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Vulnerability to poverty in Brazilian municipalities in 2000 and 2010: A multidimensional approach

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Abstract

The introduction of the temporal component into poverty analysis takes us to the study of the poverty dynamic, which focuses on investigating events of entering, remaining in and getting out of deprivation. As an effort to consider the diverse aspects unrelated to income in the study of vulnerability to poverty, the monetary approach is put aside and the multidimensional approach is used to elaborate the well-being index. The Multidimensional Poverty Index (**MPI**) is constructed with data from Brazil's 2000 and 2010 Demographic Census. First, this article intends to quantify and describe the results of the MPI in Brazilian territory, using municipalities as unit of analysis. Second, it intends to analyze the factors associated to the poverty dynamics, which can be understood through the transition probability from a non-vulnerable state to a vulnerable state, in a distribution of the MPI in deciles. Finally, it intends to identify the municipalities that went through this transition in a regional level during the intercensal period. Results show that, despite the improvement observed in its whole national territory, Brazil's North and Northeast remain with deeper deprivations while the Southern and Southeastern regions present the lowest incidence of multidimensional poverty. *Dropout Rate of Grades 3–4 of High School*, *HDI-M Education*, *HDI-M Longevity*, *Logarithm of the Population*, *Gross Value Added per capita of Industry, Service Concentration Index* and *Entrepreneur Rate* contribute positively to the reduction of municipal vulnerability to poverty. Compared to Northern municipalities, Southeastern Brazil has reduced more significantly the likelihood of position loss and has had a greater effect of increasing the probability of its upward movement.

JEL classifications: I32; R13

Keywords: Multidimensional poverty; Vulnerability; Brazil

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1. Introduction

Brazil has historically had a proportionately decreasing number of poor people. In the last decade, the share of its population in monetary poverty decreased from 41.9% in 1990 to 15.9% in 2012 and the extreme poverty rate dropped from 20% to 5.3% in the same period. There is a vast literature focused on the understanding of what causes poverty and on the better alternatives to mitigate it. However, today's poor may not be the poor of tomorrow. For this reason, the temporal component of poverty starts to draw attention.

The introduction of the temporal component into poverty analysis takes us to the study of the poverty dynamics, which focuses on investigating events of entering, remaining in and getting out of deprivation. In this context, the concept of vulnerability is used in different ways by several schools of thought, although one commonality is observed: vulnerability is related to the exposure to unknown events and to one's ability to deal with them.

The concept adopted in this study is the one embraced by economics, which defines vulnerability to poverty as the probability of well-being loss. Its choice is motivated by the lack of this type of study applied to Brazil. Therefore, this paper intends to contribute to the identification of factors capable of preventing the incidence and the deepening of poverty, and acting towards overcoming poverty as well.

As an effort to consider the diverse aspects that are unrelated to income in the study of vulnerability to poverty, the monetary approach is put aside and the multidimensional approach is used to elaborate the well-being index. The Multidimensional Poverty Index (**MPI**) is constructed with data from Brazil's 2000 and 2010 Demographic Census. Unlike what is commonly adopted in the literature of vulnerability to poverty, this paper focuses on the municipal level instead of having the individual as analysis unity. The municipality is chosen because the environment's influence on individual vulnerability to poverty is significantly important. Also, the 1988 Federal Constitution gave certain autonomy to the local level of public power, in areas such as education and health, and the municipality presents specific socioeconomic characteristics, like local labor market and violence. Hence this choice was proven pertinent.

By analyzing the 2000–10 socioeconomic scenarios, it is possible to observe some expressive changes: the Minimum Wage had a real appreciation on the order of 75%; the productive de-concentration process (initiated in 1970s) continued; social policies were expanded and the labor market intensified its formalization. However, these changes affect the municipalities in different manners because of their particularities. Consequently, the population exposure to these changes brings instability to its well-being, which makes it necessary to use physical, human and social capital to deal with likely well-being losses. The government also has an important role in this context, considering that it is capable of elaborating public policies to develop the citizens' capability of making use of the their own resources in a more productive way and to reduce local insecurity. Thus, changes in the vulnerability to poverty between 2000 and 2010 for the Brazilian municipalities had been expected.

Considering all the aspects above, this article proposes, in the first place, to quantify and describe the MPI results in Brazilian territory, using municipalities as the unit of the analysis. Second, it intends to analyze the factors associated to the poverty dynamics, which can be understood through the probability of transition from non-vulnerable state to a vulnerable state, according to the MPI levels. Finally, it intends to identify the municipalities that went through this transition in a regional level during the intercensal period.

Taking these objectives into consideration, the article is organized in five sections, including this introduction. The second section brings up the theoretical aspects supporting this study. In sequence, the methodology adopted to achieve the goals proposed herein is outlined. The fourth section treats the results obtained through the application of the methodology described previously. Finally, conclusion and considerations are made in the fifth and final section.

2. Vulnerability and multidimensional poverty

The study of poverty dynamics is characterized by the inclusion of the temporal component into the analysis of poverty. It mainly focuses on events of entering and overcoming deprivation. In this approach, poverty is divided into two principal categories: chronic and transitory. The former considers individuals under deprivation throughout the whole period studied. In the latter, a person moves into and out of poverty in the same time period. Nonetheless, the criteria utilized to define those two categories are not consensual.

The concept of vulnerability emerges in the 1970s with studies on disaster risks and its negative effects. This concept is still adopted in fields such as food safety and health. In Economics, vulnerability to poverty is the likelihood of reduction, or loss, in the well-being, or wealth, below a level defined as the minimum accepted in the current social

context (Sumner and Mallett, 2011). Despite the several different applications of the vulnerability study, the result that physical, human and social capital are key-elements to understanding the mobility of individuals in poverty and their vulnerability to poverty is quite frequent.

Under the justification that "although poor people are usually among the most vulnerable, not all vulnerable people are poor" (Moser, 1998, p. 3), the author analyzes poverty and vulnerability in urban context. The latter is defined as the process of moving in and out of poverty in some period. In the urban environment, labor is considered the most important asset to poor people because it generates income for instant consumption. While facing a drop in the level of consumption or income, the immediate response of poor people is to increase the number of workers in the household. Housing also plays a major role in the urban environment: it has capacity to increase safety, making it possible for individuals to enjoy opportunities with uncertain results, in addition to providing extra income. A house bedroom could be rented, or an entrepreneurship undertaking located in the house.

Good quality of public services, in turn, contributes to the creation of good conditions to make individuals able to use their knowledge and assets in a more productive way. Social relations are important as well. They enable the support of community members and of institutions when difficulties in dealing with exogenous well-being shocks arise. For these reasons, the capability of avoiding or reducing poverty and vulnerability depends not only on the initial stock of assets the person owns but also on his/her ability to manage them (Moser, 1998).

One of the issues in the monetary approach is that transitory poverty tends to be overestimated when analyzed by income or consumption. At the same time, there is a tendency of masking the persistent deprivations capable of keeping poor individuals in poverty, or chronic poverty (Hulme and Shepherd, 2003). The lack of capabilities,[1] besides income, is an obstacle for these persons to overcome deprivation situations on their own.

The multidimensional approach to poverty by ex-ante perspective highlights the work of Dubois and Rousseau (2008). Similarly to Chaudhuri (2003), the authors define vulnerability as the probability of the person being in an worse situation when facing an unexpected shock. With support of the Capabilities Approach, the reduction of vulnerability is associated to the development of capabilities to overcome the social consequences related to the occurrence of an unexpected shock. So, even if people own assets that could be used to face difficult moments, these assets are not very useful if they are not capable of using them correctly. Among the results found in their research, a fact stands out: several groups face different types of risks and security is obtained through the reduction of vulnerability and through the development of people's potential.[2]

Therefore, it is worth noticing that the physical, human and social capitals are essential to reduce poverty and vulnerability to it. Developing these capitals make individuals able of becoming more prepared to face adverse situations that affect negatively their well-being level. Security likewise plays a major role here. Personal insecurity can shape behaviors in a way that people would not be capable of investing in the process of moving out of poverty. It can also lead to situations in which people would be less susceptible to deprivations in the future.

The idea that monetary scarcity is not sufficient to characterize poverty has been adopted frequently in the studies of this phenomenon (e.g. Alkire and Foster, 2011; Atkinson, 2003; Kageyama and Hoffmann, 2006; Machado et al., 2014; among others). Besides their monetary needs (goods consumption), people have also other demands (access to public goods and felling as members of their communities). If there is some public policy focused on the community they live in, they want to be under its effects. These people also wish to feel capable of tracing their own future, with education having a primary role to provide knowledge and to improve abilities that make possible the achievement of this goal (Codes, 2008; Wood, 2003).

This being said, the multidimensional approach to poverty seems more adequate than the one-dimensional framework to study this thematic. Therefore, in order to depict municipal poverty in broader strokes, as explained in the section before, this study makes use of the multidimensional approach.

Thus, we developed a Multidimensional Poverty Index (MPI) to every Brazilian municipality, distributed all the values in deciles to two censual years and evaluated if there was a transition between the deciles or not, as a possible evidence of vulnerability to poverty in a multidimensional context. After the transition variable was developed, we evaluated the factors that were associated to the poverty dynamics. Then, we mapped the municipalities that are most subject to the vulnerability.

[1] Capabilities are sets of beings and doings that individuals are able to achieve.
[2] Potential is an individual's capability to do things the way he/she desires.

3. Methodology

3.1. The Multidimensional Poverty Index

As regards investigating multidimensional poverty in Brazilian municipalities, data from the national Demographic Census 2000 and 2010 is used to construct a Multidimensional Poverty Index (**MPI**). This index consists of three dimensions: Housing Conditions, Education, and Labor Market Participation. The dimension Housing Conditions brings information on sewage water provision, disposal of household waste, presence of items such as radio, color TV and refrigerator (one or two doors) and overcrowding. The dimension Education is related to functional illiteracy and school attendance rate. Child labor and adult unemployment rates compose the Labor Market dimension.[3]

Due to the difficulty of working with so much information, the number of variables must be reduced without losing the generalizations. Then, the Principal Component Analysis (**PCA**), one of the multivariate analysis tools, is used to yield the MPI. The PCA is applied to reduce the quantity of information (variables) being analyzed and to facilitate its use and its interpretation. This is done by reducing the database dimension, and generating fewer new variables, capable of representing the maximum variability of the original database (Mingoti, 2005). In this present study, the MPI indicates the poverty situation in the municipalities reported by Demographic Census' data from years 2000 and 2010.

With use of the Kaiser's Normalization Criterion, the main components with eigenvalue larger than 1 were chosen to compose the MPI (Greyling, 2013; Hoque, 2014). The next step is calculating their respective values, considering the respective weight of the variables in each chosen principal component. Lastly, a weighted average is calculated with these principal components, where the weights are their eigenvalues, resulting in the MPI.[4] This procedure maximizes the variability of the data represented by the index.

3.2. The dependent variable

After calculating the MPI through the use of PCA, we ranked the municipalities in deciles as per MPI distribution (the lower in the MPI's distribution, the less intense is the poverty in the municipality) in the years 2000 and 2010 (d_{i2000} and d_{i2010}, respectively) and, then, we compared the municipality's rankings in these two years. Thereafter, the dependent variable was generated following Eq. (1): (i) if the decile in 2010 is higher than in 2000, the dependent variable equals -1, meaning that the deprivation situation worsens; (ii) if the decile in 2010 is the same as in 2000, its zero value indicates that the position stayed the same in the MPI's distribution and; (iii) the dependent variable assumes value equal to 1 if the decile in 2010 is lower than in 2000, indicating an increase in citizen well-being in the municipality.

$$Y_i = \begin{cases} -1, & if \quad d_{i2010} > d_{i2000} \\ 0, & if \quad d_{i2010} = d_{i2000} \\ 1, & if \quad d_{i2010} < d_{i2000} \end{cases} \tag{1}$$

As can be seen, the dependent variable presents three categories of answers (-1, 0 and 1) and their order is meaningful because it is strictly connected to the fact that the municipality's position in the MPI's distribution in year 2010 can be worse, equal or better than in 2000, in this order.

3.3. The ordered probit

Vulnerability to poverty is defined as the probability of the well-being index falling below a specific threshold. Hence, some statistical method capable of calculating this probability is necessary. In this paper, the threshold is set

[3] The variables considered in each dimension are in Table 1, shown in Section 3.4.1.

[4] For further information on calculating a single indicator from a weighted average of principal components, see Greyling (2013), Kamanou (2011) and OECD (2008).

as moving to a higher decile in the MPI's distribution – in other words, worsening the multidimensional poverty's situation.

We use the Ordered Probit to calculate the municipality's probability for each category, because it can deal with dependent variables that have more than two categories and their order is relevant. In other words, the Ordered Probit allows us to predict the probabilities respective to each category of answer to the Brazilian municipalities in years 2000 and 2010 (−1, 0, 1), making possible the identification of those vulnerable to poverty – category −1. With the marginal effects of the independent variables,[5] one can analyze its impacts in the probabilities of a municipality presenting immobility, upward or downward movement along the MPI's distribution.

The estimation is built around a latent regression, given by Eq. (2). The latent variable (Y^*) is a linear combination of few predictors (X) and a disturbance term (ε) that has a standard Normal distribution.

$$Y^* = X'\beta + \varepsilon \tag{2}$$

However, Y^* is unobserved. In the case of the dependent variable built in equation 1, what is observed is represented in Eq. (3), where μ are boundary parameters.

$$Y = \begin{cases} -1, & if \quad Y^* < \mu_1 \\ 0, & if \quad \mu_1 \leq Y^* < \mu_2 \\ 1, & if \quad Y^* > \mu_2 \end{cases} \tag{3}$$

Therefore, the probabilities of each state of Y is given by Eq. (4), where Φ represents the cumulative distribution function of the Normal distribution.

$$P(Y|X) = \begin{cases} -1, & = \Phi\left(\mu_1 - X'\beta\right) \\ 0, & = \Phi\left(\mu_2 - X'\beta\right) - \Phi\left(\mu_1 - X'\beta\right) \\ 1, & = 1 - \Phi\left(\mu_2 - X'\beta\right) \end{cases} \tag{4}$$

The econometric model's dependent variable (Y) is the type of movement along the MPI's distribution the municipality presents, i.e. descending, ascending or stable. The independent variables (X) consist of: Dropout Rate for the last year of both Elementary School and High School, the dimensions of Longevity and Education from the Human Development Index for municipalities,[6] Child Mortality Rate, Homicide Rate, Urban density and Total density Ratio in the Municipality, Gross Value Added (GVA) for Agriculture, Industry and Services, Entrepreneur Rate, Gini's Index, and an index for economic concentration on service activities, named Service Concentration Index.

The Ordered Probit is estimated using data from 2000. The estimated coefficients are then used to predict the probabilities of each municipality to show an ascending or a descending movement, or immobility. This prediction is forecast for both years (2000 and 2010). This procedure allows analyzing the influence of the selected attributes on the mobility of the municipality along the MPI's distribution and, therefore, to determine the situation of vulnerability to poverty in both years.

3.4. Data sources

The chosen variables to be used in this paper are from Brazil's 2000 and 2010 Demographic Census, School Census, Educational Indexes, Mortality Information System, Annual Relation of Social Information, Ipeadata and from Human Development Atlas for Brazil 2013. The Demographic Census, elaborated by the Brazilian Institute of Geography and Statistics (IBGE), is a decennial national household survey aimed at building a portrait of the Brazilian population by presenting its socioeconomic characteristics, as well as its size and its distribution (Instituto Brasileiro de Geografia e Estatística, 2010).

The School Census by the Anísio Teixeira National Institute of Educational Studies and Research (INEP) is an annual survey that gathers educational-statistic information from all national basic education systems. The Educational

[5] The marginal effects here are obtained through the average marginal effects of all observations in the dataset.

[6] More details at http://www.atlasbrasil.org.br/2013/.

Table 1
Variables list.

Dependent variable	Indicator of municipality transition in the MPI's distribution between 2000 and 2010 (values −1, 0 and 1)	Elaborated by the authors
Variable ancillary to the elaboration of the dependent variable	Multidimensional Poverty Index	Elaborated by the authors from Demographic Census
Independent variables	Dropout rate – Elementary School 8th and 9th grades (last year)	Data from School Census
	Dropout rate – High School 3rd and 4th grades (last year)	Data from School Census
	HDI-M education	Data from Human Development Atlas for Brazil
	HDI-M longevity	Data from Human Development Atlas for Brazil
	Child mortality rate	Data from DATASUS
	Homicide rate	Elaborated by the authors from DATASUS and Demographic Census
	Urban and total density ratio	Elaborated from the Demographic Census
	Population logarithm	Data from the Demographic Census
	Gross value added per capita by sector (agriculture, industry and services)	Data from IBGE
	Service Concentration Index	Elaborated by the authors from IBGE's data
	Gini's Index	Data from Human Development Atlas for Brazil
	Entrepreneurship rate	Elaborated by the authors from IBGE's data
	Brazilian region	Data from IBGE
	MPI's distribution decile	Elaborated by the authors

Indexes, elaborated also by INEP, are a synthesis of some selected indexes generated from the School Census' data. Ipeadata is a query tool maintained by the Institute of Applied Economic Research (IPEA) that concentrates in one site primary and secondary data and historical series on national, provincial and local level. The Mortality Information System (SIM), by the Informatics Department of Health Unique System (DATASUS), gathers periodically information about mortality of the entire country. Last, but not least, the Human Development Atlas for Brazil 2013 (ADHB-2013) is a consultation platform of information about the 5565 Brazilian municipalities, having more than 180 indexes related to population, education, housing, health, labor, income and vulnerability, with data from Demographic Census of years 1991, 2000 and 2010.

3.4.1. Variables

From the aforementioned databases, the selected variables are listed in Table 1 herein below:

3.5. Multidimensional Poverty Index

The three MPI dimensions, based on the Capabilities Approach and listed in Table 2, are the following: Housing Conditions, Education, and Labor Market Participation. Following MPI calculation (through Demographic Census' data from years 2000 and 2010 for every single Brazilian municipality), categories of poverty are created for purposes of comparisons in the analysis of their vulnerability. These categories are the position of the municipality in the MPI distribution deciles, which makes possible to classify the municipality – in the 10% of the worst MPI performance or in the best-performing 10%.

Table 2
Multidimensional Poverty Index's dimensions.

1st DIMENSION Housing conditions	■ *Inadequate Sanitation Services or Sewerage System* 1 = septic tank not connected to the sewerage or storm drain systems; rudimentary pit; ditch; direct disposal into a river, lake, sea or other body of water; 0 = sewerage or storm drain system; septic tank connected to the sewerage or storm drain system ■ *Non-attendance of Water General Distribution Network* 1 = well, spring or other; 0 = general distribution network ■ *Absence of Direct Household Waste Collection* 1 = indirect collection; burning; burying on property; disposal in empty lots or public areas; dumping into rivers, lake, seas and others areas; 0 = direct collection ■ *Insufficiency of Assets* 1 = none or only one of the following assets in the household: radio, color television set, one or two-door refrigerator; 0 = at least two such assets ■ *Overcrowding* 1 = three or more people per bedroom; 0 = one or two persons per bedroom
2nd DIMENSION Education	■ *Functional Illiteracy* 1 = one or more persons aged 14 or over have no more than 3 years of schooling; 0 = no one in the household aged 14 or over has only 3 years of schooling or less ■ *School Absence* 1 = one or more members of the household between ages of 6 and 18 do not attend school; 0 = no one in the household between the ages of 6 and 18 does not attend school
3rd DIMENSION Labor market	■ *Child Labor* 1 = one or more members of the household between the ages of 5 and 17 is working; 0 = no one in that age group is working ■ *Unemployed Adults* 1 = one or more members of the household are classified as: aged 18 or older and unemployed; unemployed not attending school and not receiving income of any sort; or under 18 years of age and employed; 0 = no one in any of the above categories

4. Results

4.1. Multivariate analysis and descriptive statistics

4.1.1. Principal components analysis

PCA was adopted to generate MPI from the sub-dimensions *Inadequate Sanitation Services or Sewerage System*, *Non-attendance of Water General Distribution Network*, *Absence of Direct Household Waste Collection*, *Insufficiency of Assets*, *Overcrowding*, *Functional Illiteracy*, *School Attendance*, *Child Labor* and *Unemployed Adults*. For the sake of comparing MPI evolution from 2000 through 2010, one single PCA is applied linking these two time periods. Using the Kaiser's Normalization Criterion, the first two principal components were chosen because these were the ones with eigenvalue higher than 1. As shown in Table 3, the first component presents 47.2% of the original data's variability and the second component takes a 13.4% share, totaling 60.6% altogether.

The weights of each variable in each principal component, considering the respective eigenvalues, are reported in Table 4. As can be seen by the combination of the variables weights in both components, the overall effect of these sub-dimensions in the MPI is always positive. If we take as an example the sub-dimension *Unemployed Adults*, its Component 2 weight is negative. However, combining its effects in Components 1 and 2 – 0.1331 and −0.0791, respectively – leads to an overall effect in MPI of 0.0540. This procedure generates the IPM values to each municipality in years 2000 and 2010.

Table 3
Variability of the principal components.

Component	Eigenvalue	Variability%	Accumulated variability%
Component 1	4.25	47.24	47.24
Component 2	1.21	13.39	60.63

Table 4
Sub-dimensions' contribution to the MPI.

Variables	Component 1	Component 2	IPM
Inadequate Sanitation Services or Sewerage System	0.1184	0.0471	0.1655
Non-attendance of Water General Distribution Network	0.1038	0.0431	0.1468
Absence of Direct Household Waste Collection	0.1753	0.0184	0.1937
Insufficiency of assets	0.2031	0.0076	0.2107
Overcrowding	0.1909	−0.0283	0.1627
Functional illiteracy	0.1818	−0.0166	0.1651
School absence	0.1736	−0.0179	0.1557
Child labor	0.0951	0.0762	0.1713
Unemployed adults	0.1331	−0.0791	0.0540

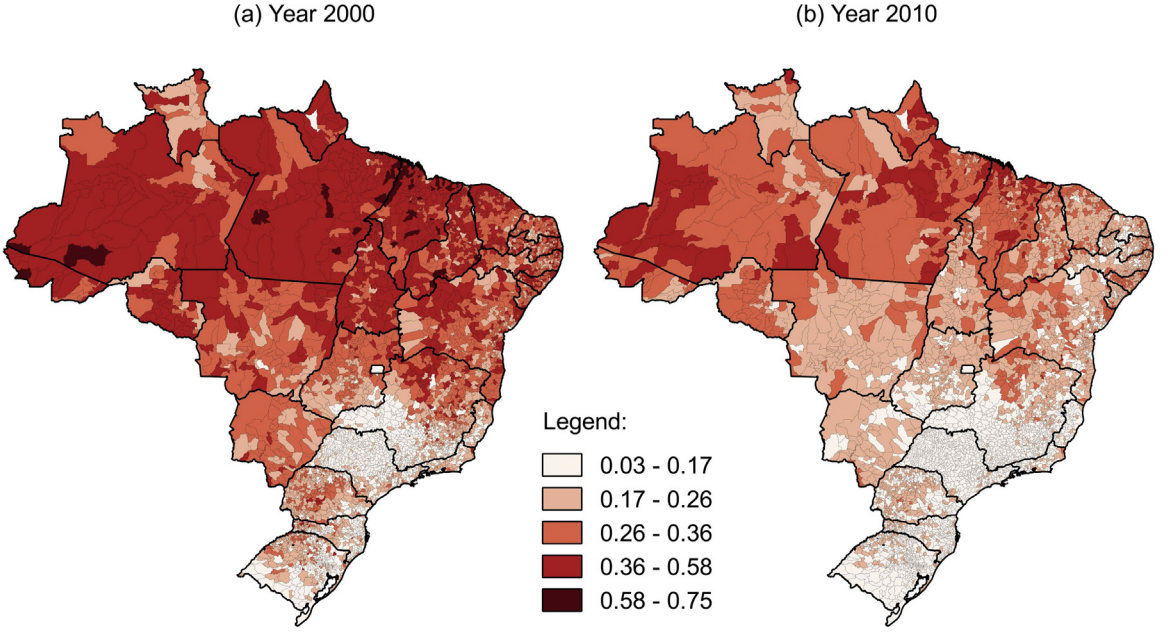

Fig. 1. MPI in 2000-10.

4.1.2. Multidimensional Poverty Index

In general, it can be noticed in Table 5 that there was a general improvement in all MPI's sub-dimensions as the observed means in year 2000 are inferior to those in 2010. Comparing the standard deviations of these sub-dimensions draws attention, except for *Unemployed Adults* and *Child Labor*, and their means, indicating the presence of outliers and the existence of an expressive heterogeneity. The maximum values of the sub-dimensions *Insufficiency of Assets*, *Overcrowding*, *Functional Illiteracy*, *School Absence*, *Child Labor* and *Unemployed Adults* were reduced from year 2000 to 2010. However, despite this improvement trend, the highest values of each sub-dimension remain still concentrated in the country's Northern and Northeastern regions.

The break values in Fig. 1 were defined according to the MPI's distribution in year 2000. The first one features 25% of the index's ordered values, while the second lies in-between the first and second distribution quartile. The third

Table 5
Descriptive statistics of the poverty sub-dimensions and of the MPI in 2000–10.

Variables	Number of observations		Minimum		Maximum		Median		Mean		Standard deviation	
	2000	2010	2000	2010	2000	2010	2000	2010	2000	2010	2000	2010
Inadequate sanitation services or sewerage system (%)	5,506	5,506	0.00	0.00	100.00	100.00	56.11	44.59	54.26	47.71	36.57	35.64
Non-attendance of water general distribution network (%)	5,506	5,506	0.00	0.00	100.00	100.00	6.46	3.57	15.54	9.57	22.63	15.99
Absence of direct household waste collection (%)	5,506	5,506	0.00	0.00	100.00	100.00	9.81	1.98	20.31	5.96	24.90	11.02
Insufficiency of assets (%)	5,506	5,506	0.00	0.00	82.84	49.44	10.59	3.23	13.37	4.58	11.59	4.33
Overcrowding (%)	5,506	5,506	0.00	0.00	92.79	74.91	34.63	21.75	35.60	23.35	13.85	11.50
Functional Illiteracy (%)	5,506	5,506	3.25	6.96	100.00	82.19	58.64	50.28	58.46	49.99	16.53	10.41
School absence (%)	5,506	5,506	0.00	0.00	61.39	31.40	14.58	9.02	15.22	9.34	6.28	3.40
Child labor (%)	5,506	5,506	0.00	0.00	59.31	26.35	4.91	3.13	5.84	3.62	4.55	2.36
Unemployed Adult (%)	5,506	5,506	0.00	0.00	92.56	73.29	42.88	36.84	42.88	36.50	10.71	9.51
IPM	5,506	5,506	0.05	0.03	0.75	0.51	0.26	0.19	0.28	0.19	0.12	0.08

Source: Demographic Census 2000 and 2010.
Note: the number of observation is inferior to the number of existing municipalities in 2000 by one. Nova Ramada (a RS municipality) has all its households in rural area in the Demographic Census 2000, so it was removed from the data for both years, 2000 and 2010, as it would not be possible to make any kind of comparisons for this municipality between these two years.

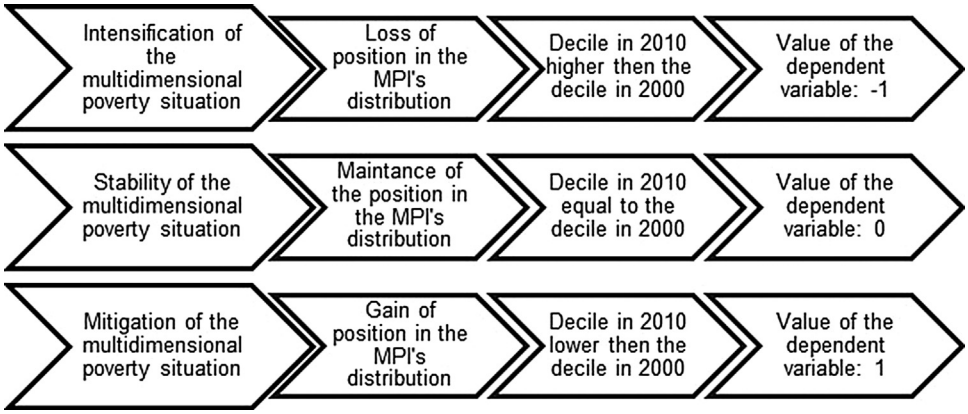

Fig. 2. Elaboration of dependent variable.

interval is the range between the second and third quartile. The fourth break value is the 99th percentile, remaining the last 1% of the MPI's values to be inserted in the last interval. As said before, the MPI was constructed by the sub-dimensions shown in Table 5 herein and normalized to assume values from 0 to 1. Hence, the closer to 0, the less intense municipal poverty is; and the closer to 1, the deprivation situation gets deeper. Consequently, lower-value municipalities are situated in the initial percentiles and the ones with higher values are in the last percentiles.

The MPI mean drops from 0.28 in 2000 to 0.19 in 2010. When analyzing the municipalities with values between 0.36 and 0.58, it is observed that they are concentrated in the regions North and Northeast. In 2010, the municipalities categorized in the fourth interval are all in Northern or Northeastern Brazil. Clusters of municipalities with MPI's values between 0.26 and 0.36, classified between the second and third quartile, changed their location in the period 2000–10 – moving from Northeastern and Midwestern Brazil to the North of the country.

Municipalities in the second interval, from 0.17 to 0.26, were located in year 2000 mostly in the Southern and Southeastern regions of Brazil. In 2010, however, the presence of municipalities with MPI values in this interval became more homogeneous in the regions Midwest and Northeast.

The municipalities with the lowest indicator values in 2000, belonging to the first break, were concentrated almost exclusively in the province of São Paulo. In 2010, the presence of municipalities with MPI values in the first range expands to other regions, mostly in the Southern portion of the country.

Therefore, it appears that there was an across-the-board multidimensional deprivation relief from 2000 through 2010. This is due to the improvement of the overall national framework in all sub-dimensions used for MPI construction. However, multidimensional poverty is to this day a typical problem in the country's North, Northeast and Midwest, while Southern and Southeastern Brazil remain the lowest-incidence regions.

Following MPI calculation and having obtained each municipality's deciles (as described herein above, in Methodology), the next step was elaborating the model's dependent variable representing the transition of the municipalities along the MPI's distribution between the years 2000 and 2010. As the initial position in the distribution represents a better multidimensional poverty situation in the municipality, the descending movement is defined as the loss of one better position in 2000 through 2010, while the ascending movement is the gain of one position closer to the beginning of the distribution. So, as can be seen in Fig. 2, the dependent variable has a value equal to −1 if the municipality in 2010 was found in a worse position than in 2000 – i.e., a higher decile in 2010 than in 2000 –, value equal to zero if the decile in 2010 is the same decile as in 2000 (stability) and value equal to 1 if the position in 2010 is better than in 2000, meaning the 2010 decil is lower than in 2000.

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The result of the municipalities' transition along the MPI's distribution in 2000–10 is displayed at Table 6.

Among the municipalities in the first decile of the MPI's distribution in 2000, 66% remained in the same position in 2010. The proportion of municipalities with stable position along the distribution in the same time period shows a downward trend down to the fifth decile, reaching 29.5% of the municipalities. After the seventh decile, the proportion increases until the last decil, from 23.1% to 66.4%. This elevated percentage of municipalities maintaining their position through the period analyzed in the first and in the last deciles is in line with expectations. The more intense the poverty, the harder it is to overcome it; to wit, 66.4% and 37.2% of the municipalities in the last and in the ninth decile, respectively, in year 2000 continued in the same decile in year 2010. Similarly, the less intense the poverty, the easier it is to remain in this situation, which can explain the fact that 66.1% of the municipalities that were in the first decil and 42.8% in the last, in year 2000, kept their position in year 2010.

It is also noteworthy that most municipalities with some movement in the MPI's distribution over 2000–10, either loss or gain, were limited to transitions from one position only, up or down. For example, among municipalities in the fourth decile in 2000, 22.2% moved up one position in 2010 and 23.1% lost one position. It can be noticed, as well, that the lower the decil being analyzed, the greater the percentage of municipalities losing positions to lower deciles. Among the municipalities in the second decile in year 2000, the highest decile reached in 2010 was the seventh, 0.54% of the municipalities. For the fifth decile in 2000, the percentage of municipalities reaching the seventh decil in 2010 is 12.7%, while the highest attained was the ninth, with 1.1% of the municipalities. When analyzing the upward transitions, the reasoning is analogous and inverse, except for the last decile in 2000, which has 0.2% of the municipalities reaching the first decile in 2010.

Among the five Brazilian regions, as can be seen in Table 7, the South was the one with the highest percentage of worsening distribution (44.7% of its municipalities). The Southeast was the region with the highest percentage of municipalities maintaining their positions throughout 2000-10, with 44.4%, while the Northeast had the country's greatest percentage of municipalities ascending in the MPI's distribution (32.8%).

A possible explanation for this result in the Southern region is the evolution of all MPI's sub-dimensions in other Brazilian regions. Although the Southern municipalities presented intermediate values in 2000, their improvement observed in year 2010 was less pronounced in comparison to the progress in the municipalities of other states with higher values for their sub-dimensions. Meanwhile, the Southeastern region was already marked, in 2000, by the presence of lower values for all its sub-dimensions. This continued in 2010, so that the other municipalities were not able to achieve similar values. As the Northeastern counties were among those with higher values for the IPM in 2000, the general improvement, expressive in many cases, in the sub-dimensions has enabled these municipalities to gain distribution positions.

4.2. Estimation results

Table 8 shows the coefficients of each independent variable obtained in the estimation of the econometric model defined in the methodology section herein above, as well as the marginal effects in the three categories of the dependent variable (descending movement, immobility and ascending movement). Even if the coefficient signal may convey a general idea about the influence of the variable on the model, the analysis of marginal effects provides a more complete interpretation of its impact. Thus, this paper will focus on the marginal effects. It is worth remembering that the estimation of the coefficients refers to the values of the independent variables in the year 2000.

The variables D*ropout Rate of Grades 8-9 of Elementary School, Dropout Rate of Grades 3–4 of High School* and *HDI-M Education* have marginal effects meeting the hypotheses that education enhances the ability of dealing with vulnerability situations. However, only the coefficients of the two last variables are statistically significant in the estimation. The results of the dropout rates indicate that the last year of High School (senior year) is able to empower individuals for social and professional needs in their adult life more efficiently than Elementary School's senior year can. The increase of 1 percentage point (p.p.) in the *Dropout Rate of Grades 3–4 of High School* elevates the municipality's probability of descending in the distribution of the MPI by 0.07p.p. This same increase, on the other hand, reduces the likelihood of stability or ascending by 0.01p.p. and 0.06p.p., respectively.

The 0.001 increase in *HDI-M Education* – this variable measures adult population schooling and youngsters' study flow – decreases the likelihood of the municipality descending in the MPI's distribution by 0.018p.p. Reversely, this

Table 6
Transition matrix of the municipalities in the MPI's distribution in 2000–10.

MPI's decile in 2000	MPI's decile in 2010										
	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	Total
1°	364	137	30	16	4	0	0	0	0	0	551
	(66.06)	(24.86)	(5.45)	(2.90)	(0.73)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(10.01)
2°	126	236	139	31	11	5	3	0	0	0	551
	(22.87)	(42.83)	(25.27)	(5.63)	(2.00)	(0.91)	(0.54)	(0.00)	(0.00)	(0.00)	(10.01)
3°	35	126	202	135	34	12	5	1	0	0	550
	(6.35)	(22.87)	(36.73)	(24.50)	(6.18)	(2.18)	(0.91)	(0.18)	(0.00)	(0.00)	(9.99)
4°	13	35	122	171	127	56	19	6	2	0	551
	(2.36)	(6.35)	(22.18)	(31.03)	(23.09)	(10.16)	(3.45)	(1.09)	(0.36)	(0.00)	(10.01)
5°	6	8	37	113	162	122	70	26	6	0	550
	(1.09)	(1.45)	(6.73)	(20.51)	(29.45)	(22.14)	(12.70)	(4.73)	(1.09)	(0.00)	(9.99)
6°	4	6	9	48	114	165	141	54	8	2	551
	(0.73)	(1.09)	(1.64)	(8.71)	(20.73)	(29.95)	(25.59)	(9.82)	(1.45)	(0.36)	(10.01)
7°	2	3	4	26	55	102	127	164	58	10	551
	(0.36)	(0.54)	(0.73)	(4.72)	(10.00)	(18.51)	(23.05)	(29.82)	(10.53)	(1.82)	(10.01)
8°	0	0	1	5	27	49	119	150	163	36	550
	(0.00)	(0.00)	(0.18)	(0.91)	(4.91)	(8.89)	(21.60)	(27.27)	(29.58)	(6.55)	(9.99)
9°	0	0	4	4	14	32	51	104	205	137	551
	(0.00)	(0.00)	(0.73)	(0.73)	(2.55)	(5.81)	(9.26)	(18.91)	(37.21)	(24.91)	(10.01)
10°	1	0	2	2	2	8	16	45	109	365	550
	(0.18)	(0.00)	(0.36)	(0.36)	(0.36)	(1.45)	(2.90)	(8.18)	(19.78)	(66.36)	(9.99)
Total	551	551	550	551	550	551	551	550	551	550	5.506
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Note: the values in parenthesis are in percentage.

Table 7
Municipality transition along the MPI's distribution (2000–2010).

Movement	REGION					
	North	Northeast	Southeast	South	Midwest	Total
Descending	136 (30.29)	499 (27.92)	434 (26.05)	517 (44.65)	184 (41.26)	1770 (32.15)
Immobility	191 (42.54)	702 (39.28)	740 (44.42)	372 (32.12)	142 (31.84)	2147 (38.99)
Ascending	122 (27.17)	586 (32.80)	492 (29.53)	269 (23.23)	120 (26.91)	1589 (28.86)
Total	449(100.00)	1787(100.00)	1666(100.00)	1,158(100.00)	446(100.00)	5506(100.00)

Note: the values in parentheses are percentage.

Table 8
Coefficients and marginal effects of the independent variables.

Variables	Coefficients	Marginal effects in the categories		
		Lost position	Stability	Gained position
Dropout rate of Grades 8–9 of Elementary School	−0.0003(0.0010)	0.0001 (0.0004)	−7.47E-06(2.97E-05)	−0.0001(0.0003)
Dropout rate of Grades 3–4 of High School**	−0.0020(0.0009)	0.0007 (0.0003)	−0.0001 (2.95E-05)	−0.0006(0.0003)
HDI-M Education*	0.5312 (0.3074)	−0.1836 (0.1062)	0.0154 (0.0093)	0.1682 (0.0973)
HDI-M Longevity**	1.1968 (0.5388)	−0.4137 (0.1861)	0.0347 (0.0169)	0.3790 (0.1705)
Child mortality rate	0.0007 (0.0006)	−0.0002 (0.0002)	1.99E-05 (1.89E-05)	0.0002 (0.0002)
Homicide rate	0.0010 (0.0011)	−0.0004 (0.0004)	2.98E-05 (3.21E-05)	0.0003 (0.0003)
Urban and total density ratio	0.0001 (0.0011)	−4.28E-05(0.0004)	3.59E-06 (3.31E-05)	3.92E-05(0.0004)
Population Logarithm***	−0.0848(0.0202)	0.0293 (0.0069)	−0.0025 (0.0007)	−0.0269(0.0064)
Agriculture's GVA *per capita*	−0.0140(0.0161)	0.0049 (0.0056)	−0.0004 (0.0005)	-0.0044 (0.0051)
Industry's GVA *per capita**	0.0140 (0.0074)	−0.0048 (0.0026)	0.0004 (0.0002)	0.0044 (0.0023)
Services' GVA *per capita*	−0.0007(0.0134)	0.0002 (0.0046)	−1.92E-05 (0.0004)	−0.0002(0.0042)
Service Concentration Index*	1.5855 (0.9514)	−0.5481 (0.3287)	0.0460 (0.0288)	0.5021 (0.3012)
Gini's Index	0.1340 (0.2797)	−0.0463 (0.0967)	0.0039 (0.0081)	0.0424 (0.0886)
Entrepreneur rate**	0.0091 (0.0037)	−0.0031 (0.0013)	0.0003 (0.0001)	0.0029 (0.0012)
Region				
Northeast***	0.5250 (0.0756)	−0.1928 (0.0278)	0.0494 (0.0112)	0.1433 (0.0190)
Southeast***	0.7779 (0.0848)	−0.2732 (0.0299)	0.0427 (0.0113)	0.2305 (0.0212)
South**	0.2195 (0.0931)	−0.0830 (0.0350)	0.0301 (0.0134)	0.0529 (0.0217)
Midwest**	0.2379 (0.0930)	−0.0899 (0.0349)	0.0321 (0.0130)	0.0578 (0.0224)
Decile in 2000				
2***	0.3521 (0.0717)	−0.1318 (0.0264)	0.0607 (0.0128)	0.0711 (0.0145)
3***	0.5551 (0.0750)	−0.2073 (0.0270)	0.0831 (0.0125)	0.1242 (0.0166)
4***	0.5967 (0.0796)	−0.2224 (0.0283)	0.0863 (0.0129)	0.1361 (0.0175)
5***	0.6917 (0.0872)	−0.2561 (0.0303)	0.0915 (0.0131)	0.1647 (0.0197)
6***	0.8499 (0.0927)	−0.3096 (0.0311)	0.0938 (0.0127)	0.2158 (0.0222)
7***	0.7884 (0.0988)	−0.2893 (0.0335)	0.0939 (0.0129)	0.1954 (0.0236)
8***	1.0217 (0.1061)	−0.3629 (0.0336)	0.0874 (0.0124)	0.2756 (0.0274)
9***	1.1841 (0.1100)	−0.4081 (0.0329)	0.0730 (0.0128)	0.3351 (0.0293)
10***	1.6700 (0.1212)	−0.5094 (0.0297)	−0.0073 (0.0166)	0.5167 (0.0319)
μ_1	1.1983			
μ_2	2.2837			
Number of observations	4,797			
Log likelihood	−5023.0147			
LR chi^2 (27)	395.81			
Prob > chi^2	0.0000			

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%; standard deviations in parenthesis.

same increase causes a rise in the probability of both immobility and ascension by 0.002p.p. and 0.017p.p., respectively. The better results of the variables *Dropout Rate of Grades 3–4 of High School* and *HDI-M Education* are consequences of quality improvement in municipal education. Such results reflect in a High School able to keep more students in school, in a decrease in the grade-age distortion of the educational system and a rise in adult population schooling. Thus, these variables directly affect the sub-dimensions *Functional Illiteracy*, *School Absence* and *Child Labor*.

A more developed human capital, on one hand, deepens the demand for an efficient government performance. This could strengthen outcries for better public services supply, represented in the sub-dimensions *Inadequate Sanitation Services or Sewerage System*, *Non-attendance of Water General Distribution Network* and *Absence of Direct Household Waste Collection*. On the other hand, it has a positive influence on citizenry productivity and their insertion capacity into the labor market, affecting indirectly the sub-dimensions *Unemployed Adults*, *Insufficiency of Assets* and *Overcrowding*, the latter two *via* labor income. Therefore, these results show that education has a positive effect in preventing the deepening of deprivation in these sub-dimensions and, consequently, it reflects in the decline of municipal vulnerability to poverty.

HDI-M Longevity presented a statistically significant coefficient and marginal effects, as expected. The 0.001 rise in this variable causes a 0.041p.p decrease in the probability of the municipality losing position along the MPI's distribution, a 0.035p.p elevation in the likelihood of stability and an increase by 0.038p.p. in the probability of the municipality presenting a better distribution position in future years. These results could be attributed to the ratio between residents' life expectancy at birth and their later physical and mental health conditions. The growth of the former indicates better conditions of the latter, reflecting in the population's ability to use its physical and human resources in a productive manner. This could be directly related to labor income and to labor market inclusion, since better physical and mental health conditions lead to greater productivity. Therefore, municipalities with higher *HDI-M Longevity* values would be able to avoid intensification of deprivations in the sub-dimensions *Unemployed Adults*, *Insufficiency of Assets* and *Overcrowding* and, hence, future MPI reductions.

The coefficients of the variables *Child Mortality Rate*, *Homicide Rate* and *Urban and Total Density Ratio* were not statistically significant. Unlike these variables, *Population logarithm* had a statistically significant coefficient in the estimation. Its one-unit rise causes an increase of 2.93p.p. in the probability of a municipal descending movement in MPI distribution, while its seesaw effects on the likelihood of immobility decreases by 0.25p.p. As for the ascending movement, a one-unit rise in this variable drops the probability by 2.69p.p. Hence, the larger its population, the more vulnerable is a municipality. The results found in *Population logarithm* could relate to a larger number of municipal residents, to greater demand for resources, for basic public services and economic opportunities that would enable its citizens to mitigate their dire-straights poverty. This greater demand, then, is harder to be met if compared to demands in lesser-populated municipalities.

Among all Gross Value Added *per capita* broken down by economy sectors, only the Industry coefficient was statistically significant. Its R$1.00 rise would reduce the likelihood of the municipality descending in the MPI's distribution by 0.48p.p., while the probability of immobility increases by 0.04p.p and the probability of an upward movement rises by 0.44p.p. The positive contribution of Industrial Gross Value Added *per capita* in reducing vulnerability to poverty could be linked to the fact that, in the analyzed period, there was an intensification of industrial activity in the whole country, sparking expressive job creation increase and triggering growth of municipal income *per capita*. As a result, the mitigation of the sub-dimensions *Unemployed Adult*, *Insufficiency of Assets* and *Overcrowding* may have been more intense in municipalities wherein Industry ruled the day as the chief local economic activity. Production increase in such counties may also have led to higher tax collection, broadening the availability of resources to fund the expansion of basic public services.

The *Service Concentration Index* coefficient was statistically significant and its effect on poverty dynamics was aligned with expectations. Recalling that this index's range is from 0 to 1, the analysis considers the variation in thousandths, to make it easier. A 0.001 increase in this variable reduces the likelihood of losing position in the MPI's distribution by 0.055p.p. As regards immobility and the ascending movement, probability elevations are in the order of 0.005p.p. and 0.05p.p., respectively. Greater polarization capacity implies that the municipality's economy is more dynamic and that the county concentrates services more complex to its productive activities, like financial services. This conjunction of factors offers the local population a wider range of possible economic activities, resulting in the same positive effects already mentioned regarding income (vide MPI's sub-dimensions).

The Gini's Index did not have statistically significant coefficients in the estimation. However, the *Entrepreneur Rate* coefficient was statistically significant and aligned with expectations. A 1p.p. rise in municipal entrepreneurship

Table 9
Vulnerable municipalities in 2000, by region.

Vulnerable	REGION					Total
	North	Northeast	Southeast	South	Midwest	
No	238 (61.03)	1207 (89.87)	1351 (84.38)	373 (36.39)	287 (65.53)	3.56 (72.05)
Yes	152 (38.97)	136 (10.13)	250 (15.62)	652 (63.61)	151 (34.47)	1341 (27.95)
Total	390(100.00)	1343(100.00)	1601(100.00)	1025(100.00)	438(100.00)	4797(100.00)

Note: the values in parenthesis are in percentage.

percentage would reduce the probability of losing position in the MPI's distribution by 0.31p.p., while the likelihood of immobility would increase by 0.03p.p. and the probability of ascending would rise by 0.29p.p. Entrepreneurship, in addition to being a source of extra income to the individual, also creates jobs nearby. Thus, the higher the number of entrepreneurs in the municipality, the higher municipal entrepreneurship soars, begetting more job opportunities and income sources in the municipality. The effects of changing this variable on the MPI are the same already discussed in this section, regarding income.

Coefficients of control variables *Region* and *Decile in 2000* were all statistically significant. Using Northern Brazil for comparative purposes, the fact that a municipality is located in the Northeast decreases the probability of it losing position by 19.28p.p. Southeastern municipalities would see a 27.32p.p reduction. Reduction in the Brazilian South and Midwest would be 8.30p.p. and 8.99p.p., respectively. Analyzing the marginal effect of regions in the likelihood of immobility, the probability increase is 4.94p.p. for municipalities in the Northeast, 4.27p.p. in the Southeast, 3.01 in the South and 3.21p.p. in the Midwest – all compared to Brazil's Northern Region, and the marginal effect for the upward movement is 14.33p.p., 23.05p.p., 5.29p.p., and 5,78p.p., respectively. These results indicate that regions have intrinsic characteristics not covered in the estimated model, like institutional relations, which directly interfere in the poverty dynamics of their municipalities.

The signs of marginal effects of the variable *Decile in 2000* went against the expected result. Taking the first decile as reference, it can be noticed that the closer to the beginning of the MPI's distribution, with the exception of the seventh decile, the greater the likelihood of the municipality moving upwards. That is, the less intense the poverty in the municipality, the higher its vulnerability. Municipalities in-between the fifth and the seventh decile are more likely to be in immobility than the other categories of movement. Municipalities at the book-end positions in the distribution are more likely to have ascending movements rather than lie in immobility and to be in descending movement. That is, the less intense the poverty in the municipality, the lower its vulnerability. These results could be justified by the MPI improvement from year 2000 through 2010 – more expressive in those municipalities located in the final distribution positions (see Fig. 1 herein). Furthermore, progress in the MPI of municipalities at the initial distribution positions was less intense, resulting in loss of positions to those municipalities on the rise.

After coefficients were estimated, the likelihood of the Brazilian municipality in each possible category of the dependent variable was predicted. A municipality was considered vulnerable if its probability of descending movement was greater than the likelihood of immobility and of ascending movement as well. A total of 4797 municipalities had these probabilities predicted in year 2000, less than the 5506 observations in the dataset because some of them did not have information on some selected independent variables.

Table 9 shows the regional distribution of the vulnerable and non-vulnerable municipalities in year 2000, namely: 39% of municipalities in the Northern region were vulnerable in 2000, 10.1% in the Northeast, 15.6% in the Southeast, 63.6% in the South and 34.5% in the Midwest. This amounted to 28% of the cities analyzed in a state of vulnerability to poverty in 2000. Given the spatial distribution of the IPM and of the independent variables in each region, one would expect that the North and Northeast regions would have the greatest percentage of vulnerable municipalities, followed by the Midwest, South and Southeast, in that order.

However, it draws attention the high percentage of vulnerable municipalities in the South in 2000, despite less intense deprivations in the IPM's sub-dimensions. This may be due to the weight of agriculture in the local economy and to demographic concentration. Large population needs a more dynamic economy to be able to meet larger demands of basic infrastructure, education and jobs. The agriculture, in turn, is not able to foster the economy dynamism enough to meet these demands. It is worth remembering that agriculture is characterized by the absorption of low-paid low-skilled workers. Another possible explanation is the concentration of approximately 50% of the municipalities between the

Table 10
Vulnerable municipalities in 2010, by region.

Vulnerable	REGION					Total
	North	Northeast	Southeast	South	Midwest	
No	395 (88.37)	1770 (99.55)	1442 (86.66)	642 (55.63)	382 (85.65)	4631 (84.37)
Yes	52 (11.63)	8 (0.45)	222 (13.34)	512 (44.37)	64 (14.35)	858 (15.63)
Total	447(100.00)	1778(100.00)	1664(100.00)	1154(100.00)	446(100.00)	5489(100.00)

Note: the values in parenthesis are in percentage.

third and fifth decile of MPI's distribution in this year, positions more susceptible to be surpassed by counties in lower deciles.[7]

The regional distribution of vulnerable municipalities in 2010 is presented in Table 10. Due to the same reason discussed for the year 2000, the number of municipalities with their probabilities calculated is 5489, lower than the 5506 municipalities in the sample. However, even with this rise in the number of municipalities being analyzed, there was a decrease of 12.32p.p in the number of vulnerable municipalities in 2010. Comparing results in Tables 9 and 10 herein, a reduction is present in all Brazilian regions. In the North, the percentage of vulnerable municipalities fell from 39% to 11.6%. In the Northeast, the decrease was from 10.1% to 0.5%, while in the Southeast the reduction was from 15.6% to 13.3%. In the South, this drop was from 63.6% to 44.4%, while the number of vulnerable municipalities in the Midwest fell from 34.5% in 2000 to 14.4% in 2010.

Despite improved independent variables in the whole country, the features that contribute positively to increase the likelihood of the municipality descend in the MPI's distribution – *Logarithm of Population*, *GVA per capita of Agriculture* and the *GVA per capita of Services* – showed no significant changes in their spatial configuration. The high values for the first and third variables remained concentrated in the South/Southeast axis and agricultural activity remains significant in the South. On the other hand, those variables that contribute to reducing the vulnerability improved in all Brazilian regions.

Even with an improved national framework of multidimensional poverty, (see Fig. 1), there was little change in the relationship between the regions and the positions occupied by their municipalities in year 2010 MPI distribution: Northern municipalities still remained in the top deciles and Southern municipalities have kept their initial positions. Hence, there is evidence that municipality ranking in the MPI's distribution is a determining factor for their vulnerability.

Summing up the results, the variables *Dropout Rate of Grade 3–4 of High School*, *HDI-M Education*, *HDI-M Longevity*, *Logarithm of the Population*, *Gross Value Added per capita of Industry, Service Concentration Index* and *Entrepreneur Rate* contribute positively to the reduction of municipal vulnerability to poverty. The less intense is poverty in the municipality, the greater the likelihood of it losing distribution position; and the more intense are the deprivations, the lower is the vulnerability to poverty. Compared to Northern municipalities, Southeastern Brazil has reduced more significantly the likelihood of position loss and has had a greater effect of increasing the probability of its upward movement. Albeit the number of vulnerable municipalities in Brazil fell by 12,32p.p between 2000 and 2010, the Northeast continued to show the lowest number of vulnerable municipalities and the South, the largest.

5. Final remarks

Using municipality as the unit of analysis made it possible to map the regional and spatial rearrangement of a welfare index, such as the MPI. Many of its dimensions are more associated with public policies rather than with consciously-made choices of municipal residents. Moreover, the construction of the MPI in this study allowed, at first, to identify the multidimensional poverty of Brazilian municipalities, addressing important aspects not directly related to income. Data of the 2000 and 2010 Census show improvements in the framework of multidimensional poverty throughout Brazil. This is due to developments observed in all sub-dimensions used to construct the index. In our

[7] The low percentage of vulnerable municipalities in the Northeast in year 2000 despite the intense presence of high MPI values in this region may be due to the fact that the Northeastern counties were concentrated mostly in the last deciles in year 2000. Thus, they were already in the end of the distribution and could not incur any further position loss.

analysis of Brazilian municipality transition along MPI's distribution in the period 2000–10, two-thirds of them were located, in 2010, in the same deciles as in 2000. The highest percentage of municipalities in immobility was found in the initial and final distribution positions.

The descriptive statistics allow us, in a certain way, to identify socioeconomic changes that Brazil has been through between 2000 and 2010. In the economy, productive activity spread through the country, continuing the process of decentralization initiated in 1970. This increased economic dynamism as a whole, in turn, generated more business opportunities for Brazilians. As a result, municipalities that once were at the margin of economic development began to be affected by it more intensely, bringing socioeconomic changes to Brazil. However, the localities that excel in the Brazilian economy in 2010 were quite the same as in 2000. The effects of the independent variables in the likelihood of each type of movement for the municipality have contributed to identify factors that should become priorities in poverty-mitigation public policies. We have observed that factors directly related to public policies like Dropout Rate of Grade 3–4 of High School, HDI-M Education, HDI-M Longevity, Logarithm of the Population, and the private initiatives, like Gross Value Added per capita of Industry, Service Concentration Index and Entrepreneur Rate, contribute positively to the reduction of municipal vulnerability to poverty.

When analyzing the effect of the municipality's initial MPI distribution position, the conclusion is the opposite of what was expected. The estimation results show that the deeper the poverty in the municipality, the lower its vulnerability. A higher proportion of municipalities showing downward movements were located in intermediate positions, while most municipalities in an upward movement occupied late slots – which might explain this counter-expectation conclusion.

Descriptive statistics also support the conclusion that even with this improvement, the North, Northeast and, to a lesser extent, the Midwest continued to experience the deepest deprivation situation. The number of vulnerable municipalities in Brazil fell by 12,32p.p between 2000 and 2010, while the Northeast continued to show the lowest number of vulnerable municipalities and the South, the largest. The South and Southeast, however, remained with the best MPI performances. Nevertheless, the presence of intra-regional heterogeneity is also observed.

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