the census did not develop actions to establish a labour activity or entrepreneurship. We have chosen to maintain the definition of the age range used by INDEC for Argentina, in order to be coherent with other research that considers the labour aspects, evaluated from the 2010 Argentine census.

Although legally in Argentina the work of children under 16 is prohibited by law, and penalizes employers who take advantage of the work of minors economically, in practice, the labour carried out by people aged 14–18 is one of the family strategies most commonly used in rural areas, in order to reproduce their material life (de Obtschako et al. 2002).

Table 1 Definition of indicators used in the deprivation index

Indicator	Definition	Also, used in other deprivation index
Insufficient Housing Quality Construction (IHQC)	IHQC housing as a percentage over the total number for a census tract. (IHQC: houses without resistant materials, solid and with adequate insulation, without drains or toilet with drainpipe.)	Fusco et al. (2013), INDEC (2003), Noble et al. (2010) and Yuan and Wu (2014)
Illiteracy Rate (Illit.)	People over 10 years old who cannot read and write as a percentage of the total number of people over 10 years old or older	Sánchez-Cantalejo et al. (2008)
Insufficient Basic Services Connection Quality (IBSCQ)	IBSQC housing as a percentage over the total number of houses for a census tract. (IBSQC: houses without water public network connection, and drainpipe or septic tank.)	Fusco et al. (2013), INDEC (2003) and Noble et al. (2010)
Overcrowding (Overc.)	Housing with more than 3 people per room, as a percentage over the total households for a census tract.	Havard et al. (2008), Jordan (2004), Morris and Carstairs (1991), Townsend (1987) and Yuan and Wu (2014)
Unemployed (U Emp.)	People between 14 and 65 years old that are unemployed as a percentage of total number of people between 14 and 65 years old for a census tract	Havard et al. (2008), Noble et al. (2010), Salmond and Crampton (2012) and Sánchez-Cantalejo et al. (2008)
No Owner Occupation Housing (NOcp.)	Households without housing ownership as a percentage of total households for a census tract	Havard et al. (2008) and Salmond and Crampton (2012)
Single-parent Household (SPH)	Single-parent households as a percentage of the total number of single-parent households for a census tract	Havard et al. (2008), Pampalon et al. (2012) and Salmond and Crampton (2012)
People living alone (PLA)	People age 14 or older who lives alone as a percentage of the total number of people age 14 or older for a census tract	Pampalon et al. (2012)

Thus, in urban areas, the labour of people between the ages of 14 and 18 corresponds to 4% of the total employed population, while for rural areas it comprises 14.5%.

The logic of exploitation of peasant family units, already described by various authors (Neiman 1989; Paz 2008, 2011), is far from being placed in the classic model of capitalist accumulation. On the contrary, the organization of production in a peasant family productive unit implies the incorporation of the nuclear and extended family, according to the requirement of the period. These processes of incorporation of labour in periods of planting or harvest are typical of the indigenous-peasant culture of rural Argentina. As evidenced by the many ancestral festivities that mark them in the calendar year and that, beyond giving rise to the transaction of goods and services, they structure the social relations towards the interior and exterior of the community. The incorporation of these people forms a family strategy of using the land destined for production, which implies a better position of the family to achieve its material reproduction during the season.

Thus, conceptually, having a labour indicator that includes workers from 14 years of age allows a greater precision of the index to estimate the aspects of material deprivation related to the employment dimension for rural areas of Argentina.

Consumer durables dimension is described by the percentage of cases in which both housing and land, upon the house is built, belong to any home member.

Finally, we considered two indicators that refer to the social dimension: percentage of single-parent households (SPH) and percentage of people living alone (PLA). Indicators related to employment, social cohesion and education were standardized according to sex and age of population. For a better index reproducibility, we consider few indicators per dimension to simplify and make it more precise.

Different authors have studied the social aspects of deprivation and poverty, based on the concepts of social cohesion and social capital have studied the social aspects of deprivation and poverty (Chan et al. 2006; Stafford et al. 2003). Social cohesion refers to the intensity of social relations and the consensus of a social group, classically understood from the existence of bonds that exist between social subjects, allowing them to have a coordinated and harmonious action. On the other hand, the concept of social capital describes the meaning and coherence of social relations and the way in which they are structured in relation to a social subject (Oxoby 2009). Both concepts allow us to think about the existence of strategies carried out by the social subject in order to make sense and reproduce their material life. In this way, including the social dimension in the concept of deprivation implies considering the social strategies of collaboration that are developed and that allow the management of the situation of relative deprivation in a better way.

In the Argentine context, the cooperative relations established by social subjects at the family level correspond to a well-established cultural trait. Its existence has allowed both rural and urban households to define strategies for collaboration and cooperation during the different economic crises that affected the country. This implies that well-established nuclear families can resort to the extended family to establish cooperative relationships. In Argentina, 33.89% of households are made up of single heads of households, of which 69.47% are women. This places single-parent households in a situation of double vulnerability, characterized by both a smaller extended family and the fact that women the fact that women are their heads of households. This implies, in the context of Argentina, an unequal treatment with regard to working conditions (salaries of minors and greater difficulties to be employed) and family responsibilities (they are generally higher and focus on the maintenance of home and family).

On the other hand, the indicator relating to people living alone makes it possible to estimate the cases in which the social subjects do not have a nuclear or extended family to which they can turn in order to go through possible situations of deprivation.

In general, the variables surveyed by the censuses do not allow us to think about the participation of social subjects in the community, therefore, in other indexes of relative deprivation elaborated from census data, indicators of single-parent families and people who live alone commonly integrate the social dimension. Although the concept of social cohesion is not exhausted from the application of both indicators, we consider that they are appropriate to the Argentine context, allowing us to estimate aspects of the social dimension of deprivation.

2.4 Definition of Factors: GDI and GEDI as Synthetic Deprivation Measures for Argentina

Usually, the variables that make up deprivation indices are weighted in two ways:

(a) Based on weights definition and its addition,
(b) Applying statistical methods, generally principal factor or components analysis (Decancq and Lugo 2013).

In this paper, as in other deprivation indices based on census data (Krishnan 2010; Messer et al. 2006; Pampalon et al. 2009; Salmond et al. 1998), it was decided to weight the index components applying a PFA method. Thus, the coefficients are not arbitrarily determined but they are deduced from the statistical relationship among indicators (Jolliffe 2002). Once the factors are identified, they can be used in subsequent analyzes. In order to perform a factorial analysis the sample must meet certain conditions, the Bartlett test (Tobias and Carlson 1969) and Kaiser–Meyer–Olkin (KMO) (MO Kaiser 1974) are two tests commonly used to test sample adequacy (Ferguson and Cox 1993). Bartlett test produces a value that verifies that the correlation matrix is not significantly different from the identity matrix, in which case the resulting value must be less than 0.001. On the other hand, the measure of adequacy of the sample given by the KMO value compares the magnitudes of the correlation coefficients with the magnitudes of the partial correlation coefficients. The KMO value varies between 0 and 1. A value close to zero indicates that the sum of the partial correlations is very large with respect to the sum of the observed correlations, which implies that the sample is not suitable for the realization of a Factorial analysis, finally when the value is close to 1, the adequacy of the sample will be greater.

Factors determined from the application of the Principal Factors Analysis (PFA) estimate different types of deprivation for a census tract; these factors can be combined in order to suggest an overall measure of intensity and deprivation composition for an area. The General Deprivation Index (GDI) defined by Langlois and Kitchen (2001) is a deprivation intensity measure that integrates the scores of the different factors determined from the application of the PFA. For a GDI formulation, it is considered that one factor is predominant in the deprivation definition. This factor is statistically defined as the one that explains the greatest variance, and conceptually, sustain or makes the deprivation state possible. The GDI value is determined as a re-scaled factor value for each census tract according to the following expressions:where

$$GDI = \frac{s_{ik}^* \left(1 + \sum_{j \neq k} s_{ij}^*\right)}{p} \tag{1}$$

- s_{ij}^* is the secondary re-scaled factor value for the i tract in the numerical range [0, 1] and it is defined as:

$$s_{ij}^* = \frac{\left(s_{ij} - min_k\right)}{max_k - min_k} \tag{2}$$

- p is the total number of factors,
- s_{ik}^* is the principal re-scaled factor value for the i tract in the numerical range [0, 1], likewise it is defined as:

$$s_{ik}^* = \frac{\left(s_{ik} - min_k\right)}{max_k - min_k} \tag{3}$$

For both s_{ij} and s_{ik}:

- $max_k - min_k$ correspond to the greatest and the smallest scores obtained for the considered factor.
- s_i is the score factor value considered for the i tract.

The GDI measure compares deprivation for tracts regardless their rural or urban location with the number of people living in them. In order to establish a relative deprivation measure that gives priority to an emergency order for the deprivation treatment in Argentina, we propose the deprivation intensity measure GEDI. GEDI gives priority to census tracts according to the ratio between the number of people living in them and the Department's total population in which it is located. In Argentina, urban areas present more numerous, concentrated and dissimilar population than rural ones, thus GEDI is defined for urban or rural population in a differentiated way:

GEDI is defined for urban tracts and is calculated as follows:

$$GDIE_u = GDI_i \left(\frac{P_{Ru_i}}{P_{Du_i}}\right)(100) \tag{4}$$

where:

- $GDIE_u$ is the General Emergency Deprivation Index value determined for urban population located in a reference census tract i.
- GDI_i is the General Deprivation Index for the census tract i.
- P_{Rui} is all the people living in the census tract i who are located in urban areas.
- P_{Dui} is the Department's total urban population that constitutes the census tract i.

Moreover, GEDI is defined for rural tracts and is calculated as follows:

$$GDIE_r = GDI_i \left(\frac{P_{Rr_i}}{P_{Dr_i}}\right)(100) \tag{5}$$

- $GDIE_r$ is the General Emergency Deprivation Index value determined for rural population located in a reference census tract i.
- GDI_i is the General Deprivation Index for the census tract i.
- P_{Rri} is all the people living in the census tract i who are located in rural areas.
- P_{Dri} is the Department's total rural population that constitutes the census tract i.

Thus, this paper forms a new application of the methodology defined by Langlois and Kitchen contributes with its validation in a context of strong centralization of the urban population and large rural areas, since the results obtained have been validated externally by correlation with another well-known indicator. However, the definition of GDIE, which uses the values determined through the application of GDI, allows the GDI methodology to be expanded, specifying in a better way the differences between urban and rural areas, which is useful for contexts such as the Argentine one.

2.5 Index Validity

The validity of a composite measurement instrument is characterized by a review of its content, reliability and indicator construction (Coste et al. 1995). The validity of content evaluates the relevance and representation of the items included on the indicator with respect to the other items that could describe the concept to be measured. The reliability criterion, on the other hand, verifies that the configuration and methodology of the index are robust through its application in samples. For example, in determining the deprivation factors for the constitution of a GID for Argentina, the set of variables and his factors scores, should be similar to that obtained at the country level, regardless of its determination in rural, urban or any particular province. The criterion of construction validity, verifies that the index is associated to the concept measured, from a theoretical point of view. This is estimated internally, by factorial validity and internal consistency, and externally, by convergence validity and discriminant validity. Factor validity refers to some variables capacity over others to measure the same attribute, which implies a better response to a PFA. Moreover, the internal consistency criterion revises the ability of the variables to replace each other, measure the same characteristic and correlate with each other. An internal reference measure is given by the Cronbach's alpha coefficient application (Cronbach 1951). The convergence validity criterion refers to the correlation of the proposed index with respect to other that measures some aspect of the same phenomenon. Finally, the discriminant validity criterion, as opposed to convergence validity, tests the non-correlation that the index has with respect to other index that does not measure the same phenomenon.

3 Results

The values of the indicators, measured at the census tract level as percentages of total population tracts, are shown in Table 2 as averages for the tracts that are located in a given Province.

Illiteracy Rate (Illit) The Illit determined from the average of the total census tracts for the country is 2.06%. The values observed for different provinces were close to the national average, except for those located in the north of the country, where they range between 3.8 and 6.28%. The highest value is observed in Chaco province (6.28%) and the minimum in Ciudad Autónoma de Buenos Aires (CABA) (0.42%).

Table 2 Characteristics of Argentinian provinces

Provincia	Illit.		Overc.		IHQC		IBSCQ		NProp.		SPH		UEmp.		PLA.	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CABA	0.42	0.66	1.51	2.78	3.76	9.09	1.55	4.25	37.68	11.91	10.25	2.75	26.83	4.24	12.53	5.74
Buenos Aires	1.12	1.37	3.05	3.86	14.02	16.96	48.13	40.83	31.98	19.42	10.18	4.79	34.58	7.38	6.85	6.16
Catamarca	2.38	2.69	5.13	4.34	41.21	32.07	41.90	33.23	20.05	13.41	13.27	5.34	45.84	11.50	5.02	3.64
Córdoba	1.43	1.82	3.20	3.97	12.65	17.81	30.48	35.07	36.90	18.28	10.31	4.53	38.10	8.65	6.73	5.49
Corrientes	5.56	5.30	6.93	7.45	43.22	33.13	57.91	40.54	35.64	24.65	10.58	5.97	49.93	13.50	6.18	9.67
Chaco	6.28	5.09	7.51	7.09	51.87	33.91	59.97	37.47	27.61	17.15	12.11	5.07	47.38	11.72	5.07	4.90
Chubut	3.07	4.91	3.34	4.36	18.69	23.77	27.64	37.03	38.05	20.62	10.94	5.57	34.87	10.01	10.17	11.59
Entre Ríos	2.26	2.97	3.71	5.43	19.41	21.32	50.74	42.79	33.68	19.72	9.28	5.92	43.14	12.03	6.67	7.83
Formosa	4.71	3.99	9.62	9.07	58.48	34.48	57.35	39.11	27.62	18.58	12.78	5.48	47.56	11.54	6.02	8.49
Jujuy	4.16	3.24	6.65	5.85	41.39	35.35	40.61	36.90	30.20	21.82	14.72	6.22	43.17	10.81	5.51	6.18
La Pampa	1.96	3.57	1.63	3.45	8.96	16.50	47.91	41.99	37.29	23.33	9.38	6.70	36.63	10.66	11.19	12.57
La Rioja	1.93	1.64	5.58	4.72	28.62	26.88	27.08	28.30	23.75	11.69	13.24	3.34	41.18	8.97	5.01	3.19
Mendoza	2.10	2.69	3.47	3.92	16.21	19.69	24.52	30.67	37.09	15.60	10.95	3.32	39.33	6.69	4.71	4.28
Misiones	4.70	4.87	4.83	5.82	44.27	31.22	59.78	35.47	26.08	16.73	10.94	4.59	45.74	10.65	5.01	6.75
Neuquén	3.39	4.23	4.77	5.59	20.65	27.64	29.74	36.99	31.78	18.75	12.84	5.03	37.80	9.65	6.85	5.24
Río negro	2.50	3.08	3.95	5.10	16.38	20.58	26.78	32.45	34.16	15.88	11.92	3.97	35.89	7.95	7.26	5.71
Salta	4.51	5.04	8.57	8.47	43.04	35.71	42.82	39.61	32.32	21.35	12.57	5.07	46.03	13.18	5.10	6.74
San Juan	2.06	1.97	5.08	4.85	33.65	28.03	40.5	28.51	34.17	16.06	12.27	3.56	43.15	8.56	3.49	4.43
San Luis	2.21	2.58	4.03	4.57	20.92	26.14	35.86	37.51	34.27	19.39	10.84	4.71	39.38	8.43	6.80	6.33
Sta. Cruz	1.46	1.53	3.00	2.85	11.22	15.85	23.02	35.11	45.37	21.73	11.23	7.53	31.63	9.04	9.36	12.20
Santa Fe	1.68	2.28	3.03	4.29	15.59	20.49	42.82	38.03	31.63	16.87	10.33	3.92	37.48	8.56	7.16	5.60
Santiago del Estero	4.12	3.27	8.12	6.50	56.67	36.81	61.54	36.81	15.94	13.53	12.76	4.38	50.86	15.02	3.80	3.92
Tucumán	2.68	2.55	6.31	5.66	35.12	29.73	46.14	35.23	24.07	16.06	11.62	4.02	48.36	11.22	3.94	5.64
Tierra del Fuego	0.76	0.79	2.34	2.45	9.41	17.28	16.98	32.91	38.37	21.33	11.90	4.66	30.90	8.06	6.79	8.72
Argentina	2.06	3.03	3.91	5.11	20.68	26.13	41.66	39.86	32.41	18.94	10.71	4.83	38.14	10.81	6.86	6.73

SD Standard deviation

Overcrowding (Overc) The range of values are between Formosa province (9.62%) and CABA (1.51%); the average for the total census tracts is 3.03%. The highest values of this indicator correspond to the Northern Provinces, ranging from 5 to 9.62%.

Inssufficient Housing Quality Construction (IHQC) The IHQC indicator presents a wide difference between CABA and the Southern Provinces population with respect to Northern Provinces. The highest value corresponds to Formosa province (58.48%), while the minimum corresponds to CABA (3.76%); and an average (20.68%) with a standard deviation (26.31%) for the total census tracts in Argentina.

Insufficient Basic Services Connection Quality (IBSCQ) The IBSCQ indicator has a similar behavior to IHQC, which presents its maximum in Formosa province (61.54%), the minimum in CABA (1.55%) and an average (41.66%) with a standard deviation (39.86%) for the total census tracts in Argentina. IBSCQ and IHQC have high values of standard deviation at country level, which refers to the inequality in access to basic services and the economic and organizational capacities for constructing good quality housing, when comparing urban with rural areas these differences are accentuated.

No Owner Occupation Housing (NOcp.) The NOcp has higher values in the Southern provinces. The maximum corresponds to Santa Cruz province (45.37%), while the minimum is located in Santiago del Estero province (15.94%), and an average (32.41%) for the total census tracts in Argentina.

Single-parent Household (SPH) The SPH values show a minimum for Entre Ríos province (9.28%) and a maximum for Jujuy province (14.72%), and an average (32.41%) for the total census tracts in Argentina.

Unemployed (UEmp.) The UEmp indicator has its maximum value in Santiago del Estero province (50.86%), while the minimum corresponds to CABA (26.86%), and an average (38.14%) for the total census tracts in Argentina.

People Living Alone (PLA) This indicator has its maximum values in Southern provinces. The highest values are registered in La Pampa province (12.57%) and Santa Cruz province (12.2%). The lowest values correspond to La Rioja province (3.19%) and Catamarca province (3.64%).

3.1 Index Construction and Inner Validity

The internal construction validity and reliability criterion were achieved from the application of Bartlett and KMO tests to the total census tracts according to their rural or urban location (Table 3). As a result, KMO values are greater than 0.7 even if they were applied to urban tracts (0.741), rural tracts (0.715) or the total population census tracts (0.714). A value ranging from 0.7 to 0.8 corresponds to Middling according to the Hutcheson and Sofroniou scale (1999). The values of significance determined from the application of The Bartlett's test of sphericity were less than 0.001 in all cases.

The PFA method, with Variamax type rotation, has been applied in a set of urban, rural and the total census tracts. According to Kaiser's criterion (Kaiser 1960), those factors with eigenvalues greater than 1 have been retained. Thus, two factors have been retained, one refers to the material dimension of deprivation (F1) and another to the social dimension (F2) both explain the 60% of the total census tracts variance. In Table 3, the bold letters indicate the highest scores and the largest participation of a variable for each factor. The number of factors extracted and their scores are retained, whether the sample is focused on rural, urban or the total census tracts (Table 3). This indicates a robust index configuration and its independent applicability for both rural and urban areas.

Table 3 PFA Results and factor composition

Type of tracts	Total census tracts		Only urban tracts		Only rural tracts	
K.M.O	0.714		0.741		0.715	
Factor loadings	Material (F1)	Social (F2)	Material (F1)	Social (F2)	Material (F1)	Social (F2)
IHQC	**0.947**	− 0.019	**0.917**	0.127	**0.939**	− 0.015
Illit.	**0.657**	− 0.029	**0.835**	0.193	**0.670**	− 0.015
IBSCQ	**0.641**	0.298	**0.736**	0.060	**0.634**	− 0.290
Overc.	**0.640**	− 0.270	**0.665**	0.205	**0.629**	0.261
UEmp.	**0.561**	− 0.117	**0.436**	0.362	**0.568**	− 0.120
NProp.	− 0.016	**0.690**	− 0.304	**− 0.781**	− 0.006	**0.712**
SPH	− 0.064	**− 0.659**	− 0.164	**− 0.768**	− 0.080	**− 0.658**
PLA.	− 0.157	**0.483**	0.019	**0.712**	− 0.165	**0.486**
Cronbach alpha	0.811	0.635	0.806	0.681	0.749	0.555
Variance explained	36.597	23.475	43.419	16.176	36.682	23.593

Both for the total tracts as well as for urban and rural census tracts, the first factor is mainly composed of the IHQC, Illit, IBSCQ, Overc and UEmp indicators. The indicators related to the housing materials and the services available assess aspects of deprivation that affect the physical conditions of the quality of life of people living in the home. Homes with poor construction quality and basic sanitary services do not provide thermal comfort nor do maintain the health of their inhabitants. On the other hand, the indicators of overcrowding, illiteracy and unemployment estimate the conditions affecting the future development of the material life of the inhabitants. Both the labour and educational aspects are related to the concept of social class and behaves as conditioning factors of the material development of people in the future. Likewise, it has been studied that the development of children in homes with high overcrowding has a strong relationship with physical and psychological health problems. Thus, the indicators that make up the first factor evaluate aspects that describe the material aspects of the home in a current way and that condition their future development. In turn, except for unemployment, these indicators correspond to aspects of structural or chronic poverty of Argentina, and have been studied in other works under the concept of patrimonial deprivation.

The second factor, like the first, does not vary according to its application according to the types of census tracts, integrating the indicators people living alone, single-parent households and non-owners. The indicator single-parent families and non-owners explain most of the variance for the second factor, on the other hand, single-parent families and people living alone are the indicators with which we refer to the concept of social cohesion and refer to the social nature of this factor. The presence of the non-proprietary indicator in social factor refers to the difficulty that single-parent households and people living alone have to take ownership of the housing they occupy. This is also related to the economic capacity of the family, which allows us to think that the social factor estimates the possible strategies of social cooperation undertaken to deal with the situation of deprivation.

Although the material and social factors maintain their composition independently of the urban or rural area, the variance explained by the indicators that make them up is different according to the grouping of census tracts. Thus, in the grouping of urban tracts, the indicators that compose the material factor has a greater share. Because this, the constructive quality of the home do not intervene as in the groups corresponding to rural and total tracts.

Likewise, for urban tracts, the social factor shows a greater participation of the unemployment indicator, which correlates in the same sense as the one for people living alone. Both correlates contrary to the pair defined by single parent and non-proprietary households. This leads us to think about the specific difficulties that urban single-parent households have (in Argentina they are predominantly led by women) with respect to the ownership of the housing they occupy. As also people who live alone with regard to the possibility of having a job.

Considering the internal consistency, this criterion of validity has been obtained by applying the Cronbach test to a set of indicators that define each factor (Table 3). This test indicates the reliability of the measurement instrument, which allows us to know if the group of indicators that make up the factors are well integrated, inter-correlate and estimate the same concept.Following the general criteria (George and Mallery 2003), the values obtained after the application of the Cronbach's alpha test for the first factor indicate that the internal consistency is acceptable for the rural tracts and good for both urban and total census tracts.

On the other hand, the results of the application of the test to the second factor indicate a degree of poor internal consistency for rural radios and questionable for urban radios and the total. This is related to the interference of the non-owner indicator within the factor.

For both urban and rural tracts, the highest variance values explained and the best results from the application of the Cronbach test correspond to the material component of deprivation. This supports its definition as predominant in the construction of GDI, according to Langlois and Kitchen (2001).

3.2 Factors Distribution: Urban–rural characterization

The PFA scores indicate a value for each deprivation component; these values are measured at the census tract level. Thus, each census tract corresponds to a material deprivation value and to a social deprivation value; this allows distributing and organizing total values in quintiles for each factor, where the lowest deprivation value corresponds to the first quintile (Q1) and the maximum value to the fifth quintile (Q5).

Figures 1 and 2 show GIS distribution images of material and social deprivation quintiles at the census tract level. The size of the tracts varies according to its location in urban or rural areas; generally, urban tracts are smaller than rural ones and show a lower population density. The boxes correspond to urban areas description; from top to bottom capital cities from Salta, Santa Fe and Entre Ríos provinces; as well as Gran Buenos Aires and CABA. Although the number of people by tract is not equivalent, we can observe that when the population density is higher, the tract size decreases and the number of tracts increase. Figure 1 shows material deprivation values in quintiles for the census tracts. The Northern and central areas of the country show the highest values. The Provinces' capitals generally show a stronger differentiation in their central and peripheral areas; the central ones being less private than the peripheral ones. This is common compared to what is observed at national level between large urban centres and rural extensions with low population density. Likewise, the material deprivation factor has much greater values in rural tracts than in urban ones. The social deprivation values are shown in Fig. 2; the highest values are concentrated in the centre, west, south and northeast of the country. Unlike the northwest, that does not show a block of homogeneous values. Generally, in Province's capital cities, the observed relationship between peripheral and central areas considering the material factor is inverted; in this case, the social deprivation values are higher in the
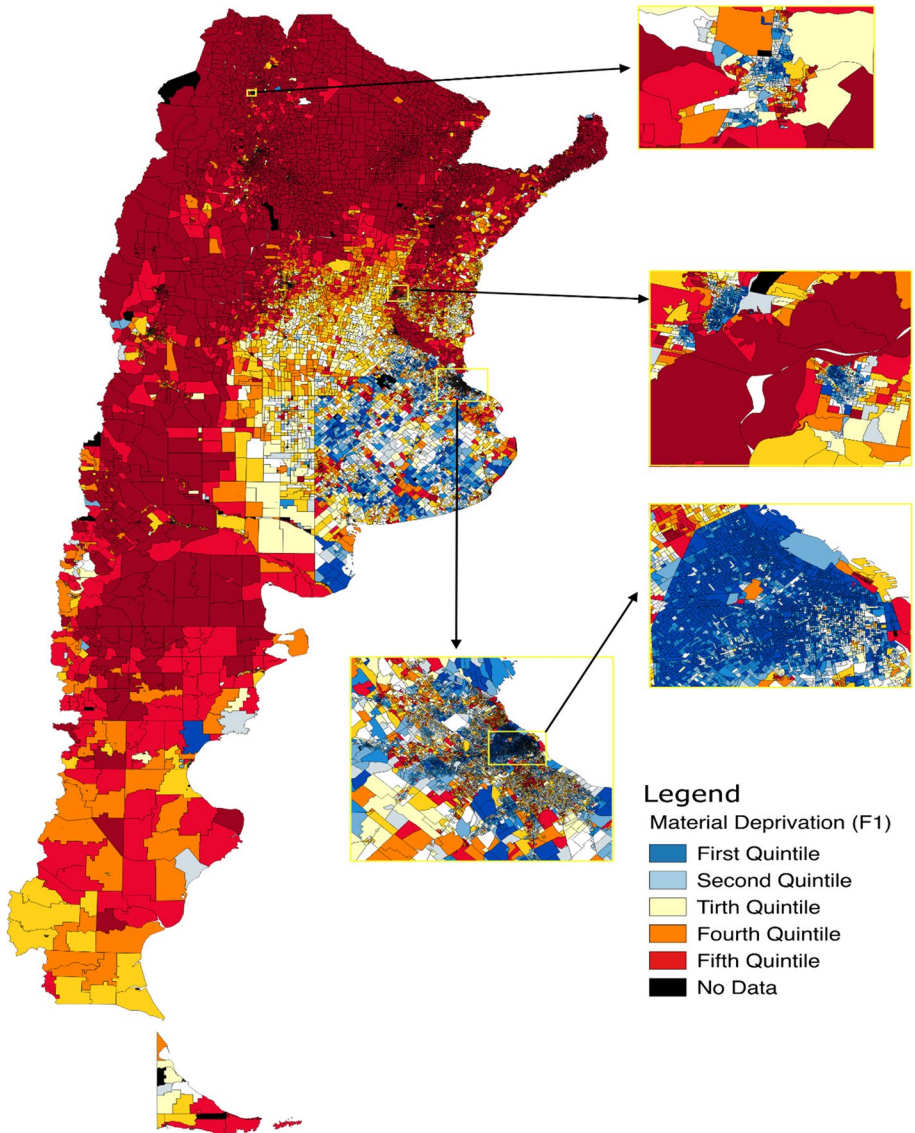
Fig. 1 Quintiles of material deprivation factor for census tracts

central areas and lower in the peripheral ones. Finally, the values of the social deprivation factor are lower in the rural tracts than in the urban ones.

Independence in measuring social and material factors of deprivation allows to describe their situation in each census tract. Thus, a tract can belong at the same time to different quintiles of material and social deprivation, this allows to review the concept of deprivation both in its intensity and composition for each small area.
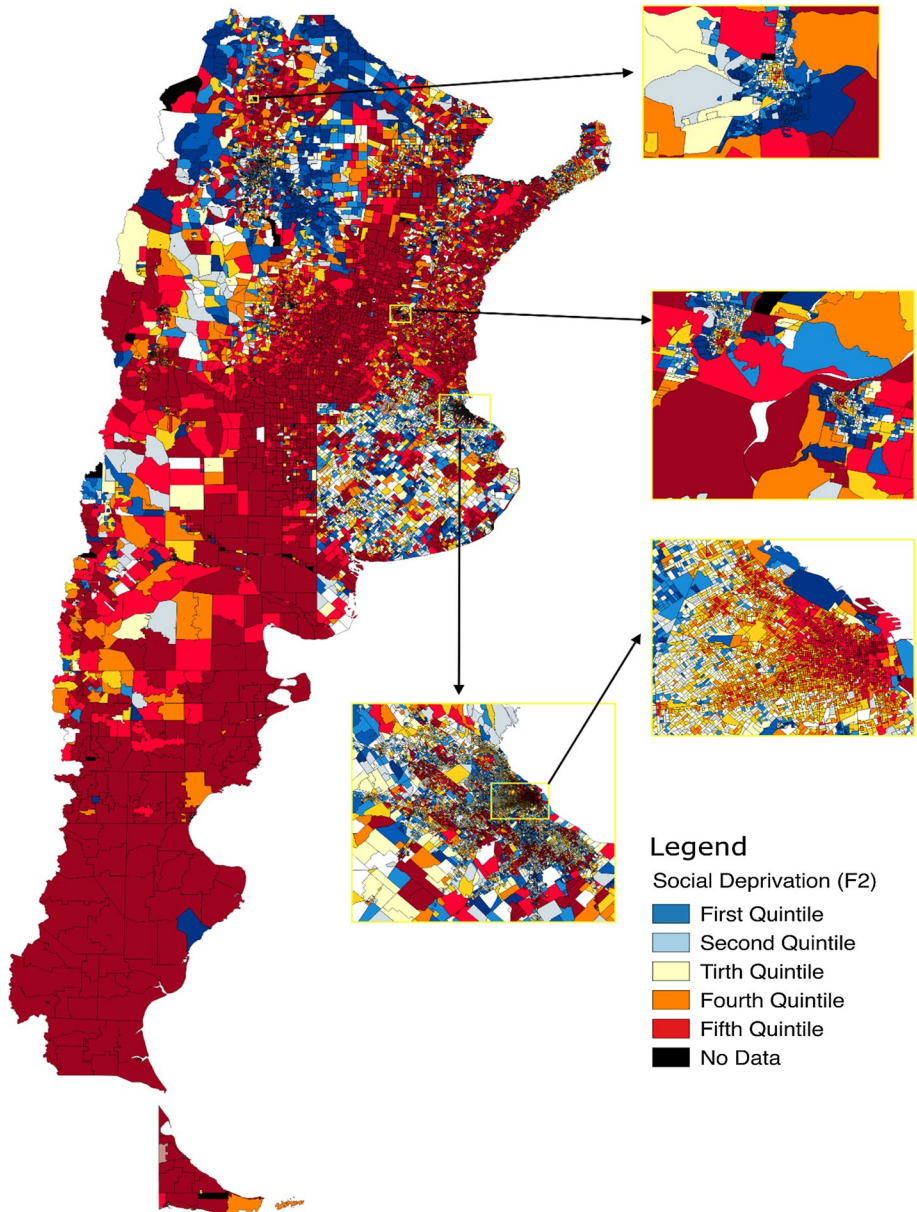
Fig. 2 Quintiles of social deprivation factor for census tracts

Table 4 shows the percentage of rural (R), urban (U) and total (T) tracts, according to their presence in a given combination of deprivation factors quintiles. In this way, symmetric relationships between deprivation factors are exposed in shades of blue for the minimum values (combinations among: Q1, Q2 and Q3 for both factors) and in shades of red for the maximum values (combinations among Q3, Q4 and Q5 for both factors).

Table 4 Distribution in quintiles for factors deprivation and their combination as percent of: Urban, Rural and Total census tracts. (Color table online)

	Social deprivation quintiles														
	Q1			Q2			Q3			Q4			Q5		
Material deprivation quintiles	T (%)	U (%)	R (%)	T (%)	U (%)	R (%)	T (%)	U (%)	R (%)	T (%)	U (%)	R (%)	T (%)	U (%)	R (%)
Q1	2.17	2.86%	0.09	3.36	4.44	0.04	4.49	5.94	0.04	6.07	8.02	0.06	3.91	5.15	0.07
Q2	3.19	4.09	0.52	4.88	6.33	0.47	5.63	7.20	0.80	4.35	5.42	1.04	1.95	1.79	2.29
Q3	3.57	4.52	0.77	4.32	5.47	0.91	3.99	4.90	1.30	3.67	3.88	3.15	4.46	1.05	14.24
Q4	4.85	5.96	1.62	4.14	5.09	1.33	3.37	4.00	1.63	2.81	2.49	4.22	4.84	0.57	17.37
Q5	6.23	5.53	8.82	3.30	2.64	5.50	2.52	1.53	5.69	3.11	0.81	10.15	4.85	0.31	17.87

T Total Census Tracts. *U* Urban Census Tracts. *R* Rural Census Tracts

Asymmetric relationships are exposed in shades of green for cases where high values of material deprivation and low values of social deprivation are observed (Q1, Q2 for the social factor; and Q4, Q5 for the material factor). Shades of greys are for those cases that show high values of social deprivation and low values of material deprivation (combining Q1, Q2 for material deprivation; and Q4, Q5 for social deprivation). According to deprivation quintiles distribution for rural and urban tracts, there is a great proportion of urban tracts that belong to the first and second quintiles of material deprivation, while the fourth and fifth quintiles are represented mainly by rural areas.

There is a wide inequality between percentages of urban and rural tracts distribution for the minimum and maximum values of material deprivation: rural tracts (0.3%) versus urban tracts (26.41%) belonging to Q1. This difference is reversed in material deprivation urban tracts (10.82%) versus rural tracts (48.08%) belonging to Q5. In the case of material deprivation for urban tracts (51.23%) belonging to Q1 and Q2; and for urban tracts (28.92%) belonging to Q4 and Q5. This is the opposite in the case of material deprivation for rural tracts (5.41%) belonging to Q1 and Q2 and for rural tracts (74.21%) belonging to Q4 and Q5. The percentage that belongs to Q3 is approximately equivalent for urban and rural tracts (20.38%). With respect to the social deprivation factor, belong to Q1 22.96% of the urban tracts and 11.81% of the rural ones. Similar to the material deprivation factor, there is an asymmetry between the percentage of tracts related to social deprivation belonging to Q5, urban tracts (8.87%) and rural tracts (51.84%). The distribution of the minimum deprivation values (Q1 and Q2) correspond to urban tracts (46.93%) and rural tracts (20.07%). While for Q4 and Q5 quintiles it is 70.46% for rural tracts and 27.49% for urban tracts.

Figures 3, 4 and 5 show the census tracts percentage in relationship with the total census tracts, whether they belong to urban or rural areas, and the combination of material and social deprivation quintiles. Figure 3 shows that the urban tracts highest percentages (darkest colours) are presented for combinations of social quintiles Q3–Q4 and material quintile Q1, together with the social quintiles Q2–Q3 and the material quintile Q2. Thus, urban tracts have low values of material deprivation and social deprivation mean values. A second group of tracts, not as numerous as the first, is centred on combinations of material and social deprivation mean values. Finally, the smallest number of urban tracts presents extreme material deprivation values and their combinations for social deprivation.

Figure 4 shows the combination of deprivation quintiles for rural tracts. Opposed to what is observed for urban tracts, the combinations of the highest number of tracts are defined for material deprivation Q4 and Q5. Only material deprivation Q5 is associated with other quintiles of social deprivation that do not belong to Q5. Rural tracts are mostly concentrated in combinations with the highest values of material and social deprivation.

Fig. 3 Distribution of census urban tracts for material and social deprivation as percentage of total
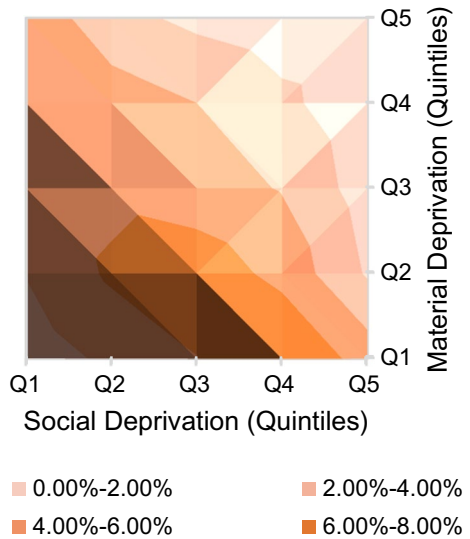

Fig. 4 Distribution of census rural tracts for material and social deprivation as percentage of total
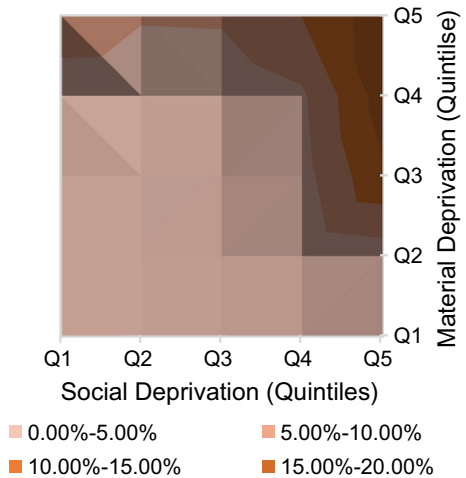
Figure 5 shows the concentration of total census tracts in quintiles, two common combinations are observed:

(a) Mean—low values combinations for material deprivation factors (Q1, Q2 and Q3) and medium—high (Q2, Q3 and Q4) for social deprivation ones.

(b) High material deprivation values (Q4, Q5) correspond to minimum or maximum values of social deprivation factors (Q1 or Q5). Thus, tracts with maximum values of material deprivation, corresponding to a situation of structural poverty, can be differentiated in two groups; those who can dispose of social or cultural capital to allow strategies for the reproduction of their material life, and those who cannot do it. In the last group would be those who are structural poor and socially excluded.

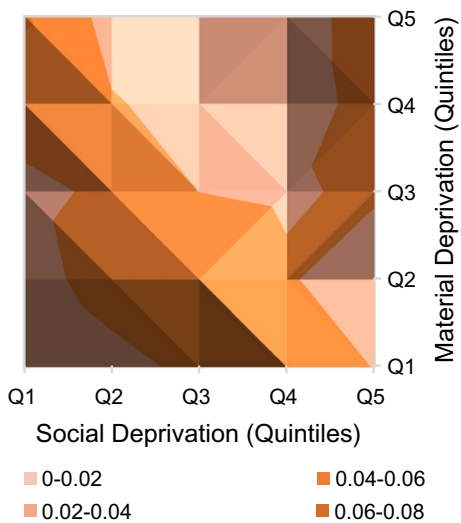**Fig. 5** Distribution of total census tracts for material and social deprivation as of total

Figure 6 shows the distribution of material and social deprivation quintiles combinations for the total census tracts in Argentina expressed by colours in Table 4. The first index refers to the material deprivation factor (F1) while the second to the social deprivation factor (F2). Rural tracts, geographically larger than urban tracts, are distributed in two general ways, either presenting high values of material and social deprivation (Q4 and Q5 combinations for each factor) or high values of material deprivation and low values of social deprivation (Q4 and Q5 material deprivation combinations, Q1 and Q2 social deprivation combinations). For urban tracts, the combination of mid and low quintiles are the most common (23.13% of the total) the combination of maxima and minima (between Q1 and Q5) are approximately equal and are represented with 5%, much higher than the corresponding to maximum and minimum extremes (Q1–Q1, or Q5–Q5). Finally, the urban space is characterized by combinations of absolute minimum deprivation (Q1–Q1) (2.86%) compared to the absolute maximum (Q5–Q5) (0.31%).

In this way, combinations of medium to low quintiles for each factor characterizes urban environments, and the asymmetries among factors, described as combinations between high values for one and low for other, comprising 39.61% of the total urban tracts.

3.3 GDI and GDIE Results

The GDI index synthesizes the material and social deprivation factors in a single value. It also weighs factors giving greater importance to one of them; in agreement to Langlois and Kitchen (2001) we propose the material factor as a determinant for a deprivation definition. Figure 7 shows the GDI values in quintiles at the census tract level. The deprivation intensity is different from urban to rural tracts. GDI for rural tracts (49.89%) belongs to Q5, while (26.90%) belongs to Q4. On the contrary, urban tracts (27.02%) belong to Q1, while (25.77%) belong to Q2. The strong differences described between rural and urban environments from the GDI measure state serious problems of access to elementary rights in rural versus urban tracts. Haimovich and Winkler (2005) also share this characterization.
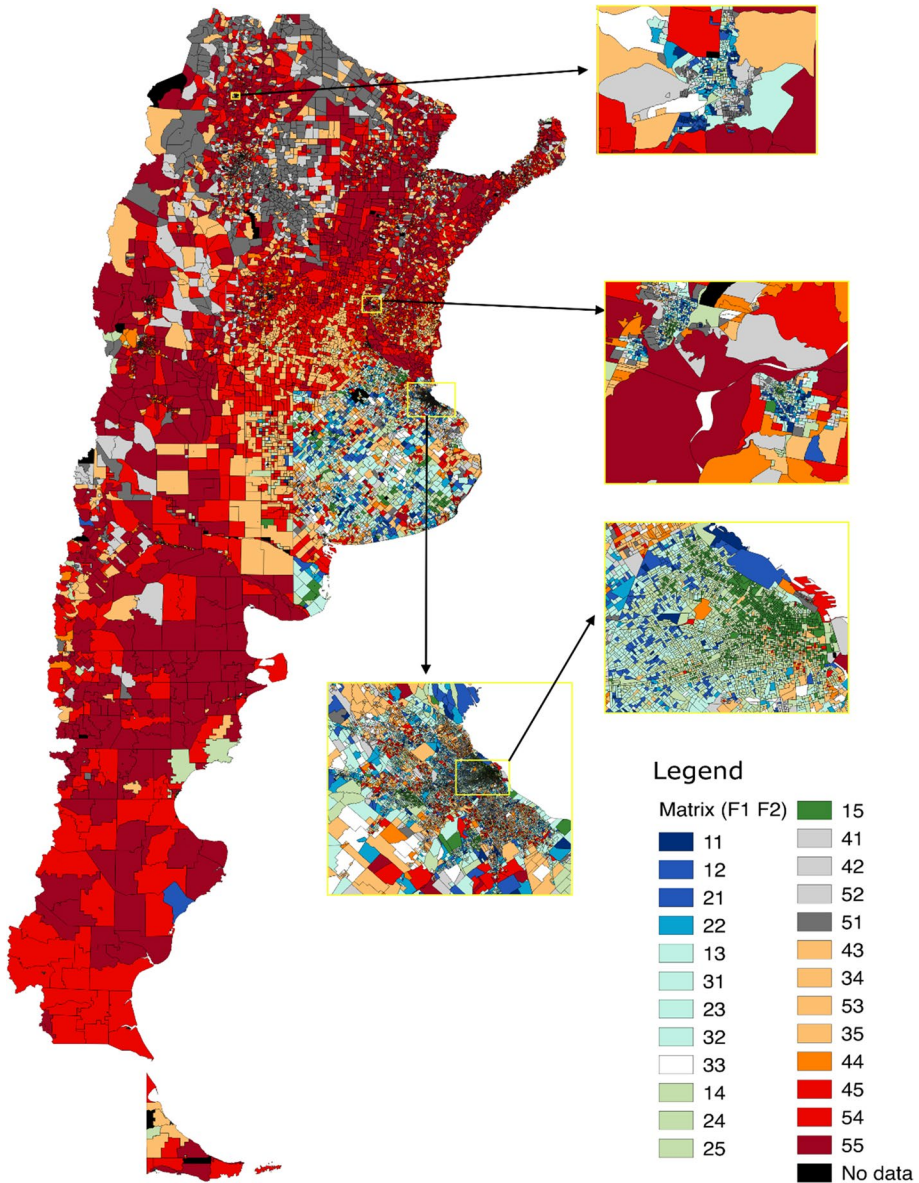
Fig. 6 Social and material deprivation factors for census tracts

The intensity with which the indicators act on the GDI measure is a result of the conformation of the that bring them together. In this way, it should be noted that the material factor, which we propose as a determinant for the state of deprivation in Argentina, is composed of the aspects associated with structural poverty. In addition, these aspects are related to access to basic and inalienable rights, such as education, work, and living conditions of the home that ensure the development of a decent life. Although the determining
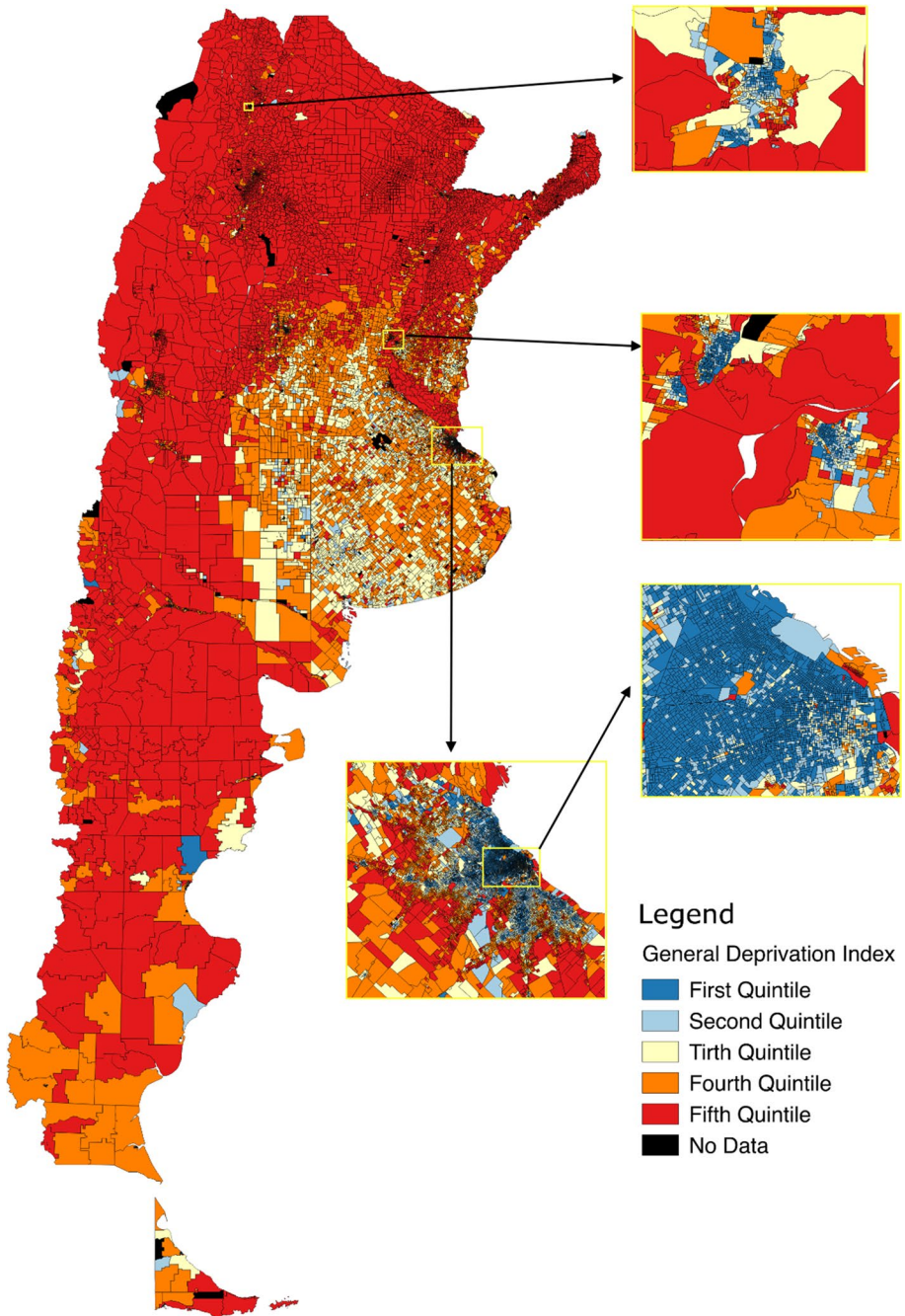
Fig. 7 Quintiles of general deprivation Index for census tracts

factor is the material, the GDI index considers the social factor as secondary, expanding the estimates of the material deprivation developed in Argentina for data from the 2001 census. Conceptually, this factor refers to the state of social cohesion of the human group and allows defining areas that present average values of material deprivation.

Due to the lack of information regarding the economic, labour, educational and health situation of Argentine rural households, the GDI indicator presents a contribution to deprivation studies in Argentine rural areas. The obtained values allow confirming comparisons made in other works with respect to the differences between the situation of poverty estimated for the urban and rural Argentine areas. With respect to rural areas, the differences between the Argentine regions are clearly observed, with lower values for the central zone -principal agricultural productive area- and higher for the Norte Grande region. These aspects were already present in the survey of the social impact of the crisis carried out by the World Bank in Argentina in 2001 -the year after the Argentine institutional and political economic crisis- and they make up a structural feature of the inequality in access to goods and rights in Argentine history.

The GDI values for the southern region of the country (Patagonia) are higher than the values for the central region of the country and lower than those for the Norte Grande region. This is consistent with its role in the national production of primary energy, such as gas and oil and the low population density it has compared to Norte Grande. Historically, the Norte Grande region has been presenting the highest values of poverty and inequality, the development of its rural economy is linked to farms that have a lower yield than those in the center of the country. Also, within the framework of the expansion of the Argentine agricultural frontier and the technification of sowing and harvesting, the Norte Grande has changed its productive matrix. In this way, agricultural production, which previously required intensive labor, is currently characterized by high technification and strong centralization through soybean monoculture planting pools. The effects of this process on rural households implied a situation of greater deprivation and the expulsion of a significant number of people towards the hard core of poverty in the urban margins. However, we observe heterogeneous values of deprivation for rural areas, which can be explained from the relationship between these spaces and their relationship with the production of raw materials. Thus, at the same time that the rural population was expelled (formerly required as intensive and low-skilled labor), the improvement of technology centralized rents in a small group of people.

In urban areas, the results of GDI differentiate between the center of the cities and the hard core of poverty, located mainly in its margins. This characterization accounts for the spatial arrangement manifested through the situation of deprivation. Private households are the ones that present problems related to access to elementary rights such as employment, education and a dignified life that cluster on the margins of the city. The spatial differentiation of the urban population and its relationship with its socio-economic aspects is being worked on by different authors, as is explained by the productions related to the problems suffered by the Argentine middle class during the 90′s. In this period at the same time that a large number of people reinforced the hard core of poverty in the cities, the boom of closed neighborhoods or country clubs began, which shows the effects of the disintegration of the middle class and the deepening of the economic asymmetries.

The GDI results show differences according to the urban reference areas, from which it is observed that the deprivation values of the central cities are lower than those located in the north of the country, this also refers to asymmetries of development between the cities that reflect those observed among rural–urban spaces.

The external validity criterion is achieved by correlating the GDI index with another well-known and widely used indicator in Argentina, the UBN. Pearson's linear correlation coefficient between GDI and UBN is 0.659, which indicates that both indices measure different aspects of poverty in the same direction. Conceptually, these indicators highlight different aspects of inequality. The UBN index, proposed by CEPAL for the study of poverty in the 1970s (Feres and Mancero 2001), has been officially estimated since the 1980s by INDEC (1984). The UBN concept defines minimum welfare thresholds that the population meets. A housing unit will be below the UBN line when it meets one of the following conditions:

1. The family resides in a tenancy, hotel, pension or non-housing.
2. The house does not have a toilet.
3. There are more than three people per room.
4. There is at least one school-age child (6 to 12 years old) who does not attend to school.
5. Those households that have four or more people per employed member and whose head has completed third grade of primary school (in total, less than 4 years of schooling).

In addition to GDI, it is useful to have an indicator to give priority to development policy actions in terms of:

(a) Census tracts deprivation characteristics
(b) Number of people who will be affected by these enforcement measures.

Thereby, a GEDI definition is proposed. This measure weighs the GDI results according to the total number of people in a rural census tract in relation to the total number of people for a rural area at Department level. Or, alternatively, according to the total number of people in an urban census tract in relation to the total number of people for an urban area at Department level. Thus, for each Department of Argentina, the GEDI gives priority to those urban or rural tracts in which a high GDI value has been estimated and where there is a greater number of people with respect to the total number of people for the rural or urban area at Department level.

Figure 8 shows the distribution of urban or rural tracts in quintiles for the GEDI according to Departments in Argentina. The boundaries of each Department are displayed in thick lines; the distribution in deprivation quintiles for each Department according to the tract type is displayed in thin lines. The results of urban and rural GEDI estimation are observed in two maps that have been overlapped in the Fig. 8. Due to the difference in size between urban and rural tracts, GEDI distribution for rural tracts is exposed for a map in Argentina; while the boxes show GEDI distribution values only for urban tracts in some cities. The tracts in white, observed in the margins of the cities correspond to rural tracts, which value is not evaluated by the urban GEDI.

The GEDI values that have been estimated allow us to appreciate the centralization of the human groups in the urban or rural zones of Argentina with respect to their relative deprivation state. In this way, the definition of public development policies against deprivation can be defined according to an order of priority. The results of the GEDI coincide with the definition of the hard core of poverty in both rural and urban areas.

In rural areas, the highest GEDI values coincide with the location of indigenous communities or small farmers. The change in agricultural productive logic in Argentina included the replacement of product diversification by monoculture, high technification, and the
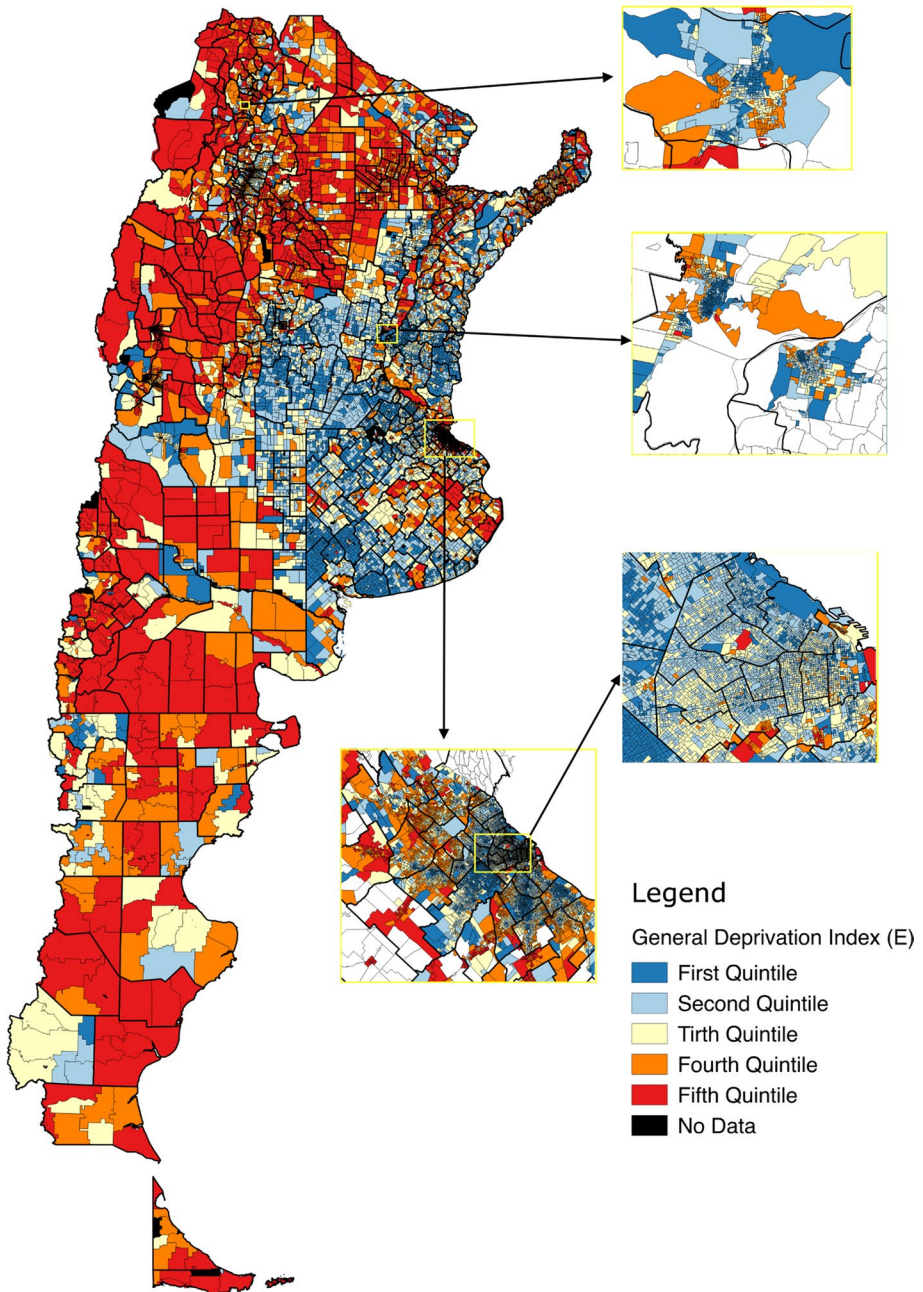
Fig. 8 General emergency deprivation index. Quintiles distribution for rural and urban census tracts

formation of large sowing pools with the participation of various international financial institutions. This has had the effect in the short term of the expansion of the agricultural frontier and the clearing of large territories of native forest, which implied the territorial

reduction of the native communities, which are living in a smaller area than the required for their subsistence (Briones 2015). The effects of this process are particularly evident in the Norte Grande, particularly in the Department of Rivadavia, in the province of Salta, where several aboriginal communities traditionally dedicated to fishing and gathering, present serious problems of child malnutrition and extreme poverty (Buliubasich 2013).

On the other hand, peasant communities that do not call themselves indigenous are not exempt from the effects of the transformation of the sector. Thus, many of the peasants were unemployed and consequently migrated to the periphery of the cities. Likewise, many of the small producers who own their land are currently leasing it to the financial groups that exploit the intensive soy monoculture. This situation means a lower income in addition to the consequences of the depletion of the land resulting from the application of agrochemical packages (Manzanal and Arzeno 2010).

With respect to urban areas, the GEDI allows locating and comparing the situation of deprivation among different small areas, identifying the hard core of poverty. As can be seen, the highest values are focused on the margins of cities and are related to precarious settlements made up of rural population that has been expelled, or, by urban population that has not been reached by urban development policies. Likewise, its occupational, health and educational characteristics make it possible to define this urban population as vulnerable to the economic changes that may arise. Hence, this population covers most of the employment and undeclared employment gaps during changes in these indicators.

Unlike other indicators commonly used for the definition of public policies in Argentina, the GEDI results allow to establish a quick comparison between the values of deprivation of the different rural and urban areas at the same time that it proposes an order of priority for the action. This is particularly useful for the definition of policies of wide national scope that act on the structural factors that sustain them.

4 Conclusions

Concepts related to poverty and inequality (such as relative deprivation), as well as the index proposed in this paper, correspond to partial constructions that are historically situated and show limitations. Nevertheless, the index presented in this paper is useful for a number of reasons: it covers a knowledge gap with respect to studies of relative deprivation in Argentina based on the last census; it is easily reproducible; and it allows characterizing the aspects of material and social deprivation for Argentina in the most precise way that the census data base allows. Finally, it has a robust construction and offers a good performance for rural and urban environments study.

The objective of this paper was the construction of a deprivation index based on Census 2010 data source, recently published by INDEC. This index is useful in the definition and application of public development policies on a broad spectrum, since it proposes to conceptualize the main aspects of deprivation processes and inequality from material and social factors. It enables us to evaluate locally the problems that affect the structural aspects of the population, such as health, work and education. The concept of relative deprivation allows us to work with its dimensions and estimate both the intensity and the way in which deprivation is structured in a given environment. Likewise, it has been defined a composition matrix based on the combination of material and social deprivation quintiles. This makes it possible to homogenize and test the way census tracts are distributed according to deprivation types resulting from factors combination. According to Langlois

and Kitchen (2001) the material and social factors have been synthesized in a single index called GDI, which predominant factor corresponds to a material deprivation. In order to make available an evaluation of the deprivation focused on the design of public policies for immediate action, the GEDI has been defined. GEDI weighs GDI values according to the total number of people living in a rural or urban tract and the total of people who compose the urbanity or rurality of a Department. In this way, this estimation methodology differentiates between urban and rural tracts and gives priority to those which show a higher deprivation value and more number of people with respect to the total Department's urban or rural environments.

Statistical validation test of the sample and internal and external consistency tests have been applied to both the material and social factors -defined by PFA- as well as the GDI index. In all cases these tests conclusively demonstrated its validity, Cronbach's alpha coefficient value for material deprivation factor 0.811, and for social deprivation factor 0.635. The explained variance is 60.07% and the KMO value being 0.714. The external validity criterion was tested using Pearson's correlation coefficient between the GDI and UBN indicator being 0.659. Both the scores of the variables grouped in the construction of each factor, as well as the KMO values, variance, and the Cronbach alpha coefficients are approximately equal for the group of urban and rural census tracts and for the total. This validates the index constitution and its functioning in both rural and urban areas.

The proposed indicators estimates show differences regarding quintiles deprivation distribution for central areas and the rest of the country. Likewise, the GDI estimation determined that 76.79% of rural tracts have high deprivation values, while 53.92% of urban tracts have low deprivation values. Numerous contributions highlighted these differences in and explained from the review of the demographic and productive development of the country, the formation of populated centres and their distribution, the disposition of roads for communication and distribution of production, among others (Altimir et al. 2002; Kessler 2015; Paz and Piselli 2000; Rofman and Marqués 1988). Ciudad Autónoma de Buenos Aires, the country capital, and Buenos Aires province, the most populated province of the country, have been the urban productive pole par excellence since Argentina was founded (Cao and Vaca 2006). From then on, the country has developed a productive economic structure mostly based on raw materials exportation produced by a strong agricultural sector. The resulting income from this productive activity is mainly accumulated in the central region (Rapoport et al. 2006). In addition, Buenos Aires' strategic position with respect to the main port of Argentina, built at the end of the 19th century and currently handling approximately 90% of the country's exportation and importation (Guma 2016), has collaborated in the concentration of economic resources. The dichotomous relationship between the centre and the periphery of Argentina is visible from not only the unequal distribution and management of economic and productive resources but also permeates multiple symbolic aspects that structure the population perception on daily basis and conclude in concrete social exclusion and inclusion practices. Some examples are indigenous people and ethnic minorities' segregation (whose phenotypic expressions do not match with the Eurocentric archetypes of migration policies during the late nineteenth century). As well as the formulation of the "interior" of the country as a distant, exotic environment, homogeneous and subject to discourses elaborated in the main country urban centres. This can be seen in the political-administrative practices of economic resources distribution, as well as in the production of elaborated speeches by the mass media with national coverage. All of this helps to contextualize the obtained results presented in this paper.

Other contributions reflect the unequal resources distribution and the differences in rights and services access between the centre and the periphery of Argentina, based on the

concept of poverty (A. Bolsi et al. 2005; ASC Bolsi and Paolasso 2009; Haimovich and Winkler 2005; Ziccardi 2008). The UBN indicator has been designed from a multidimensional perspective in order to establish which population sector is below the basic needs line. The results of GDI, exposed through the application of QGIS, complement papers on poverty based on the estimation of UBN in Argentina. Studying the UBN of many geographical areas identified by GDI that correspond to already determined structural poor sectors. However, the deprivation assessment through measures of intensity and factors composition allows proposing alternatives for public policies design that were not possible to achieve by estimating the UBN.

The index obtained, by the application of the PFA method, is supported both by the conceptual framework that gives theoretical meaning to the factors that comprise it and by the correlations of the indicators that integrate it. This differentiation implies both a limitation and an opportunity to achieve the reproduction of the GDI configuration in other contexts. Although the correlation values of the variables used are specific to the Argentine socio-historical context present in the year 2010 (time of census taking), the conceptual framework can be taken into account for its development in other contexts, since it refers to structural aspects of material and social deprivation. In fact, the dimensions that we have considered to define the factors are present in other indices of deprivation based on census data. Likewise, we consider that the conceptual definition of this index could be useful for its reproduction in countries of the region such as Bolivia, Uruguay, Paraguay and Brazil that exhibit similar census questionnaires, large rural extensions and problems of inequality and deprivation similar to that of Argentina.

On the other hand, the methodology of the GEDI index can easily be reproduced in any indicator of deprivation based on the GDI methodology, such as the one defined for Quebec. This is because it affects the GDI value from the relationship between the total of people defined according to a political administration unit and the urban or rural area for each census tract.

Although many indices of deprivation have been developed and applied for the definition of health policies, this paper presents a deprivation index devised to develop public policies of welfare in a broad spectrum. In turn, this study presents typical limitations from those based on an ecological design, which means that the observations and results are based on census tracts and cannot be extrapolated to individuals. Hence, it does not determine the effects of context between individuals and the deprivation levels defined for the area.

In conclusion, this index is a useful tool to define Argentina's development and equity policies based on local aspects. In turn, it can be used in rural and urban areas. Its formulation is simple and easily reproducible. It identifies socioeconomic disparities while classifying inequality patterns from the combination of social and material deprivation quintiles.

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