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HUMAN DEVELOPMENT AND LAND TENURE IN BRAZIL

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1 INTRODUCTION

The perpetuation of profound socio-economic inequalities between the countryside and the city, inscribed in the differences between their respective quality of life indicators, allows us to state that rural and urban environments still have distinct social realities, despite territorial contiguity and the rising intercommunication between these spaces. This study proposes to investigate how living conditions and human development in the rural environment might be linked to a structural characteristic of the Brazilian countryside: the high concentration of land ownership.

Starting with a literature review dedicated to this approach—whose starting point is the seminal article by José Gomes da Silva (1980), *Terra e Qualidade de Vida* (*Land and Quality of Life*)—this paper aims to present statistical evidence that allows for the estimation of how patently unequal land tenure structures can be linked to relatively low living conditions.

To this end, on the one hand, social indicators were selected such as mortality rates for one- and five-year-old infants, illiteracy rates, the expectation of years of schooling for the current generation of children and teenagers, and the Human Development Index (HDI), estimated for municipalities and micro-regions. On the other hand, the Land Gini Index was selected as a land tenure and ownership indicator, calculated for the same land units. Another indicator used in the analysis was the proportion of the rural population relative to the total population of the municipalities and micro-regions. This indicator played a dual role in the methodology: at times being a variable in correlations, and at others serving as a limiting criterion for the universe of analysis. Further detail about these processes can be found in the methodology section.

The statistical results found in this study offer a perspective of the relationship between the land tenure structure—that is, of primary assets—and relevant aspects of the social living conditions of the population, especially in rural areas. If, to a certain extent, some quality of life indicators are often cited, along with inequality, as signs of Brazilian underdevelopment, the task undertaken by this paper was to show that such signs are strongly linked to a long-lasting and practically untouched historical inequality that permeates Brazilian reality: the concentration of land ownership.

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2 LAND AND QUALITY OF LIFE

In an article published in 1980, entitled Land and Quality of Life, in a bulletin of the Brazilian Association of Agrarian Reform (*Associação Brasileira de Reforma Agrária*—ABRA), José Gomes da Silva sought to gather empirical evidence that would enable the estimation of the impact of land ownership on the well-being of rural producers and workers. He mentioned a study by Schattan and Vassimon (1968), which, focusing on the municipality of Tietê in the Brazilian state of São Paulo, highlighted a significant improvement in the quality of life of residents of rural areas who were small landowners (or 'ranchers'), compared to temporary workers (daily workers or monthly workers) or partners. Among the ranchers, the best indicators were of health, education (literacy), domestic comfort and food and nutrition security. To this last indicator—especially important in a social context whereby hunger and malnutrition were much more serious and wide-ranging problems than in current times—the author attributed particular relevance, noting that the beneficial effects that a more egalitarian agrarian structure could have on the food and nutrition security of the most vulnerable portions of the population were already recognised by the government authorities of the time, which were "habitually averse to this type of concern" (da Silva 1980). Da Silva cited a declaration by the president of the National Institute of Food and Nutrition at the time,[4] stating that the majority of the problems related to poverty, food and nutrition in the countryside could be solved through more objective intervention into the land tenure structure, together with feeding programmes and policies for better income distribution.

In the same ABRA publication that contained da Silva's article, a study by Cesar Victora and Nelson Blank (1980) offers a first, more analytical perspective of the correlation between child mortality and land tenure structure in the Brazilian state of Rio Grande do Sul. The object of this study, which can claim to have pioneered a whole line of work that relies on similar technical and methodological approaches, would later be revisited and expanded by Victora and Vaughan (1987). This particular study investigates the relationship between child mortality and malnutrition, and the patterns of land ownership in Rio Grande do Sul.

The starting point for the authors was the realisation that, although the state displayed the lowest coefficients of child mortality in the country at the end of the 1970s—40 deaths per 1,000 live births—these rates were very heterogeneous within the state, reaching as low as 20 per 1,000 in the north and rising to as many as 70 per 1,000 in the south. Given the coincidence between the geographical distribution of these indicators and distinct patterns of land occupation, with a predominance of small family properties in the northern part of the state and large commercial agricultural establishments (usually cattle breeding) in the south,[5] a hypothesis was raised that child mortality could be lower in areas of small family properties due to the better nutritional status of children, and that the variations between the north and south of the state could be associated with the distinct models of access to land and agricultural production predominant in those regions.

Three types of evidence corroborate this hypothesis. The first is known as occupational evidence. Considering the percentage of deceased children according to the employment situation of their father, estimated from the 1950 demographic census for the state of Rio Grande do Sul, the authors point out that, given all economic sectors, the proportion of deaths among the children of employees was always far higher than among the children of employers, with the proportion of deaths among children of independent or self-employed workers being somewhere in the middle.

However, in the agricultural sector, mortality among the children of independent workers (family farmers) was very similar to that recorded for the children of employers. These results were later compared with data from a random sample of 1 per cent of the records of the 1970 and 1980 censuses, including a larger range of demographic and socio-economic variables. Taking as reference the proportion of women between 15 and 35 years old who had lost children in the period (16.3 per cent in 1970 and 9.6 per cent in 1980), data were analysed[6] in terms of relative risk of child mortality according to the employment situation of the head of the household. It was then verified that the children of independent workers—mostly small family farmers—presented mortality rates that were significantly lower than those of the children of rural wage workers ('low-status workers') in the 1970s and 1980s, although in the latter decade the difference was less pronounced. Such evidence supports the hypothesis that there is a correlation between access to land and child mortality.

The second piece of evidence, brought by Victora and Vaughan (1987), regarding micro-regions in the state of Rio Grande do Sul, points to the strong correlation between those that presented, between 1973 and 1977, higher rates of child mortality[7] and those where higher rates of malnutrition were found.[8] The authors also found that the estimation of child mortality maintained a significant correlation with the Land Gini Index and that nutritional indicators were significantly associated with this and other agricultural variables—'percentage of land area occupied by cattle ranching', 'percentage of land area occupied by plantations' and 'percentage of wage workers'. Results showed that 'unhealthy' micro-regions were characterised by large rural properties, cattle ranching and a high proportion of wage workers (employees) among the labour force, therefore reaffirming the initial hypothesis and leading to the conclusion that patterns of access to land and agricultural production influenced the nutritional status of children in rural areas.

The third piece of evidence offered by the authors was an empirical comparison between children residing in two neighbouring micro-regions in Rio Grande do Sul: Colonial do Alto Taquari—an area typically comprising small rural properties, where the smallest coefficient of child mortality in the entire state was recorded—and Campos de Vacaria, whose landscape is marked by large properties and where high mortality rates were computed. With a statistically significant sampling scheme, the authors coordinated a survey of weights and heights of children between 12 and 35 months old who resided in those micro-regions, and found that not only did children in the rural area characterised by large properties present a far worse nutritional status than children in small properties—four times worse for height/age, 13 times worse for weight/age and three times worse for weight/height—but also that the same differentials were far smaller among children residing in the respective urban areas of the same municipalities (Victora and Vaughan 1987, 142).

All of this evidence led to the study's conclusion that the form of access to land has an influence over the determination of the mortality and malnutrition rates of children: according to the authors, there is higher mortality and prevalence of malnutrition among children who reside in "areas of large landed estates and cattle ranching, with a high proportion of salaried rural workers", than among children who reside in "areas of smallholding, with a subsistence culture and family labour" (ibid., 127).

Tackling the theme of the relationship between inequality of distribution of land ownership and human development indicators, Hoffmann (2007) states having been inspired by the aforementioned Victora and Blank (1980) study, to "analyse the relationships between child mortality and life expectancy at birth, and the characteristics of the land tenure structure in Brazilian micro-regions". Their conclusion points to the existence of a statistically very significant association between inequality in the distribution of land ownership, and child mortality rates and life expectancy at birth. Excluding from its universe of analysis the micro-regions with a population of over 500,000 people, in an effort to avoid data from metropolitan areas—where the demographic weight of rural areas is not very relevant—interfering with the results, Hoffmann (2007) selects eight variables related to the human development of Brazilian micro-regions[9] and correlates them with the Land Gini Index as measured from results of the 1995-1996 agricultural census. The correlations were weighted by the population size of each micro-region, and multiple weighted regressions were set up with the aim of understanding the variations of child mortality rates and life expectancy at birth as a function of a measure of inequality of access to land.

When commenting on the results, the author, states that it is surprising to verify a strong correlation between the inequality of the land tenure structure in each micro-region and its corresponding indicators of health, considering that these refer to the entire population of each micro-region, and not strictly to people in rural occupations or whose household is located in the countryside (Hoffmann (2006, 223).

In his conclusion, Hoffmann states that the Gini Index is an imperfect measure for determining the economic inequality of land ownership because it does not allow variations regarding quality of the soil and the location of land plots to be estimated, and he affirms that inequality in the land tenure structure in the micro-regions, as measured by the agricultural census, can be considered a "good proxy for the inequality of this structure along many decades" (ibid.) and understood as a conditioning element of the socio-economic reality of the micro-regions. This interpretation helps to explain the strong correlation found between this measure and variables that are indicative of well-being and human development regarding health, in the case of child mortality and life expectancy at birth, but also regarding education, since the study finds that the worst records of health status strongly coincide with the worst educational conditions.

Another line of study geared towards identifying the correlations between human development indicators and land tenure structure, analysing the micro-regions belonging to the same states, allows a different reading of the issue. For example, three scientific articles that follow this approach can be highlighted. Souza et al. (2004) study the extent to which patterns of land distribution can influence the degree of economic and social development of municipalities in the north and northeast of the Brazilian state of Rio de Janeiro, regions that are "clearly distinct" (ibid., 387) regarding their land ownership profiles and whose municipalities present very diverse socio-economic indicators.

The characterisation of the land tenure structure of the sets of municipalities under analysis made use of four indicators, extracted from Incra's annual statistical records from 1991 to 1998: the Gini indicator, average area, percentage of area corresponding to the 50 per cent smallest rural properties and the percentage of area corresponding to the 5 per cent largest. To describe the level of socio-economic development of municipalities, four other indicators were used,[10] of which, however, for comparison's sake, only the municipal HDI is relevant for the purposes of this article.

In short, the study points out that the HDI tends to be higher ('positively associated') where the total area corresponding to the 50 per cent smallest rural properties tends to be larger, whereas it tends to be lower ('negatively associated') where the total area corresponding to the 5 per cent largest rural properties tends to be higher. In addition, the HDI maintains a positive relationship with the average area of properties (ibid., 402). However, the linear regression presented in the text did not reveal significant values for the correlation between HDI and the Gini index; taken together with other findings—the lack of significance of the coefficients and the contradictory sense of the data in some cases[11]—this result led the authors to state that there is no conclusive evidence regarding the relationship between the land tenure structure and socio-economic development indicators. Other factors, most notably the population size and resulting political power of larger municipalities in the competition for public investment, would more effectively explain the variation of development indexes.

Two other recent studies that analyse micro-regions of the state of Rio Grande do Sul indicate other visions regarding the discussion around the relationships between land tenure structure and human development. Ottonelli et al. (2010), adopting thematic cartography as their methodology and restricting their investigation to the micro-regions of Carazinho and Frederico Westphalen, state that their study hypothesis, according to which less inequality in land distribution would positively impact human development indicators, did not find conclusive confirmation in the data. Highlighting the heterogeneity of the land tenure structure of Rio Grande do Sul, the authors adopt three intervals for area—properties with less than 50 hectares (ha), with more than 50 and less than 500 ha, and over 500 ha—and, using data from the 2006 agricultural census, they trace the land ownership profile of the two micro-regions under analysis.

In Carazinho the properties with less than 50 ha represent 89.3 per cent of the total number and occupy 31.3 per cent of the total area; properties between 50 and 500 ha represent 8.6 per cent of the total number and 35.7 per cent of the total area, and those over 500 ha represent 1 per cent of the total number of properties and 32.9 per cent of the total area. The Land Gini Index is 0.50, representing a low to medium concentration of land in the micro-region. However, the HDI measured for the micro-region of Carazinho, where there is a higher concentration of land ownership, is slightly higher than that of Frederico Westphalen, where land ownership is less concentrated: 0.77 and 0.75, respectively. The authors seek to further detail this centesimal difference by highlighting the greater proportion of municipalities in Carazinho (37 per cent) with a higher HDI (equal to or over 0.80) compared with the lower proportion of municipalities in Frederico Westphalen that reach this mark (19 per cent).

It is the contrast between these results that allows the study to conclude with the rejection of the initial hypothesis, which expected to find better human development indicators in the micro-region where land distribution is less unequal. However, it is worth noting that the authors did not estimate the degree of significance of these discrepancies in statistical terms and that, in the specific case they cover, the similarities appear more significant than the differences.

Two other elements can be presented to question the results. Although Frederico Westphalen presents more equitable land ownership, the proportion of properties with less than 10 ha in this micro-region is slightly higher than that found in Carazinho (48 per cent and 45 per cent, respectively), data that can be considered an indicator of an increase in smallholding. However, and very particularly, the difference in the proportion of the rural population in the two micro-regions is quite considerable: according to the 2010 population census, the rural population of Carazinho was only 22 per cent of the total, whereas it reached 47 per cent in Frederico Westphalen. Therefore, considering the entire micro-regional population in the computation of human development indicators, the study does not consider that the effects of a higher degree of urbanisation, in the case of Carazinho, might be more relevant to explain the social conditions of living of its population than the land tenure structure of its municipalities, given that those indicators cover access to services (such as health and education), which are well known to be better in cities than in rural areas.

The study by Giovani et al. (2011), covering all micro-regions in Rio Grande do Sul, also tests the hypothesis that concentration of land ownership might be a hindering factor to human development. The authors provide a brief historical context for the current land tenure structure in the region, demonstrating that the heterogeneity that characterises it justifies the comparison between the micro-regions in the state, especially because the distribution of human development indicators follows the same logic. Starting from the premise of Amartya Sen, according to which human development is constituted as a process of expansion of 'real freedoms' (capacities), the authors point out that to ensure real opportunities to individuals, they must have access to 'basic freedoms', which, to people living in rural areas, means having access to land assets. From this point of view, it would be appropriate to "consider that a concentrated land tenure structure can highlight the deprivation of access to land" (and income), and that this restriction of freedom, influencing other aspects of an individual's life, would be related to the deprivation of other types of freedom (ibid., 265), such as access to education and health care.

The research covers the layout of the land tenure structure of the state of Rio Grande do Sul: the southern part being characterised by the concentration of land and by cattle ranching in large properties, almost constituting a monopoly regarding the use of land—which is today also taken up by rice and soy—and the north-north-eastern part being characterised by the presence of small land holdings and by diversified production. The statistical purpose of the study—to estimate the relationship between human development indicators and the land tenure structure—is accomplished by calculating correlations and adjusting multiple regressions between these variables. It uses data from the *Atlas of Human Development in Brazil* (UNDP 2013), which was based on the 2000 population census and the 1995-1996 agricultural census. From the calculation of the Gini index for the micro-regions in Rio Grande do Sul, the authors have created thematic maps, aiming to provide greater visibility for the correlations between the land tenure structure and the HDI of municipalities, disaggregated into HDI-income, HDI-education and HDI-longevity.[12]

Based on this process, the authors conclude that the highest levels of income are located in the regions with lower Gini indexes—which, furthermore, have evolved to later stages of industrial development—but that this correlation is not perfect, insofar as micro-regions with low Gini indexes and low municipal income HDIs can be found. Regarding the indicators of education and longevity, the study points out that, of the seven micro-regions that record the highest educational levels, only one does not present a low Gini score, and that the best longevity indicators also apply to micro-regions with less land concentration. However, in estimating statistical correlations[13] to measure the occurrence of significant linkages between indicative variations of human development and the land tenure structure, the authors concluded that, despite these variables being correlated in the expected sense of their hypothesis, the correlation with the Gini index was only statistically significant[14] in two cases: for life expectancy at birth and for the average years of schooling for people aged 25 and older. The authors emphasise the statistical finding that supports the thesis according to which the micro-regions with higher concentration of land ownership also register lower life expectancy, but they also highlight that, although the other correlations are weak, they attest, by their value, a certain degree of influence of the land tenure structure over human development indicators—that is, they point out that these variables do not behave completely randomly among themselves.

While all of the aforementioned studies indicate the existence of a persistent correlation between land tenure structure and human development indicators, their findings are not always conclusive because, generally speaking, their universes of analysis and comparison are not constrained to spaces—micro-regions or municipalities—that are markedly rural, which is to say, those where the rural population or rural workers are preponderant. It is evident that, in the social and economic geography of those spaces, the configurations of the rural and urban worlds are not independent processes but, rather, closely linked.

The study by Giovanni et al. referenced earlier illustrates this fact by noting that the micro-regions in Rio Grande do Sul which were predominantly characterised by smallholding and productive capacity were also the ones where, historically, a greater degree of industrial development was found: in effect, according to the authors, the less unequal profile of income distribution in these micro-regions led to a higher demand for manufactured goods, stimulating the birth of industry (Giovanni et al. 2011, 268). As previously seen, Hoffmann (2007), recognising the weight of this difference, removed from his universe of analysis the metropolitan regions and those with a population of more than 500,000 people. Also for this reason more statistically significant correlation values between the land tenure structure and human development are found. In effect, for the statistical measurement of the degree of determinacy of land concentration over human development indicators, it would be important to more carefully consider the regions most characterised by rurality, not only to 'drive out' the influence of markedly urban determinants over such indicators, but especially to establish a more accurate comparison between distinct forms of occupation of agricultural space and their respective consequences regarding the living conditions of populations. This is what we intend to demonstrate in the following sections of this paper.

3 DATABASE AND METHODOLOGY

The evaluation of the relationship between well-being, as measured by the HDI and child mortality rates (under one and under five years of age) and land concentration has roughly followed the specifications proposed by Hoffmann (2007), described in the previous section. The main difference of this study lies in the implementation of the analysis at the municipal level and, in the case of micro-regions, where no densely populated—and, therefore, not very rural—areas were discarded. We have decided to include the 'proportion of the rural population relative to the territory's total population' variable in the specification of the weighted least squares regression instead of excluding characteristically urban areas.
In the case of the educational variable, schooling expectancy (average years of schooling) was implemented for school-age children and teenagers, in case the current standards are maintained, instead of schooling variables for the population over 25 years old.

For association analysis, two tests were performed. The first kept the data from all the 558 micro-regions, while the second replicated the methodology used by Hoffmann (2007), which excludes the micro-regions with a population of over 500,000 people from the universe of analysis, to avoid interference by data from metropolitan areas. The tests presented a stronger degree of association between these variables, both in 2000 and 2010, after removing the micro-regions with a population of over 500,000 people from the sample.

Regarding regression analysis, it was generally unnecessary to discard micro-regions or municipalities with low rural population or a high population contingent. However, discards were made in two cases: i) in the regression of under-5 child mortality rates for the micro-regions, those whose proportion of the urban population is equal to or greater than 98 per cent were not considered; and ii) in the HDI regression, in the municipal universe, the municipality of São Paulo was removed. Not removing these observations results in statistically insignificant coefficients for 2010. It is worth highlighting that without the discard, coefficients present expected results. We have worked with demographic and human development data derived from the 2000 and 2010 population censuses, and land data from the agricultural censuses of 1996 and 2006 (see Table 1). Regressions were performed for all municipalities and micro-regions, making it clear that land concentration continues to negatively influence well-being.

TABLE 1
Variables, data sources and reference periods

Variable	Source	Years
HDI	IBGE/Ipea/FJP/UNDP	2000 and 2010
Gini Land Index (G_terra)	IBGE	1996 and 2006
Rural population as a proportion of total population (%_rural)	IBGE	2000 and 2010
Under-1 child mortality rates (TM_1)	IBGE/Ipea/FJP/UNDP	2000 and 2010
Under-5 child mortality rates (TM_5)	IBGE/Ipea/FJP/UNDP	2000 and 2010
Illiteracy rate for the adult population 25 years and older (analf.)	IBGE	2000 and 2010
Expected years of schooling (expec_anos_est)*	IBGE/Ipea/FJP/UNDP	2000 and 2010

Source: Authors' elaboration.
* Average number of years of schooling that a generation of children entering school will need to complete by the time they reach 18, if current patterns are maintained throughout their school life.

Three regressions by weighted least squares were estimated—for the HDI and rates of under-1 and under-5 child mortality rates—with the Land Gini Index and the relative size of the rural population as explanatory variables. The expected years of schooling were incorporated into the regressions with child mortality rates. The weight is the population of the municipality or of the micro-region. To that end, we have calculated HDIs, child mortality rates, expected years of schooling and literacy rates for the micro-regions through a weighted average of municipal values, using different weights depending on the variable. Therefore, in the case of HDI, the total population, using the population of up to one year and up to five years old for the mortality rates and the population of up to 17 years old for the estimated future years of schooling of children and adolescents. The Land Gini Indexes related to the micro-regions were calculated based on microdata from the agricultural censuses.[15] In further revisions of this study, we intend to use as yet unpublished HDI data by micro-region, as well as population counts from 1997 and 2005 for degree of rurality.

The analysis was performed for two periods, paring data from the 2000 population census with those from the 1996 agricultural census, and data from the 2010 demographic census with the 2006 agricultural census. These were the child mortality indicators (under-1 and under-5—TM1 and TM5, respectively), the estimation of average future schooling of the population aged 15 and younger (expec_anos_est) and the proportion of the rural population compared to the total population (%_rural) of each geographical unit—municipality or micro-region—for 2000 and 2010.

Therefore, three development variables were adopted (the HDI, under-1 child mortality rates and under-5 child mortality rates) over two periods (1996–2000 and 2006–2010) and two territorial levels (municipal and micro-regional), totalling 12 regressions (Table 2).

TABLE 2
Models of ordinary least square regressions, weighted by population

Equations	Years	Territorial levels
IDH = α + β G_terra + γ %_rural + ε	1996–2000 and 2006–2010	Municipalities and micro-regions
TM1 = α + β G_terra + γ %_rural + δ expec_anos_est + ε		
TM5 = α + β G_terra + γ %_rural + δ expec_anos_est + ε		

Source: Authors' elaboration.

As previously stated, in the estimations by micro-regions, as well as in those by municipalities, we employ the degree of rurality as an explanatory variable (proportion of the rural population compared to the total population). Even though this concept, according to various studies, is problematic and biased, results show that including the variable in the regressions is the correct choice, given that, on the one hand, no discretionary discards are processed regarding the universe of micro-regions, and, on the other hand, results are not altered, demonstrating that the concentration of the primary asset (land) does, in fact, affect quality of life.

As will be shown further, over recent years we have observed a process of homogenisation of quality of life indicators and of degrees of rurality. Conversely, the micro-regional indexes of land concentration have undergone little to no alteration. It is important to note that the influence of the concentration of land ownership highlights the differences between urban and rural areas regarding the provision of health services, education and infrastructure. We will demonstrate the negative influence of land concentration on mortality indicators when the educational variable is inserted. However, if the positive performance of the HDI between 2000 and 2010 allows one to expect a lesser influence of land ownership on quality of life, the extent of this reduction undoubtedly offers a parameter to conclude how the pronounced inequality in the distribution of land ownership continues to be an indelible sign of Brazilian underdevelopment.

4 STYLISED FACTS

Between 2000 and 2010 there were improvements in the HDI and a reduction in mortality and illiteracy rates. The rural population also declined as a proportion of the total population. However, between 1996 and 2006 we observed stability in the degree of land concentration. Therefore, this scenario is characterised by, on the one hand, an improvement in quality of life indicators and, on the other, stability in land concentration and the reduction of rural flight. Such tendencies point towards a reduction of the negative effect of land concentration on quality of life.

The positive changes in the country's overall quality of life, as indicated by the human development reports, were more thoroughly detailed in the three editions of the *Atlas of Human Development in Brazil* (1998, 2003 and 2013). In its latest edition, the Atlas features, in addition to municipal HDI, over 200 indicators for demographics, education, income, labour, housing and vulnerability, with data extracted from the population censuses of 1991, 2000 and 2010, and adapted for the country's municipal mesh in 2010—with 5,565 municipalities.

Despite the limitation of synthetic indicators—which gather multiple dimensions in a single number—we have opted for the use of the municipal HDI, not only because, as mentioned earlier, previous studies rely on indicators of the same type, but mainly because the HDI offers a comprehensive, grouped and compatible municipal database which allows for the testing of the impacts of the addition of other data in the models.

The country's human development has made significant strides regarding longevity, education and income, as a result of the adoption of inclusive strategies that have driven the country over the past few decades, such as conditional cash transfers and investments in health and education. However, Brazil still features enormous regional inequalities (UNDP, Ipea and FJP 2013). These discrepancies decreased towards the end of the 2000s, as can be seen in Table 3, which features minimum, maximum, average, median and selected percentile values of the HDI of the micro-regions in 2000 and 2010.[16] A decrease in the dispersion between highest and lowest HDI can be seen, with a growth of the index in all measurements under consideration and, more pointedly, among the micro-regions that presented a lower HDI in 2000.

TABLE 3
Average, median and selected percentile values of HDI and under-1 child mortality rates in the micro-regions, 2000 and 2010

Statistic	HDI		Under-1 child mortality rate	
	2000	2010	2000	2010
Median	0.557	0.683	27.8	16.8
Average	0.543	0.674	31.8	18.7
Maximum	0.730	0.824	67.2	36.7
Minimum	0.296	0.474	13.2	9.3
60th percentile	0.592	0.708	34.2	18.9
40th percentile	0.509	0.652	23.9	15.1
20th percentile	0.439	0.602	19.1	13.2

Source: Authors' elaboration based on UNDP, Ipea and FJP (2013).

An improvement in the values and less dispersion can be clearly observed in the descriptive statistics of the HDI by micro-regions. The standard deviation falls from 0.1042 to 0.0719 in the interval considered. The decrease in dispersion is also observed among municipalities, with the differential between the worst and best results falling from 0.612 to 0.444; for micro-regions this decrease was from 0.434 to 0.350. These results are even more worthy of note after the verification of an increase in amplitude between 1991 and 2000, as the Atlas points out.

In other words, HDI growth was concentrated in the worst-performing values—both for micro-regions and municipalities—and was greatly influenced by the smaller possibility of growth for those values that had already attained a given level in the indicator. These changes are also observed in the mortality and illiteracy rates between 2000 and 2010: for the average municipal and micro-regional rates, the decrease was from 67.3 to 19.2 and from 31.8 to 18.7, respectively, in under-1 child mortality rate. The average micro-regional rates of illiteracy fell from 24.7 to 18.8 per cent of the adult population. There was a 23 per cent reduction in municipal illiteracy rates.

The most pronounced and positive changes are observed in mortality rates: the highest values among micro-regions went from 67.2 to 36.7 deaths among children under one year old per 1,000 live births, and from 78.5 to 40.1 among children under five years old. The improvement was such that the minimum values in 2010 barely surpassed the average values for 2000. The most significant decreases in mortality rates are concentrated in municipalities with the worst overall rates: the average deviation falls from 11.5 to 5.3 deaths of under-1 infants per 1,000 live births.

A decrease in illiteracy among those aged over 25 is also observed in all municipalities: the average municipal rates fell from 24.7 per cent to 18.8 per cent between 2000 and 2010. This reduction of 5.9 percentage points represents a 24 per cent reduction, which is less than the 42 per cent reduction in under-1 infant mortality rates and is equal to the HDI increase. Also worthy of note is the fact that the illiteracy rate decreases more sharply in municipalities with rates at better levels. In other words, it is a different pattern from the convergence observed in the cases of HDI and mortality rates.

TABLE 4

Average, median and selected percentile values of illiteracy rates and of the estimates of years of schooling for children of the micro-regions, 2000 and 2010

Statistic	Illiteracy rate (%)		Estimated years of schooling	
	2000	2010	2000	2010
Median	20.1	14.5	8.5	9.4
Average	24.7	18.8	8.4	9.4
Maximum	60.8	51.1	11.1	11.2
Minimum	4.1	2.8	3.1	6.0
60th percentile	27.0	19.6	9.1	9.6
40th percentile	16.4	11.3	8.0	9.2
20th percentile	10.6	7.3	6.8	8.8

Source: UNDP, Ipea and FJP (2013).

The data gathered in the HDI-M Atlas point to similar results, although the descriptive statistics for the HDI and other measurements presented previously have a distinct focus. Here, the base municipal information is presented, and the descriptive statistics are based on the number of units—municipalities or micro-regions. The Atlas, in turn, when presenting national data, considers the country as a unit of analysis. Table 5 reproduces information from the Atlas regarding the evolution of the HDI-M, its partial indexes and some of the base indicators for Brazil in 1991 and 2010. It clearly displays the difference in levels among each of the partial indexes, with longevity at the very high development level, while income is at the high and education at the average development level. Significant gains in longevity reflect the sharp decrease in fertility and in child mortality rates. On the other hand, the worst-ranking 'education' dimension was the one whose indicators showed the sharpest improvements, highlighting the gap between municipalities even further. School flow indicators—most notably for the youth—represent the greatest improvements.

TABLE 5
Evolution of Brazil's HDI-M, its partial indexes and select indicators, 1991, 2000 and 2010

Indicator/dimension/variable	1991	2000	2010
HDI-M	0.493	0.612	0.727
HDI-M Longevity	0.662	0.727	0.816
Life expectancy at birth (years)	64.7	68.6	73.9
HDI-M Education	0.279	0.456	0.637
% of population aged 18 or older with complete basic schooling	30.1	39.8	54.9
% of children aged 5–6 enrolled in school	37.3	71.5	91.1
% of population aged 11–13 in the final years of basic schooling	36.8	59.1	84.9
% of population aged 15–17 with complete basic schooling	20.0	39.7	57.2
% of population aged 18–20 with complete secondary schooling	13.0	24.8	41.0
HDI-M Income	0.647	0.692	0.739
Monthly income per capita (BRL)	447.56	592.46	793.87

Source: Authors' elaboration based on UNDP, Ipea and FJP (2013).

The decrease in heterogeneity of the partial index of longevity is presented in the Atlas through two stylised facts. For one, it is observed that of the "5,565 Brazilian municipalities, 2,356, or 42.3 per cent, have a superior HDI-M Longevity indicator compared to the country's"—or, in other words, with an average value that is not significantly higher than the median. Another fact is the 'horizontalisation' presented by the generalised Lorenz curve—by hundredths of the number of municipalities—of the HDI-M Longevity indicator, between 2000 and 2010, which illustrates a reduction in the inequality of the index among Brazilian municipalities.

This is happening, as has been previously stated, because from 2000—or better yet, from 1991—to 2010, the "leap in HDI-M Longevity was greater in municipalities that had the lowest indicators in the distribution".

Regarding HDI-M Education, the value for Brazil went from 0.456 in 2000 to 0.637 in 2010. In effect, this is an absolute increase of 0.181—less than the one observed in the previous decade—reflecting two important advances in education in the country over recent years: the increase of 15.1 percentage points in the population over 18 years old with complete basic schooling—or, in relative terms, a growth of 38 per cent—and the increase of 0.198 in the sub-index of school flows—a growth of 41 per cent. It is worth noting that the advances in flow indicators were more pronounced in the previous decade, partly because of the very depressed level of some of the indicators.

Further, the Atlas points out that in the 1990s gains were higher in the "municipalities that already had the highest HDI-M Education", while in the 2000s the most significant increases were in municipalities with the worst indicators.

The fact that the Brazilian figure for HDI-M Income is close to the 90th percentile of HDI-M Municipal Incomes shows how concentrated income truly is, notwithstanding the fact (also highlighted by the Atlas) that 72 per cent of municipalities recorded a growth of per capita income during the 2000s that is higher than the national average. An analysis of the generalised Lorenz curves of the HDI-M Income for Brazilian municipalities for 1991, 2000 and 2010, grouped by centiles, shows that the increase in income was greater in municipalities with the lowest centiles, most notably in the 2000s.

Something different is observed in the municipal values of the Land Gini Index and its dispersion and behaviour through the different agricultural censuses. The average value rose from 0.704 to 0.711, with the national average remaining virtually unaltered—a 0.12 per cent decrease. The standard deviation among municipal Gini indexes decreased merely from 0.130 to 0.120.

TABLE 6

Average, median and selected percentile values of the Land Gini Indexes and percentile proportions of rural populations of micro-regions, 2000 and 2010

Statistic	Land Gini Index (x 100)		Rural population as a proportion of total population (%)	
	1996	2006	2000	2010
Median	73.8	78.5	32.6	27.3
Average	73.8	77.6	32.2	28.0
Maximum	95.8	96.2	79.3	77.7
Minimum	41.4	43.9	0.0	0.0
60^{th} percentile	67.0	71.4	37.8	32.9
40^{th} percentile	71.7	76.2	25.6	21.3
20^{th} percentile	76.4	80.3	13.8	11.6

Source: Authors' elaboration based on UNDP, Ipea and FJP (2013).

The proportion of the rural population compared to the total population has decreased less sharply than in the past and was, in statistical terms, less expressive than the variations observed in other quality of life indicators. Furthermore, the variability of the degree of rurality among municipalities decreased, due to the fact that 'rural' is, in legal terms, the remaining and excluded portion of what the municipalities establish at their own discretion as the urban perimeter, which is always expanding. Still, the 12 per cent decrease in the average proportion of the rural population in the total population of municipalities is less pronounced than the one observed in the average of municipal indicators of economic development and their components—illiteracy rates (-23 per cent), under-1 child mortality rates (-41 per cent) and HDI (+26 per cent).

The highest fertility rates in the rural areas, the significant improvement of agricultural income and the increase in government transfers to those same areas, together with the real increase in the minimum wage and the consolidation of the *Bolsa Família* programme, have largely reduced migration to urban areas and mitigated the decrease in rural employment.

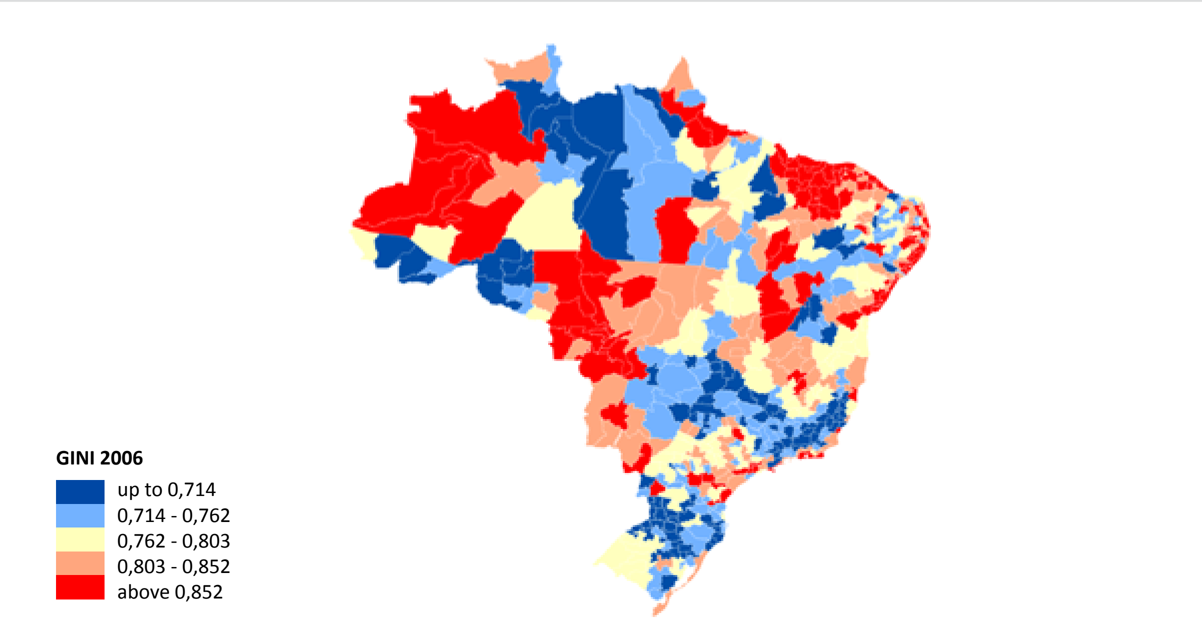
Therefore, on the one hand, HDI values and municipal and micro-regional mortality rates are improving significantly and becoming more equitable—horizontal—in their distribution between municipalities and micro-regions, and, on the other, there are less significant changes in the proportion of the rural population compared to the total population, a decrease in the variability and also of the stability of the concentration of land ownership. It is in this context that the following section attempts to analyse the degree of association between land concentration and quality of life.

5 LAND AND QUALITY OF LIFE: AN ANALYSIS BASED ON DATA FROM THE 2000 AND 2010 POPULATION CENSUSES AND THE 1996 AND 2006 AGRICULTURAL CENSUSES

Based on the spatial distribution—in this case, by micro-regions—of the indicators of concentration of land ownership, of the HDI and of the proportion of the rural population, this study seeks to provide an initial interpretation of the degree of association between quality of life, on the one hand, and land concentration and degree of rurality, on the other. We will provide three micro-region maps, classified according to the Land Gini Index in 2006 and the HDI and under-1 infant mortality rates in 2010. The following maps can be found attached: a) rate of illiteracy by micro-region and municipality in 2000 and 2010; b) Gini Land Index, in 1996 and 2006 for municipalities, and in 1996 for micro-regions; and c) the HDI and infant mortality rates for micro-regions in 2000, and for municipalities in 2000 and 2010.

Figure 1 depicts the distribution of the Land Gini Index across micro-regions, according to five strata.[17]

FIGURE 1
Land Gini Index in the micro-regions, 2006



Source: 2006 agricultural census (IBGE 2006).

The territorial distribution of the concentration of land ownership shows some uniform areas. In the case of micro-regions with the lowest Land Gini Indexes (under 0.714), two patches are observed in the centre-south and north of the country. In the north,[18] a patch covering the states of Acre and Rondônia can be seen extending from southern Roraima to the northeastern Amazonas, as far as the border of this state with Pará.

In the centre-south, other clearly outlined areas of 'low' land concentration can be noted. In the South region, the patch covers the valleys of the rivers Caí, Taquari and Sinos and the region of the Serra Gaúcha (a mountainous area in the state of Rio Grande do Sul), Alto Uruguai, western and southern Santa Catarina, Vale do Itajaí and southeast and southwest Pará. Among these micro-regions can be found the smaller average areas, most notably in Santa Catarina: this space corresponds to a territorial occupation based on small and medium-sized properties, with no historical connection to large exporting agricultural estates. In the Southeast region of the country, the patch representing areas of a lesser degree of concentration of land ownership, which extends as far as the state of Goiás, is bordered by São Paulo in the south, and in the north and west by the savannahs of Mato Grosso, the Pantanal and the centre-north part of the state of Minas Gerais. This area with 'low' rates of inequality of land ownership forms an arc extending across the southwestern part of Goiás, west of the Triângulo Mineiro region in Minas Gerais, Alto Paraíba, a portion of southern Minas Gerais, the Zona da Mata region, also in Minas Gerais, western Vale do Paraíba, the valleys of the rivers Doce and Itapemirim, and mountainous colonised regions in the state of Espírito Santo. In this set, a larger dispersion of the average area of properties can be seen, reaching 100 ha in some micro-regions.

The areas of largest land concentration are centre-west Amazonas, the 'traditional' savannah of Mato Grosso and northern Goiás, the Pantanal region in Mato Grosso do Sul, the hinterlands of the North (Maranhão, Piauí and Ceará) and the Northeast region of the country more broadly. São Paulo and the centre-north of Minas Gerais find themselves in the intermediary strata of the Land Gini Index. On the other hand, the centre-east of the northeastern wilderness of the country is a patchwork: no contiguous areas can be found in the spatial distribution of the Gini Index, as is the case for the HDI and degree of rurality indicators.

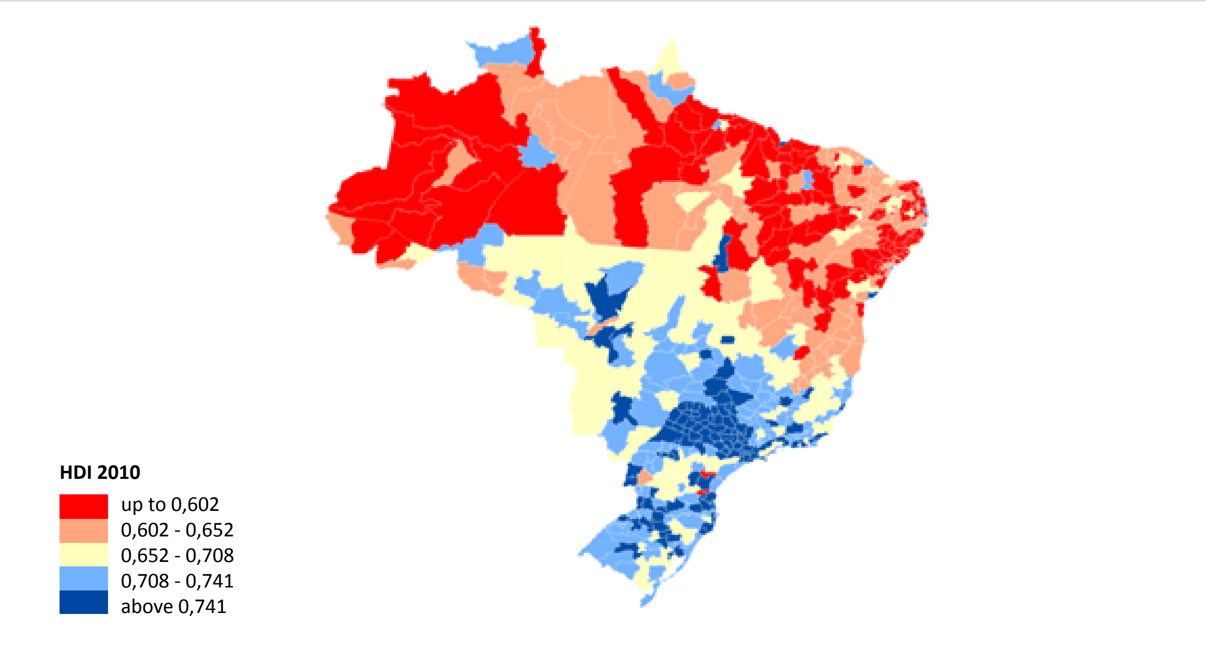
In Figure 2, which represents the HDI distribution by micro-region, a clear distinction can be seen between the North-Northeast, where rates lower than 0.652 can be found, and the South-Southeast, where rates above 0.708 are predominant. Worthy of note is the state of São Paulo—except for the micro-regions to the southeast of the state—and Minas Gerais. In northern Minas Gerais and in the Centre-West region of the country, micro-regions with an HDI between 0.652 and 0.708 are the norm.

The regional profile of the degree of human development highlights the country's marked north–south divide. One could effectively trace a dividing line between the centre-south and the centre-north-northeast of Brazil regarding quality of life. However, there are, strictly speaking, four large, distinct areas in the country regarding the degree of human development: the North and Northeast regions (low); the Centre-West region—Pantanal and *cerrado* areas (intermediate); and the state of São Paulo and its surroundings, most notably to its north and west, as well as the family farming area in the south of the country (high).

Regarding the proportion of the rural population compared to the total population in the micro-regions, two large areas can be determined. On the one hand, there is the most urbanised territory, extending from the east coast (Curitiba–Rio de Janeiro) to the border between Brazil, Paraguay and Bolivia, roughly comprising the states of São Paulo, Minas Gerais, Goiás, Mato Grosso do Sul and the centre-north portion of Paraná. On the other hand, there are the North and Northeast regions of the country, with a larger share of the rural population, especially the micro-regions with over a third of their populations living in the countryside.

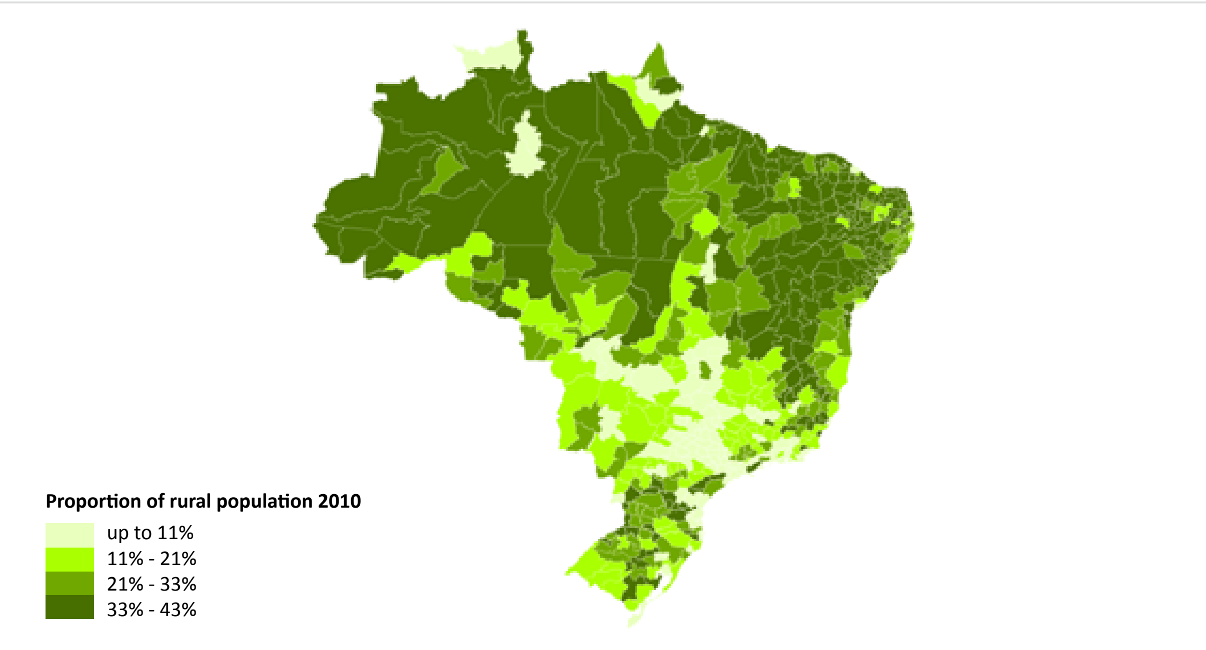
The South region is a mosaic of different contexts, possessing, however, great adherence regarding the areas of greater rurality and family farming. Parts of the eastern and southern portions of the state of Rio Grande do Sul do not fit neatly into this situation. Strictly speaking, regarding the proportion of the rural population compared to the total population of the micro-regions, that same dividing line between the north-northeast and centre-south of the country is nowhere to be seen. Even so, a negative association between rurality and quality of life can be observed, based on the north-northeast and the centre of the country.

FIGURE 2
Human Development Index by micro-region, 2010



Source: UNDP, Ipea and FJP (2013).

FIGURE 3
Proportion of the rural population in the micro-regions, 2010



Source: 2010 population census (IBGE 2010).

Based on the spatial distributions of the HDI, of the rural population and the Land Gini Index, linkages between quality of life and rurality, and between quality of life and land concentration can be found. As previously mentioned, the correlation between the proportion of the rural population and the Land Gini Index is weak. This is why the relative size of the rural population has been adopted as an explanatory variable in all the regressions, differently from Hoffman's proposal. As a result, all micro-regions and municipalities are included in the regressions, without needing to discard more urbanised areas.

Tables 7 and 8 feature the correlation matrixes weighted by population size, between the employed variables of human development—quality of life—and the explanatory variables at the micro-regional level[19]—for 1996/2000 and 2006/2010. Initially, we can observe a high correlation between a relatively larger rural population and higher rates of illiteracy and child mortality, and a lower HDI. The Gini Index presents correlations with the quality of life variables in the expected sense—a negative association. The correlations in this case are not as expressive, being around 0.40 for 1996/2000 and 0.35 in 2006/2010. In addition, there is no association between rurality and land concentration, given that the correlation between these variables, evaluated by micro-region, is 0.063 and 0.23 for the 1996/2000 and 2006/2010 periods, respectively.

It is worth noting that the land tenure structure continues to sustain a negative association with indicators of quality of life, as pointed out in the article by da Silva (1980) published 35 years ago and previously mentioned in the second section of this paper. Today, however, the degree of association—correlation—has become less strong: as can be noted in the comparison between 1996/2000 and 2006/2010, the correlation coefficient of the Gini index and the HDI fell from -0.358 to -0.287. This attenuation can also be verified between the Gini index and the mortality rates: the correlation coefficient between under-1 child mortality rates and the Gini index fell from 0.419 to 0.370.[20]

Among the changes in correlations, the reduction in the degree of association between years of schooling and other variables is of particular note—especially with illiteracy and mortality rates. The coefficients regarding the Gini index are also reduced; or, in other words, their association with socio-economic variables is decreased. Such a decrease is more pronounced with the 'years of schooling' variable (42 per cent) and less intense with the HDI and under-1 and under-5 mortality rates: 20 per cent, 12 per cent and 17 per cent, respectively.

Replicating the methodology used by Hoffmann (2007), which excludes from the universe of analysis the micro-regions with a population of over 500,000 people, to avoid data from metropolitan areas interfering with the results,[21] and redoing these correlations, we can observe (in Table 9) that, in the analysis for 2006/2010, with the removal of these micro-regions, the degree of negative association between the variables of the land tenure structure and quality of life indicators are even more significant, as can be noted in the coefficient of correlation between the Gini index and HDI, which rose from -0.287 to -0.386. The same can be observed regarding child mortality: its association with the Gini Index rose to 0.424 from 0.370.

The analysis of the association between these variables for 1996/2000 (see Table 10) also demonstrates that the degree of association—correlation—became less pronounced between the periods under analysis, as can be noted in the comparison between 1996/2000 and 2006/2010, where the coefficient of the correlation between the Gini index and the IDH fell from -0.420 to -0.386. There was little alteration in the correlations between the Land Gini Index and under-1 child mortality rates.

TABLE 7

Correlation matrix: illiteracy rate, estimation of years of study, Land Gini Index, child mortality rates, HDI and relative size of the rural population—micro-regions, 1996 and 2000

Variables	Illiteracy rate	Estimation of average years of schooling	Land Gini Index	Human Development Index	Under-1 child mortality rate	Under-5 child mortality rate	Rural population as a proportion of total population
Illiteracy rate	1						
Estimation of average years of schooling	-0.833	1					
Land Gini Index	0.384	-0.367	1				
HDI	-0.933	0.930	-0.358	1			
Under-1 child mortality rate	0.902	-0.807	0.419	-0.886	1		
Under-5 child mortality rate	0.901	-0.785	0.420	-0.876	0.991	1	
Rural population as a proportion of total population	0.715	-0.668	0.063	-0.802	0.610	0.601	1

Source: Primary data: IBGE (demographic censuses 2000 and 2010 and agricultural censuses of 1996 and 2006) and UNDP, Ipea and FJP (2013).

TABLE 8

Correlation matrix: illiteracy rate, estimation of years of study, Land Gini Index, child mortality rates, HDI and relative size of the rural population—micro-regions, 2006 and 2010

Variables	Illiteracy rate	Estimation of average years of schooling	Land Gini Index	Human Development Index	Under-1 child mortality rate	Under-5 child mortality rate	Rural population as a proportion of total population
Illiteracy rate	1						
Estimation of average years of schooling	-0.550	1					
Land Gini Index	0.330	-0.211	1				
HDI	-0.912	0.740	-0.287	1			
Under-1 child mortality rate	0.908	-0.570	0.370	-0.887	1		
Under-5 child mortality rate	0.888	-0.538	0.347	-0.865	0.971	1	
Rural population as a proportion of total population	0.715	-0.523	0.023	-0.817	0.660	0.665	1

Source: Primary data: IBGE (demographic censuses 2000 and 2010 and agricultural censuses of 1996 and 2006) and UNDP, Ipea and FJP (2013).

TABLE 9

Correlation matrix: illiteracy rate, estimation of years of study, Land Gini Index, child mortality rates, HDI and relative size of the rural population—micro-regions with under 500,000 inhabitants, 2006 and 2010

Variables	Illiteracy rate	Estimation of average years of schooling	Land Gini Index	Human Development Index	Under-1 child mortality rate	Under-5 child mortality rate	Rural population as a proportion of total population
Illiteracy rate	1						
Estimation of average years of schooling	-0.532	1					
Land Gini Index	0.408	-0.252	1				
HDI	-0.904	0.743	-0.386	1			
Under-1 child mortality rate	0.908	-0.556	0.424	-0.892	1		
Under-5 child mortality rate	0.899	-0.545	0.432	-0.879	0.991	1	
Rural population as a proportion of total population	0.680	-0.513	0.109	-0.787	0.644	0.638	1

Source: Primary data: IBGE (demographic censuses of 2000 and 2010 and agricultural censuses of 1996 and 2006) and UNDP, Ipea and FJP (2013).

TABLE 10

Correlation matrix: illiteracy rate, estimation of years of study, Land Gini Index, child mortality rates, HDI and relative size of the rural population—micro-regions with under 500,000 inhabitants, 1996 and 2010

Variables	Illiteracy rate	Estimation of average years of schooling	Land Gini Index	Human Development Index	Under-1 child mortality rate	Under-5 child mortality rate	Rural population as a proportion of total population
Illiteracy rate	1						
Estimation of average years of schooling	-0.823	1					
Land Gini Index	0.433	-0.385	1				
HDI	-0.928	0.930	-0.420	1			
Under-1 child mortality rate	0.909	-0.798	0.427	-0.896	1		
Under-5 child mortality rate	0.908	-0.774	0.427	-0.886	0.991	1	
Rural population as a proportion of total population	0.687	-0.657	0.144	-0.783	0.617	0.609	1

Source: Primary data: IBGE (demographic censuses 2000 and 2010 and agricultural censuses of 1996 and 2006) and UNDP, Ipea and FJP, (2013) .

6 RESULTS

Twelve regressions were estimated, given the use of three dependent variables (HDI, under-1 child mortality rate and under-5 child mortality rate) for two spatial levels (municipalities and micro-regions) and two periods (1996/2000 and 2006/2010). In this section the results of these regressions will be presented, making the negative effects of concentrated land ownership on the population's quality of life indicators very obvious. It is worth noting that, unlike in previously mentioned studies, all the micro-regions and municipalities were considered, including those with a high level of urbanity. Two discards were made: at the micro-region level, for the regressions for under-5 child mortality rate, those where the rural population comprised less than 2 per cent of the total population were discarded. At the municipality level, the municipality of São Paulo was removed from HDI regressions.

Table 11 presents the results of the regressions for micro-regions, and Table 12 for municipalities. The Land Gini Indexes display a negative influence over the HDI and a positive influence over under-1 and under-5 child mortality rates, considering the effect of rurality and, for mortality rates, the expected years of schooling. The 'rurality' variable also affects quality of life, in the case of both the HDI and child mortality rates. Regarding the educational co-variable employed in the regressions for child mortality rates, estimations point to positive effects—that is, increases in the level of education imply reductions in child mortality rates.

It is worthy of note that, in the case of under-5 child mortality, not discarding almost exclusively urban micro-regions (where at least 98 per cent of the population is urban) would imply non-statistically significant coefficients for the intercept and the expected years of schooling variable.

In the micro-region regressions, the Gini and rurality coefficients are not as expressive, there having been a reduction between the periods: the coefficients have decreased, in absolute terms, from 0.333 to 0.127 and from 0.493 to 0.394, respectively (Table 11). On the other hand, the reduction is more pronounced in the Land Gini Index. While in 2000 the HDI grew 16.5 per cent as the Land Gini Index decreased from 0.85 to 0.60, considering the average rurality of micro-regions, the increase was of 4.8 per cent in 2010. These Land Gini Index values represent, on one side, the values for those areas where family agriculture is predominant, and on the other, the median/average values of the Land Gini Index for micro-regions. In absolute terms, the predicted HDIs for these Gini indexes were 0.588 and 0.505 in 2000, and 0.696 and 0.664 in 2010. Please note that the averages of the relative size of the rural population of the micro-regions were used—28 per cent and 32.2 per cent of the total population in 2010 and 2000, respectively.

In the case of under-1 child mortality, while in 2000 the concentration of land was more determinant than rurality, in 2010 the situation changed. A reduction in the educational indicator coefficient was also observed. Figure 4, depicting the predicted under-1 child mortality rates for the two periods, according to variations in Gini or in rurality,[22] demonstrates these results: changes in the curves of the predicted values and an increased relative difference between child mortality rates and the two typical Gini indexes. Concerning the curves, we can observe between the two periods an increase in the inclination of the one relative to rurality and a smoothing of the one relative to the Gini index. This, however, did not represent a reduction in the relative difference between the predicted under-1 child mortality rates for the selected typical Ginis.

Effectively, between the two periods, we see a growth of the relative distance between the predicted child mortality rates for the areas characterised by small properties and those with a land structure similar to what happens in the rest of the country: from 15.5 per cent to 22 per cent.[23] It is interesting to note that the educational indicator applied—the expected average years of schooling of the school-age population—explains the variations in child mortality rate, having had its effect significantly reduced. Considering the micro-regional averages of the Gini and of the relative size of the rural population, an extra year in the expected years of schooling would imply a reduction of 5.8
(17.8 per cent) in the mortality rate in 2000, and of 1.7 (8.7 per cent) in 2010.

TABLE 11
Coefficients and standard errors of the weighted least square regressions of the HDI and under-1 and under-5 child mortality rates for the micro-regions

Variable	Intercept	Land Gini Index	% Rural pop.	Estimated avg. schooling (up to 17 years old)	Number of observations (n)	R^2 and Test F
HDI (2000)	0.9467 (0.0302)	-0.3329 (0.0365)	-0.4930 (0.0160)		557	R^2 = 0.8199 F=479.05
Under-1 child mort. (2000)	61.0312 (5.2453)	21.6543 (4.9328)	11.9108 (3.5773)	-5.7677 (0.3766)	557	R^2 = 0.7565 F=273.11
Under-1 child mort. (2000)	66.9864 (7.7526)	36.9110 (6.4872)	15.3335 (3.9604)	-7.1475 (0.4861)	548	R^2 = 0.7503 F=251.15
HDI (2010)	0.8827 (0.0316)	-0.1270 (0.0437)	-0.3943 (0.0147)		558	R^2 = 0.8052 F=613.12
Under-1 child mort. (2000)	14.3960 (3.4139)	18.0302 (2.0479)	22.5883 (1.2533)	-1.6590 (0.0235)	558	R^2 = 0.7053 F=271.97
Under-1 child mort. (2000)	9.3324 (3.5035)	20.5717 (2.0991)	23.6538 (1.6401)	-1.1633 (0.3124)	542	R^2 = 0.6252 F=206.28

Source: Primary data: IBGE (demographic censuses 2000 and 2010 and agricultural censuses of 1996 and 2006) and UNDP, Ipea and FJP (2013).

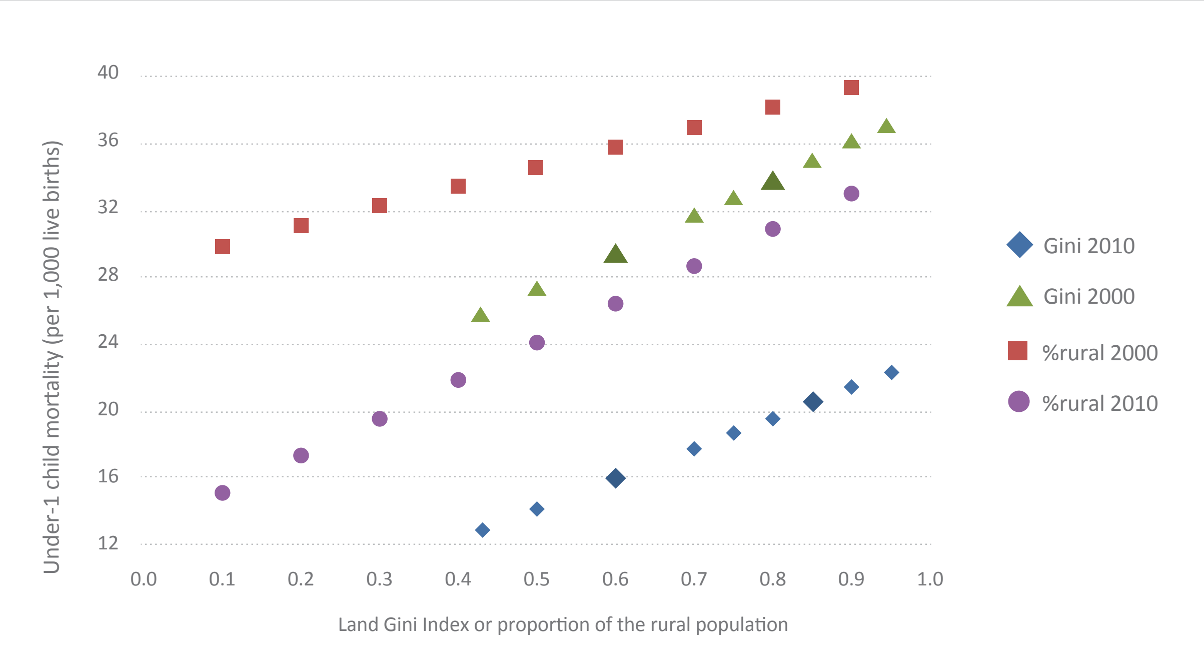
Note: In the case of under-5 child mortality, micro-regions with a rural population comprising less than 2 per cent of the total population were removed, representing 9 and 16 micro-regions discarded in 2000 and 2010, respectively.

In the case of the under-5 child mortality rate, the coefficients are all significant and with the expected signals. It is important to note that they all present variations in the mortality rate, with rurality increasing its influence over the two periods. As can be seen, the results are similar to those computed for the under-1 child mortality rate. By employing the average values of rurality and schooling, one can predict a reduction in child mortality in the case of a lower average Gini for family farming areas, from 26 per cent in 2000 to 20.9 per cent in 2010.

The regressions for the municipalities also show that land concentration and degree of rurality negatively affect the HDI and also two proxy indicators of well-being (Table 12). As in the regressions for the micro-regions, the influence of land concentration and schooling on child mortality rates decreases, with the degree of rurality becoming more significant. Regarding the HDI, we can observe a reduction in the magnitude of the Land Gini Indexes and the relative size of the rural population—in absolute terms, the first parameter decreases from 0.158 to 0.055 from 1996/2000 to 2006/2010.

FIGURE 4

Estimated values—predicted under-1 child mortality rate, according to the proportion of the rural population and the degree of concentration of land ownership in the micro-regions, 2000 (1996/2000) and 2010 (2006/2010)



Source: Authors' elaboration.

TABLE 12

Coefficients and standard errors of the weighted least square regressions of HDI and under-1 and under-5 child mortality rates of municipalities

Variable	Intercept	Land Gini Index	% Rural pop.	Estimated avg. schooling (up to 17 years old)	Number of observations (n)	R^2 and Test F
HDI (2000)	0,7861 (0,0200)	-0,1584 (0,0113)	-0,3778 (0,0113)		5484	R^2 = 0,6583 F=581,92
Under-1 child mort. (2000)	64,6164 (3,0856)	16,0065 (2,7303)	6,7956 (1,4196)	-5,5583 (0,1766)	5485	R^2 = 0,6596 F=1035,57
Under-1 child mort. (2000)	75,4010 (4,1968)	24,7394 (3,7312)	9,2993 (2,0116)	-6,9271 (0,2456)	5185	R^2 = 0,6508 F=950,31
HDI (2010)	0,8036 (0,0152)	–0,0549 (0,0200)	-0,3026 (,0093)		5479	R^2 = 0,6502 F=530,40
Under-1 child mort. (2000)	28,7475 (1,9915)	5,1205 (1,4703)	14,91,4 (0,6441)	-1,9106 (0,1268)	5480	R^2 = 0,4926 F=611,67
Under-1 child mort. (2000)	15,5249 (5,2284)	12,4889 (4,1166)	20,0755 (1,3227)	-1,0756 (0,2476)	5480	R^2 = 0,4545 F=348,92

Source: Primary data: IBGE (demographic censuses 2000 and 2010 and agricultural censuses of 1996 and 2006) and UNDP, Ipea and FJP (2013).

Note: In the case of the HDI, the municipality of São Paulo (SP) was removed. With its inclusion, the Land Gini Index was not statistically significant in 2010.

In effect, an increase of 0.1 in the Gini index would result in a 6 per cent increase in the child mortality rate in 2010, setting rurality and the schooling indicator at the average micro-regional level.

7 CONCLUSION

This study intended to offer statistical evidence that would allow for the estimation of how the markedly unequal distribution of land ownership in Brazil can affect the indicators of human development, especially of the rural population. In other words, it attempted to estimate the degree of influence of land concentration over the social conditions of life, according to typical well-being indicators.

The analysis was performed across two territorial levels: micro-regions and municipalities. At both levels, the results allow for the conclusion that this 'trademark' of Brazil's underdevelopment—the high concentration of primary assets (land, in this case) can be related to comparatively low standards of well-being. Although, generally speaking, the tendencies outlined in this study point towards a reduction in the negative effect of land concentration on quality of life indicators, we can notice, among other things, the existence of a statistically very significant association between inequality in land ownership—that is, the agrarian structure—and child mortality.

Therefore, despite all the changes that have occurred in the Brazilian countryside and agriculture, inequality in land ownership is an obstacle to human development, and the path to overcoming it must necessarily pass through agrarian reform. We hope that the results of this study are added to a vast body of data regarding the social conditions of life of rural populations and can reinforce the conclusion that the majority of the issues related to poverty and food and nutrition security in the countryside can be solved through more decisive intervention in the land tenure structure, together with comprehensive feeding programmes and better policies for income distribution.

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APPENDIX

TABLE A.I
Correlation matrix: illiteracy rate, estimation of years of study, Land Gini Index, child mortality rates, HDI and relative size of the rural population—municipalities, 1996 and 2000

Variables	Illiteracy rate	Estimation of average years of schooling	Land Gini Index	Human Development Index	Under-1 child mortality rate	Under-5 child mortality rate	Rural population as a proportion of total population
Illiteracy rate	1						
Estimation of average years of schooling	-0.835	1					
Land Gini Index	0.243	-0.246	1				
HDI	-0.925	0.909	-0.197	1			
Under-1 child mortality rate	0.847	-0.796	0.326	-0.826	1		
Under-5 child mortality rate	0.848	-0.784	0.351	-0.820	0.990	1	
Rural population as a proportion of total population	0.759	-0.656	0.02	-0.791	0.569	0.562	1

Source: Primary data: IBGE (demographic censuses 2000 and 2010 and agricultural censuses of 1996 and 2006) and UNDP, Ipea and FJP (2013).

TABLE A.II
Correlation matrix: illiteracy rate, estimation of years of study, Land Gini Index, child mortality rates, HDI and relative size of the rural population—municipalities, 2006 and 2010

Variables	Illiteracy rate	Estimation of average years of schooling	Land Gini Index	Human Development Index	Under-1 child mortality rate	Under-5 child mortality rate	Rural population as a proportion of total population
Illiteracy rate	1						
Estimation of average years of schooling	-0.537	1					
Land Gini Index	0.085	0.013	1				
HDI	-0.905	0.673	-0.004	1			
Under-1 child mortality rate	0.863	-0.520	0.087	-0.829	1		
Under-5 child mortality rate	0.763	-0.392	0.200	-0.732	0.850	1	
Rural population as a proportion of total population	0.762	-0.464	-0.044	-0.808	0.647	0.624	1

Source: Primary data: IBGE (demographic censuses 2000 and 2010 and agricultural censuses of 1996 and 2006) and UNDP, Ipea and FJP (2013).

NOTES

4. Given to the newspaper *O Estado de S. Paulo*, on 21 September 1980, in a piece entitled *INAN pede o fim de desequilíbrio*.

5. Since the beginnings of the colonial era, especially during the leather cycle, southern Rio Grande do Sul was occupied by large cattle ranches, whose production supplied mining areas and the capital of the colony. The mountainous and more forested regions in the north of the state started being settled between 1820 (by German immigrants) and 1870 (by Italian immigrants); each family would receive a 24-hectare plot of land to grow subsistence crops, selling any surplus to the cattle-ranching regions and to the centre of the country (Victora and Vaughan 1987, 132).

6. Data were analysed by logistical regression, having as a dependent variable the logarithm of the ratio between the number of dead children and the number of surviving children, for each mother; the effect of the intervening maternal variables of 'age' and 'parity' "was controlled by including them in the regression model before the inclusion of the labour situation of the head of the household" (Victora and Vaughan 1987, 136–137).

7. Official averages of the child mortality coefficient.

8. Data relative to the proportion of underweight live births in 1980, by micro-region, based on statistics gathered by the State Health Bureau, and data relative to the intake of calories and proteins, extracted from the nutritional survey carried out between 1974 and 1975 by the IBGE, the *Estudo Nacional da Despesa Familiar* (ENDEF).

9. The variables are: population of the micro-region; HDI of the micro-region; living conditions index; life expectancy at birth (in years); child mortality rate; illiteracy rate among people aged 15 or older; average years of schooling for people aged 25 or older; and percentage of people aged 25 or older with less than four years of schooling (source: Ipea and IBGE 1998).

10. HDI, socio-economic development index, index of municipal quality and index of municipal quality according to municipal needs (*IQM-Carências*).

11. The authors state, for example, that the positive relationship between the HDI and the average area of the property is "contrary to what was expected". The inclusion, in the universe of analysis, of municipalities in the north of the state of Rio de Janeiro that receive oil royalties presents further complications to the parsing of the results.

12. The authors use seven indicators in total: municipal HDI, socio-economic development index, literacy rate, child mortality rate, life expectancy at birth, percentage of people aged 25 or older with less than four years of schooling, and the average years of schooling for people aged 25 or older.

13. When a variable X presents a given variation, and another variable Y presents variation in the same sense, it is said that there is a positive direct correlation between them (and the correlation coefficient will be close to 1). If there is no relationship between X and Y, then both are randomly variable: it is then said that there is no correlation (and the coefficient value will be close to 0). If the variables vary in opposite directions—one increasing while the other decreases—it is said that there is a negative correlation between the variables (and the value of the coefficient will be close to -1).

14. After the data have been weighted by the population of the micro-regions.

15. The values of the data for each municipality are available in IBGE's Sidra database. The data used here were granted by the IBGE after a formal request to the management of the agricultural census. The authors would like to extend their particular thanks to Antônio Florido for his swift response.

16. The data in Tables 3, 4 and 6 were the result of employing the number of micro-regions (and not of the population) as the universe of analysis, with 558 micro-regions and 5,565 municipalities. In the case of land ownership indicators, the number of municipalities was 5,485 in 1996 and 2006.

17. Strata are one-fifths of the distribution of the number of micro-regions for each of the indicators. We have decided to build the fifths based on the number of rural establishments for the Land Gini Index; the rural population for the degree of rurality; and the population for the HDI. The weight of the indicator for the construction of the fifths and its cartographical presentation does not appear to better or worse illustrate the associations between quality of life, rurality and concentration of land ownership.

18. In the case of the North region of Brazil, it is important to highlight that the size of the micro-regions and municipalities can imply a certain detachment from the agrarian reality.

19. The appendix contains the correlation matrixes for the municipal data for the two periods observed.

20. Other variables related to the agricultural productive structure, such as wage earning levels and the use of soil, were not incorporated. According to recent studies, the decrease in rural poverty was quite expressive among households of salaried agricultural workers, which is related to an increase in the formalisation of work. Therefore, one can infer that the negative association between rural wage earning and quality of live must have been reduced or disappeared entirely.

21. This resulted in the exclusion of 70 micro-regions, reducing the total from the original 558 to 488.

22. The other two co-variables were fixed according to micro-regional averages. Therefore, when the Gini values are altered, the proportion of the rural population compared to the total population and expected schooling for children and teenagers are the micro-regional averages for the respective periods—Tables 4 and 6. The same goes for alterations in the proportion of the rural population.

23. Considering the average values of rurality and of expected years of schooling, the predicted under-1 child mortality rates are, for 2000, 29.4 and 34.8 per 1,000 live births for the 0.60 and 0.85 Ginis, respectively. For 2010, these figures are 15.9 and 20.5 per 1,000 live births, respectively.

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