International Journal of Business, Economics and Management
2024 Vol. 11, No. 2, pp. 28-42
ISSN(e): 2312-0916
ISSN(p): 2312-5772
DOI: 10.18488/62.v11i2.3744

Inequality in the appropriation of wealth generated between the richest and poorest municipalities in Brazil between 1999 and 2020

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Article History
Received: 26 July 2024
Revised: 29 March 2024
Accepted: 18 April 2024
Published: 7 May 2024

Keywords
Absolute poverty
Gross domestic product
Human capital
Minimum wage
Poverty cycle
Relative poverty.

JEL Classification:
D31; O15; R11.

ABSTRACT

This research aimed to show the evolution of the Gross Domestic Product (GDP) per capita of the poorest Brazilian municipalities, in relation to that observed in the country's richest municipalities in the period 1999-2020. The data used were: total GDPs; GDP per capita; and agricultural GDP. The data source was the Brazilian Institute of Geography and Statistics (IBGE). We indexed all values for 2020 using the General Price Index (GPI) of the Getúlio Vargas Foundation. Brazil's 5,570 municipalities were ranked in ascending order using annual GDP per capita, and organized into deciles. We selected the first decile, which included the 557 municipalities with the lowest GDP per capita, and the last decile, which included the 557 municipalities with the highest GDP per capita, for comparison purposes. We evaluated the evolution of the per capita GDP/total GDP ratio in these deciles. Geometric Growth Rates (GGR) were estimated in order to gauge the trends observed in these ratios between 1999-2020. The evidence showed that the magnitudes of GDP per capita observed in the tenth and first deciles are quite unequal. However, the study also showed that there was a small reduction in the evolution of the GDP per capita/total GDP between 1999-2020, which suggests a small reduction in inequality in the appropriation of wealth generated in Brazil over the period evaluated. It was also observed that in the richest deciles, the agricultural GDP/total GDP ratio was lower than that observed in the poorest deciles.

Contribution/Originality: Over a period of time, there have been no scientific studies comparing the GDP per capita of the poorest municipalities with that of the richest municipalities in Brazil, such as this study. There are also no studies showing that in Brazil's poorest municipalities, agricultural GDP has a greater share of total GDP.

1. INTRODUCTION

Brazil is known for its inequality in relation to the patterns of appropriation of the wealth generated and the development of its five regions, its 26 states, the Federal District, and its current 5570 municipalities. A small portion of its population enjoys standards of income and quality of life comparable to those observed in the world's most developed economies. However, when they do, the majority have access to income levels that significantly

affect this population's quality of life. This results in some of the highest indicators of poverty and social exclusion in the country (Lemos, 2012).

In fact, the 5,570 municipalities have very different shares of both the total wealth generated and the per capita share. This is most pronounced in the North and Northeast regions, where the majority of municipalities have the lowest GDP, both total and per capita. This fact is manifested, among other reasons, by the human capital differential that prevails in the two poorest regions, compared to the richest: Southeast and South (Barbosa & Lemos, 2019).

This phenomenon has manifested itself historically and has been a cause for concern for the country's rulers. Thus, the Legislative Branch created Law no. 185, which the then the President of Republic, Getúlio Vargas, sanctioned on January 14, 1936. Article 1 of the law established that "Every worker has the right, in payment for services rendered, to a minimum wage capable of satisfying, in a given region of the country and at a given time, their normal needs for food, housing, clothing, hygiene, and transportation" (Chamber of Deputies, 1936).

However, the seventh article of the law, which established the minimum wage, already establishes a difference in value based on the region:

Art. 7: For the purposes of this law, the country shall be divided into 22 regions corresponding to the 20 states, the Federal District, and the Territory of Acre. Each region shall have a wage commission headquartered in the capital of the state, the Federal District, and in that of the general government in the territory of Acre (Chamber of Deputies, 1936).

In this way, the federal government established minimum wage differentials between Brazilian regions and states, penalizing the poorest, who were precisely in the North and Northeast of the country. However, the military government in Brazil unified the minimum wage throughout the country in May 1984.Complementary Law 103 allows states to set state floors higher than the national minimum.

It is clear, therefore, that the creation of the minimum wage, first in a differentiated way between the Brazilian states and regions, and then in a unified way, constituted an attempt by the federal government to interfere in the purchasing power of the Brazilian population. An attempt that, unfortunately, has not materialized in practice, given that there are a huge number of municipalities whose populations have no income at all or survive on incomes below the minimum wage.

This research aims to show the evolution of GDP per capita in the poorest municipalities, in relation to that observed in the richest municipalities, between 1999 and 2020. The specific objectives of the study are a) To evaluate the variations in absolute and relative totals, as well as populations, in municipalities whose GDP per capita was at most one minimum wage per year between 1999 and 2020; b) To present the evolution of the ratio between the GDP per capita of municipalities belonging to the first decile (the one with the lowest GDP per capita) compared to those belonging to the decile with the highest GDP per capita; c) Present the variations in the ratio between GDP per capita and the minimum wage in the municipalities of the first and tenth deciles over the period analyzed; d) Evaluate the evolution of the shares of agricultural GDPs in relation to total GDPs in the first and last deciles over the course of the evaluation between 1999 and 2020; e) evaluate the evolution of the annual populations of the first and last deciles.

2. THEORETICAL BACKGROUND

This section provides a brief overview of the concept of poverty, which has various forms of measurement. The concept of multifunctional poverty, which incorporates several variables, as well as the more restricted concept, which only considers aspects related to the appropriation of income, is the focus of this research. Additionally, we discuss the significance of the agriculture's sectors contribution to overall income. It is based on the premise that agriculture plays a more significant role in shaping the incomes of poorer economies. The aim of this research was to validate or refute this claim.

2.1. Poverty

The concept of poverty lacks a standardized and universal definition. It is possible, however, to state that it manifests itself in situations of deprivation, where individuals face difficulties in maintaining a basic standard of living according to the norms established in a given historical context (Lemos, 2012).

The discussion of poverty must inevitably address a crucial factor that drives it, which is access to a minimum income that provides for the basic needs of individuals and families. Classical political economists not only recognized this interconnection, but also elevated it to the category of "the main problem of political economy." Their concern was with the reciprocal effects of the distributive profile on economic growth, i.e., the accumulation of wealth or capital (Carvalho & Souza, 2021).

According to the analysis of Barros, Henrique, and Mendonca (2000), Brazil is not an economically poor country but rather a nation that faces the significant presence of people in poverty. It is a country that has resources; however, their distribution is unequal, concentrated in the hands of a few, while the majority has limited access, including with regard to public goods and services, whose responsibility falls on the state.

Neoclassical economists based their definition of poverty on the concept of utility, used as an indicator of an individual's general well-being. This perspective viewed well-being as a quantitative variable, directly and proportionally linked to an individual's income (Lago, 1990).

This neoclassical interpretation suggests that income growth is the key to eradicating poverty. In this line of thought, the theory argues that individuals and families have the capacity to overcome poverty by simply increasing the average individual or family income (Loayza, Fajnzylber, & Calderón, 2005).

This analytical approach does not take into account that poverty is both a cause and a result of the wealth produced in the economic context. Therefore, an increase in income will not necessarily guarantee improvements in development standards, conceived as a generalized advance in social well-being (Human Development Report, 1994; Langoni, 1972).

From the perspective of interpreting the political or historical economy of poverty, solving this problem requires a change in social relations. This implies a transformation in the way and processes by which social groups acquire and retain control over productive, social, and environmental assets (Lemos, 2020; Veloso, Villela, & Giambiagi, 2008).

This research uses the GDP per capita of the Brazilian municipalities used as observation units to measure poverty in aggregate terms. In this way, it is assumed that GDP per capita is a proxy for the average income of each municipality, and a relationship is made between this approximate average income and the minimum wage. As per capita GDPs are averages, the research will not be able to capture how they are distributed around the average, but it will show the populations of municipalities that have a certain level of average income. The research will also show the inequalities in the appropriation of GDP per capita between municipalities and will also show that municipalities where GDP per capita is below the annual minimum wage can be considered poor on average, in the absolute sense.

2.2. Impact of Agricultural GDP on Total GDP as a Definition of Poverty

There is a debate among economics scholars in general and those specializing in rural economics in particular about the relative participation of the agricultural sector's GDP as an inducer of economic development. Evidence shows that, in the process of economic development, the relative share of agricultural GDP in the total GDP of a society (country, region, state, municipality, or village) tends to decrease.

However, this decrease should be relative, and in absolute terms, the generated wealth share should increase over time. This trend is justified by considering the dynamics of economic development as a "moving train," where the locomotive that "pulls" the wagons would be represented by the urban-industrial sector, which includes the manufacturing and services segments. In this context, the "wagon" associated with wealth generation in the

agricultural sector plays a supporting role. In this scenario, the agricultural sector is expected to be able to supply the raw materials and food demanded by the other segments that make up the development "train" efficiently, quickly, and at low costs.

To achieve this, the agricultural sector must have a comprehensive technological infrastructure and adequate equipment to ensure that the productivity of the land and other factors involved in agricultural production are efficient, both from a technical and economic point of view.

The urban-industrial sector, as the "lever" of the development process, should be endowed with good equipment, advanced technologies, capital stock, and human capital (Solow, 1956).

The dynamics of all productive sectors are quite complex. Vieira Filho and Silveira (2012) highlight the role of investments in generating technological innovations and technically and economically efficient combinations of inputs, which provide comparative and competitive advantages. But this is only possible if there is a qualified and vigorous workforce, from a health point of view (Becker, 1964; Schütz, 1962).

Studies such as those by Johansen (2014); Larionova and Varlamova (2015) and Lee and Lee (2018), highlight the relevance of human capital by demonstrating that a more equal distribution of education contributes significantly to reducing income inequalities.

There are studies that show that the reduction of inequalities in income distribution may have been influenced by the improvement of human capital skills, and, reciprocally, improvements in income distribution affect the quality of human capital. This proposition had already been defended by Galor (2012), who showed both theoretically and through empirical evidence that income distribution has an impact on the formation of human capital and the dynamics of economic development.

Therefore, it follows that economic growth and development in any sector must lead to an increase in the income of the populations involved. Thus, in the municipalities with the lowest GDP per capita, this is due to the low quality of the workforce in general, the low level of investment in productive capital and technology. In these cases, the rural sector generally exhibits low levels of productivity across all factors of production, particularly the workforce.

This is reflected in the total productivity differentials (Barbosa & Lemos, 2019). These deficiencies tend to be greater in the poorer municipalities, which are also poor because of this. Forming a vicious circle (Nurkse, 1953).

In this search, which is based on the total GDP and GDP per capita of all Brazilian municipalities, it will not be possible to assess the role of human capital in these municipal income indicators. However, it is believed that the low quality of human capital, which is more prevalent in the poorest regions of Brazil (North and Northeast), was one of the factors influencing the differences in this variable in Brazilian municipalities.

3. MATERIAL AND METHODS

The research used secondary data on Brazilian municipal GDP, published by the Brazilian Institute of Geography and Statistics (IBGE), for the period between 1999 and 2020. The variables studied were: Total GDP, GDP per capita, Agricultural GDP and Population. The units of observation are the Brazilian municipalities existing in the period investigated. The research also used the annual values of minimum wages for each year. We corrected all the annual values using the General Price Index of the Getúlio Vargas Foundation (GPI) as an index, based on the year 2021.

When then corrected values in Brazilian reais (Brazilian currency) into US dollars using the average exchange rate for 2021 (R$5.5748/US$). During the studied period, Brazil saw an increase in the number of municipalities, with 5507 in 1999 and 2000; 5560 from 2001 to 2004; 5564 from 2005 to 2008; 5563 in 2009; 5565 from 2010 to 2012; 5570 from 2013 to 2018; 5568 in 2019 and 2020. We ranked the data for each year in ascending order based on GDP per capita. Below are the methodologies used to achieve each of the four research objectives.

3.1. Methodology to Achieve Objective "A"

In order to identify the absolute and relative totals of municipalities with a GDP per capita of no more than one annual minimum wage, adjusted to 2021 values, Brazilian municipalities were ranked in ascending order during the period studied, at five-year intervals.

We obtained the annualized minimum wages for these years. Initially, all the municipalities per state and their respective populations that met this criterion were counted. Next, the total number of municipalities per state in the first and last deciles were counted, respectively, those with the lowest and highest GDP per capita, along with their respective populations that also met this criterion.

3.2. Methodology for Reaching the Second "B"

In order to demonstrate the evolution of the relationship between the GDP per capita of the first decile (the 10% of municipalities with the lowest values) and those in the last decile (made up of the 10% with the highest GDP per capita in Brazil) in the period from 1999 to 2020, the populations and GDP per capita of the first and last deciles of Brazilian municipalities over the historical series were evaluated.

When then used Equation 1 to estimate the instantaneous geometric growth rate of this ratio: using Equation 1:

$$Y_t = \beta . e^{(\rho T + \epsilon t)} \qquad (1)$$

In Equation 1, the linear coefficient has been transformed into a linear log. The constant "e" corresponds to natural logarithms base. The variable "T" represents time (T = 0, 1, ..., 21). The value T = 0 corresponds to the year 1999, T = 1 to the year 2000, and so on. The angular coefficient "ρ" is the derivative of the logarithm of Yt with respect to time [d(logYt / dT)], multiplied by 100, to express this value as a percentage, representing the instantaneous annual TGC of Yt. The random term "Єt", by assumption, meets the requirements of the classic linear model, which means that it has zero mean, constant variance, and is not autoregressive (Wooldridge, 2015).

If GGRis statistically greater than zero, this indicates that the variable Yt has grown at an annual rate defined by its estimated magnitude. If TGC is statistically less than zero, it means that there was a decrease in the ratio of the Yt variable during the period analyzed at an average annual rate defined by the magnitude of TGC. If TGC is not statistically different from zero, it suggests that the variable has remained stable over time.

3.3. Methodology for Measuring Objective "C"

To assess the annual evolution of the relationship between GDP per capita and the annualized minimum wage for each decile studied, the GDP per capita value was divided by the wage, transforming the result into a percentage. Subsequently, the GGRof this ratio is calculated, following the procedure indicated in Equation 1.

3.4. Methodology for Measuring Objectives "D" and "E"

In order to achieve this objective, the research sought to assess the annual variation in the share of agricultural GDP in relation to total GDP for each decile examined (first and tenth decile), as well as the populations corresponding to each decile. Agricultural GDP was divided by the total GDP of the municipalities, and the annual populations in the first and tenth deciles were calculated. To calculate the average of this ratio over the period, the Geometric Growth Rate (GGR) was used, as shown in Equation 1.

In Equation 1, the linear coefficient has been transformed into a linear logarithm. The constant "e" corresponds to the base of natural logarithms. The variable "T" represents time (T = 0, 1, ..., 21). The value T = 0 corresponds to the year 1999, T = 1 to the year 2000 and so on. The angular coefficient "ρ" is the derivative of the logarithm of Yt with respect to time [d(logYt / dT)], multiplied by 100, to express this value as a percentage, representing the instantaneous annual TGC of Yt. The random term "Єt", by assumption, meets the requirements of the classic linear model, which means that it has zero mean, constant variance, and is not autoregressive (Wooldridge, 2015).

If TGC is statistically greater than zero, this indicates that the variable Yt has grown at an annual rate defined by its estimated magnitude.

If TGC is statistically less than zero, this means that there has been a decrease in the proportion of the Yt variable during the period analyzed at an average annual rate defined by the magnitude of TGC. If TGC is not statistically different from zero, this suggests that the variable remained stable during the period.

3.5. Methodology for Measuring Objectives "D" and "E"

In order to achieve these objectives, the research sought to evaluate the annual variation in the share of agricultural GDP in relation to total GDP for each decile examined (first and tenth deciles), as well as the populations corresponding to each decile. We divided the agricultural GDP by the total GDP of the municipalities and calculated the annual populations in the first and the tenth deciles. In order to calculate the changes as well as the average rates of change in these ratios over the period, the instantaneous Geometric Growth Rate (GGR) over the period was estimated using Equation 1.

4. RESULTS AND DISCUSSION

Each of the set objectives will guide the presentation of the research results. This approach has been adopted by the document's authors to make it easier for readers to understand. However, before showing these results, the research evidence showed that between 1999 and 2020, the minimum wage in Brazil, in 2021 values, varied between US$1828.35 and US$3255.74, with an average value of US$2537.92 and a coefficient of variation of 19.6%. In the same period, inflation in Brazil, measured by the Getúlio Vargas Foundation's GPI, had a geometric growth rate (GGR) of 2.7%.

The minimum wage experienced GGR=3.0%. Therefore, between 1999 and 2020, there was a real gain in the purchasing power of the minimum wage in Brazil.

4.1. Results Found to Meet Objective "A"

Before analyzing the disparities between the deciles (poorest and richest), it is necessary to examine the quantitative evolution of the municipalities whose residents have a per capita income of up to one annualized minimum wage. We observed that the proportion of municipalities with an income of less than one annualized minimum wage remained at a minimum of 27.9% in 2000 and a maximum of 35.2% in 2006. The population for these years was approximately 25.03 million and 32.86 million, respectively, representing 14.61% of the Brazilian population in 2000 and 17.59% in 2006.

Among the states that had municipalities in this condition, Bahia stood out as having the largest absolute number of municipalities that met the criteria established for this objective, throughout all the years, reaching its peak in 2017, with 331 of its 417 municipalities (79.4%), whose GDP per capita was less than one minimum wage, and a population of 6.52 million inhabitants. This contingent represents 3.14% of the country's total population that year, and corresponds to 20.22% of the municipalities considered to be the poorest, those in the first decile.

Next in line was the state of Minas Gerais, which had 289 municipalities and a population of 2.74 million in the same year. In 2019, Maranhão had 85.25% (185) of its municipalities and a population of 4.93 million individuals with an average income of less than one annualized minimum wage. It should be noted that, proportionally, Maranhão is the state with the poorest municipalities in the country.

Although the number of municipalities is relevant information, analyzing the size of the population in these conditions is even more important. To this end, Figure 1 illustrates the evolution of the population by state in specific years, and Table 1 shows this evolution by year. Thus, in 2020, there were 1656 (29.7%) municipalities whose GDP per capita was at most one minimum wage. These municipalities had 29.93 million inhabitants.

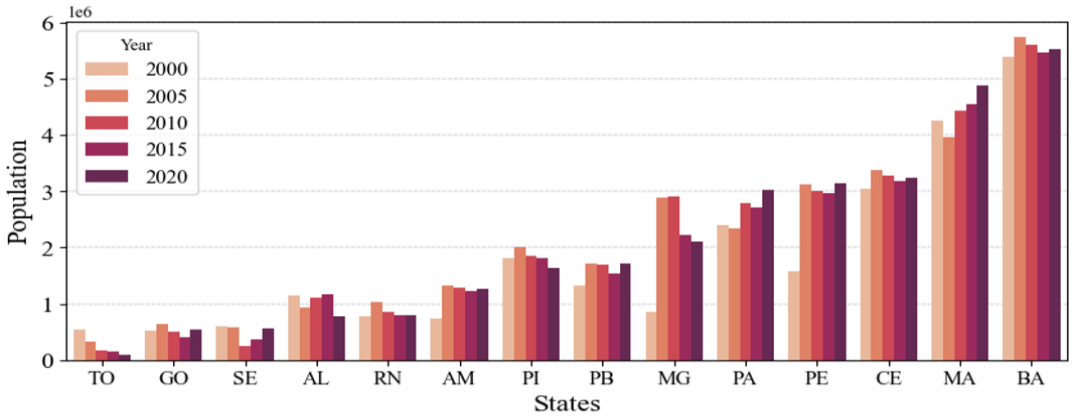


Figure 1. Evolution of the number of people, by state, whose GDP per capita was at most one annualized minimum wage.
Note: Legend: "1e6" is an abbreviated way of expressing a value in the order of millions. For example, 6 1e6 equals 6 million.
States of Brazil: Tocantins (TO), Goiás (GO), Sergipe (SE), Alagoas (AL), Rio Grande do Norte (RN), Amazonas (AM), Piauí (PI), Paraíba (PB), Minas Gerais (MG), Pará (PA), Pernambuco (PE), Ceará (CE), Maranhão (MA), Bahia (BA).
Source: Brazilian institute of geography and statistics(IBGE) data, various years.

Table 1. Evolution of the number of municipalities and their population whose GDP per capita was less than 1 minimum wage.

Year	Municipality	Absolute population*	Relative population**(%)
2000	1536	25033	14.60
2005	1861	30544	16.60
2010	1827	29973	15.70
2015	1712	28884	14.10
2020	1656	29939	14.10

Note: * Population in 1000 inhabitants; ** Proportion of the population living in municipalities whose GDP per capita was less than one annualized minimum wage in relation to the country's total population for the respective year.
Source: Prepared by the authors based on Brazilian institute of geography and statistics(IBGE) data, various years.

Figure 2 illustrates the distribution of municipalities by state in the first decile (where the poorest municipalities are) over the years studied. São Paulo, Goiás and Sergipe had only one municipality each, while Tocantins had 38 municipalities in 2000, down to 3 in 2005. Among the states portrayed, Maranhão, relatively, stood out with the highest number of municipalities with the lowest GDP per capita in the country, despite having experienced a decrease from 171 (in 2000) to 140 (in 2020). Piauí also achieved a remarkable result, reducing the number of poor municipalities from 127 (in 2000) to 54 (in 2020). The states of Ceará, Amazonas, Alagoas, and Rio Grande do Norte showed no significant changes in the number of municipalities over the period analyzed. On the other hand, Minas Gerais and Pernambuco saw an annual increase in the number of poor municipalities, reaching 31 and 51, respectively, in 2020. Paraíba, on the other hand, registered a notable increase, reaching 41 municipalities in 2020, more than double the number five years earlier.

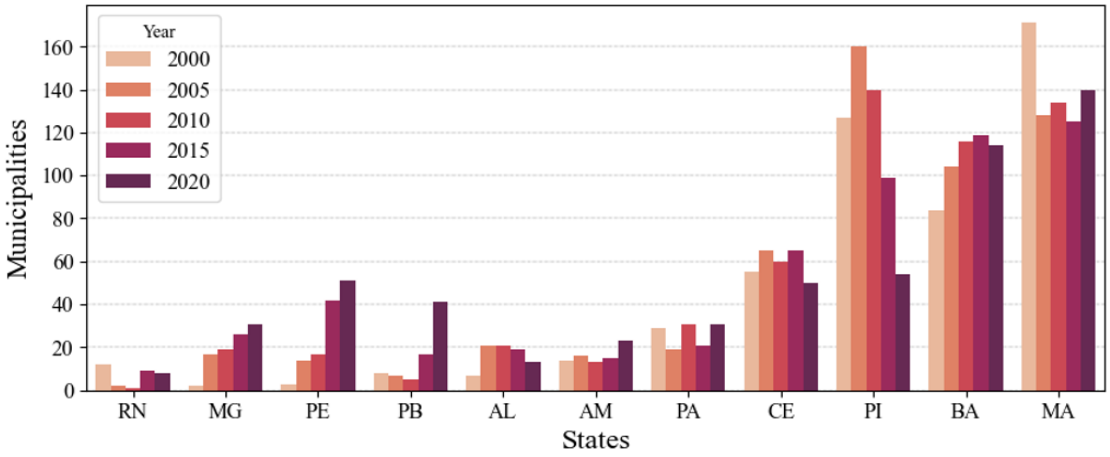


Figure 2. Evolution of the number of municipalities and states whose GDP per capita was in the first decile.
Source: Prepared by the authors based on Brazilian institute of geography and statistics(IBGE) data, various years.

Table 2 shows the populations trends over time for the municipalities with the lowest GDP per capita (first deciles) in each state.

This gives an overview of the number of inhabitants occupying the most income-deprived municipalities in the country. As mentioned earlier, Maranhão is the state with the largest contingent of individuals living in municipalities with the lowest GDP per capita, followed by Bahia. In 2020, the population of Bahia living in the municipalities with the lowest GDP per capita represented 57.9% of the population of Maranhão living in that condition.

Compared to 2000, the population surviving in the municipalities in the first decile in Pernambuco increased by 93.65%, in Minas Gerais by 94.44% and in Paraíba by 79.69%. On the other hand, the population of Rio Grande do Norte fell by 59.31%, and even Maranhão, by 16.62%.

Table 2. Evolution of the population (POP) of Brazil and municipalities per Brazilian state that were part of the first decile.

State	Population in 1000 inhabitants.				
	2000	2005	2010	2015	2020
Maranhão	3,709	2,392	2,707	2,551	3,181
Bahia	1,402	1,730	1,785	1975	1,841
Pernambuco	68	225	254	796	1,068
Ceará	985	1,223	1,103	1,321	1,009
Pará	942	415	907	555	928
Amazonas	266	361	247	457	640
Piauí	976	1,223	1,029	718	490
Paraíba	76	71	50	151	373
Minas Gerais	17	186	190	253	309
Alagoas	168	337	317	312	193
Rio Grande do Norte	127	20	10	85	80
Total (1)	8,736	8,183	8,599	9,174	10,112
Brazil POP. (2)	171280	184181	190585	204283	211587
%Relationship (1) / (2)	5.10%	4.44%	4.51%	4.49%	4.78%

Source: Brazilian institute of geography and statistics(IBGE) data, various years.

The results shown in Table 2 suggest that the resident populations in the first deciles grew from 8,736,000 to 10,112,000 inhabitants, an increase of 15.75%.

This increase in the population of municipalities in the top decile in 2020 compared to 2019 and, why not, to other years, can be attributed to the COVID-19 pandemic, which led to the general impoverishment of the country and had an impact, above all, on the population of the poorest municipalities. There was probably a migration of populations from the upper deciles to the decile that grouped together the municipalities with the lowest GDP per capita.

Figure 3 illustrates the distribution of municipalities in Brazil's richest bracket (decile 10). It is important to note that states from the Southeast and South regions dominate this category. Since 2000, the state of São Paulo has held the lead, with 167 municipalities, but this number fell to 103 in 2020. Both Rio Grande do Sul and Rio de Janeiro showed a more significant drop in the number of municipalities. On the other hand, the states of Mato Grosso and Paraná recorded a substantial increase in the number of municipalities in this range over the period analyzed.

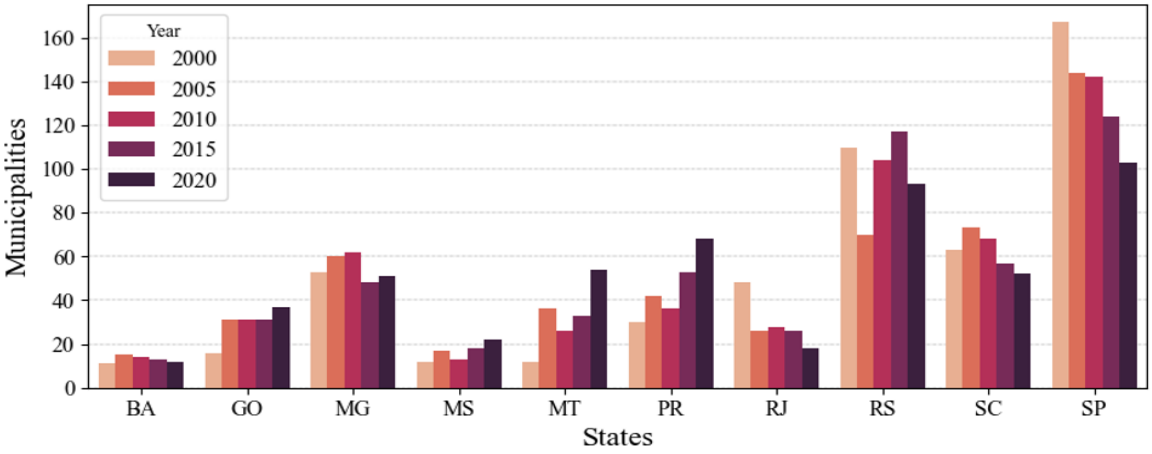


Figure 3. Changes in the number of municipalities per Brazilian state whose GDPper capita was in the richest decile.

Note: States of Brazil: Mato Grosso do Sul (MS), Mato Grosso (MT), Paraná (PR), Rio de Janeiro (RJ), Rio Grande do Sul (RS), Santa Catarina (SC), São Paulo (SP).

Source: Brazilian institute of geography and statistics(IBGE) data, various years.

Figure 4 illustrates the distribution, by state, of municipalities that were part of the first decile (in red) and those that were part of the last decile (in blue) in the years 2010 and 2020. As observed in this map which is confirmed in Figures 2 and 3, the municipalities remain concentrated in practically the same states (in the first and 10th deciles) over the years, with only the quantities varying.

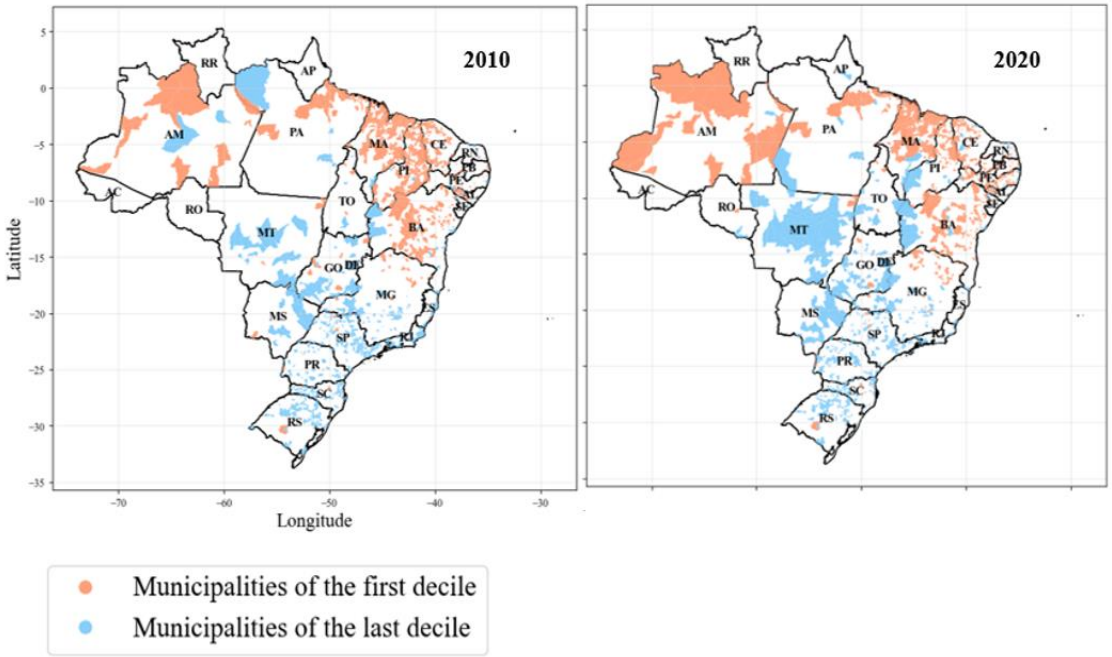


Figure 4. Distribution of municipalities by Brazilian state in 2010 and 2020, according to deciles.

Source: Based on the survey results in 2010 and 2020.

Table 3shows the changes in resident populations within the richest deciles municipalities and states during the survey years. As expected, the state of São Paulo leads the way with a significant number, exceeding 22.6 million people in 2020. Minas Gerais is in second place, with around 2.4 million, representing approximately 1/9 of São Paulo's population.

Table 3. Evolution of the population (POP) of the states with municipalities whose GDP per capita were in the richest decile.

States	Population in 1000 inhabitants				
	2000	2005	2010	2015	2020
São Paulo	23,025	26,296	27,479	25,640	22,608
Minas Gerais	3,029	3,000	6,322	3,321	2,445
Santa Catarina	1,892	2,771	3,278	3,247	2,042
Rio de Janeiro	8,735	9,139	9,980	10,466	1,933
Rio Grande do Sul	4,459	3,913	4,748	4,403	1,808
Paraná	1,096	4,005	3,559	4,018	1,651
Mato Grosso	168	1,124	639	781	1,253
Bahia	529	711	794	776	730
Goiás	174	644	1001	760	581
Mato Grosso do Sul	145	332	300	407	486
Total (1)	43,252	51,935	58,100	53,819	35,537
Brazil POP. (2)	171280	184181	190585	204283	211587
%Relationship (1) / (2)	25.25%	28.20%	30.49%	26.35%	16.80%

Source: Brazilian institute of geography and statistics(IBGE) data, various years.

The evidence shown in Table 3 suggests that between 2000 and 2020 there was a reduction of -21.71% in the populations living in the municipalities that were part of the tenth deciles, those with the highest GDP per capita. In this case, it was observed that the trajectory of the populations evolved between the years 2000, 2005, and 2010. In 2015, it already experienced a decline, which continued in 2020. The COVID-19 pandemic may have aggravated the decline in the populations of municipalities in the tenth decile in 2020, leading some of these populations to migrate to the lower deciles.

4.2. Results Found for Objectives "B"; "C" And "D"

Table 4 displays the result for these objectives. This table uses the following names for the variables: D1 refers to the first decile of municipalities, those with the lowest GDP per capita in each of the years observed. The variables PER_{D1t} and PER_{D10t}, respectively, refer to the GDP per capita of the first decile and the last decile in the t-th year. The variable MW_t refers to each year's minimum wage. The GDP_{D1t} and $GDP_{D10}t$ variables, respectively, refer to the total annual GDP of the municipalities in the first and last decile. The variables POP_{D1t} and POP_{D10t} quantify the populations observed annually in the first and tenth deciles, respectively. Finally, the $GDPAGR_{D1t}$ and $GDPAGR_{D10t}$ variables, respectively, quantify the agricultural GDP recorded in the first and last decile each year.

Table 4. Results found for estimating the geometric growth rates.

Variable	Constant		Geometric rate of growth		
	Value	Sign	Value	Sign	Adjust R^2
GDP_{D1t} / GDP_{D10t}	-4.44	0.000	0.019	0.000	0.640
PER_{D1t}/PER_{D10t}	-2.55	0.000	0.017	0.000	0.956
$PER_{D1}t/MW_t$	-0.63	0.000	0.006	0.000	0.750
PER_{D10t}/MW_t	1.92	0.000	-0.010	0.000	0.852
$GDPAGR_{D1t}$ / GDP_{D1t}	-1.46	0.000	-0.035	0.000	0.974
$GDPAGR_{D10}t/GDP_{D10t}$	-3.80	0.000	-0.007	0.487	0.156
POP_{D1t}	15.91	0.000	0.007	0.000	0.709
POP_{D10t}	17.80	0.000	0.004	0.297	0.232

Note: Gross domestic product (GDP), Minimum wage (MW), Agricultural gross domestic product (GDPAGR), Gross domestic product per capita (PER).
Source: Brazilian institute of geography and statistics (IBGE), various years.

4.2.1. Results Found to Achieve Objective "B"

From the results presented in Table 4 and Figure 5, it can be inferred that, over the period investigated (1999 to 2020), there has been an evolution in the ratio between the total GDP of the top decile and the bottom decile.

This ratio progressed at an average annual rate of 1.9%. This indicator suggests that, in aggregate terms, there has been a reduction in inequalities in the generation of wealth between the 10% of municipalities with the lowest total GDP compared to the 10% that had the highest volume of wealth generated in the period evaluated.

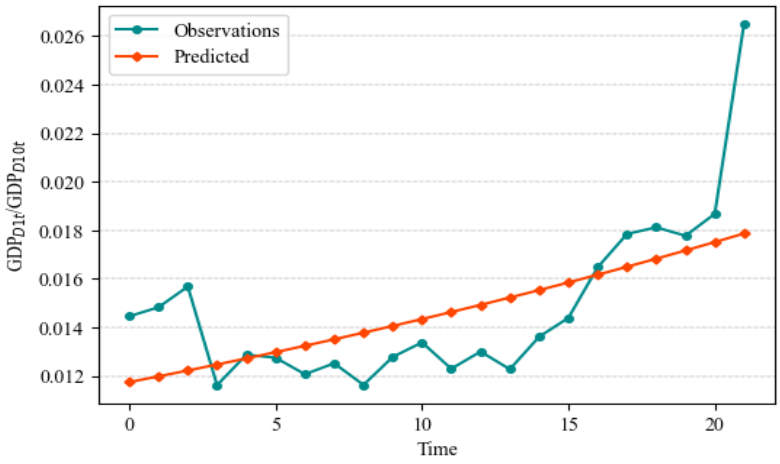


Figure 5. Geometric growth rate of the ratio between total GDP in the first and last decile.
Source: IBGE data, various years.

The ratios between the GDP per capita of the municipalities in the bottom decile and those in the top decile also rose at an average annual rate of 1.7% per year. This suggests a reduction in inequalities between the two groups of municipalities (Table 4 and Figure 6).

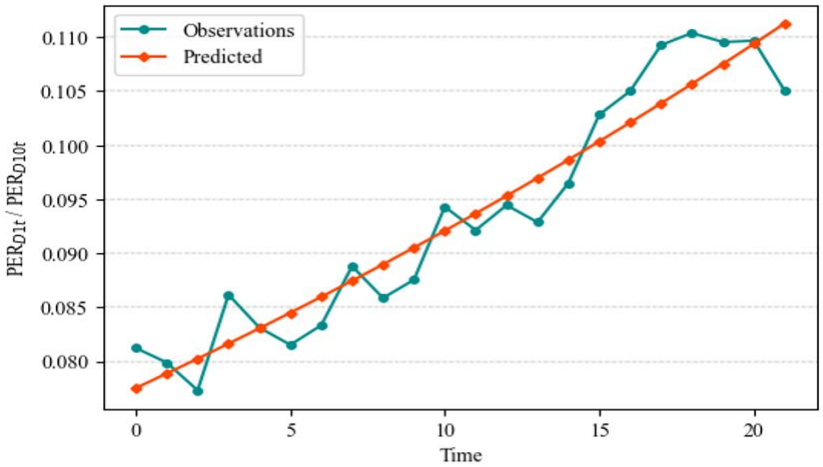


Figure 6. Geometric growth rate of the ratio between GDP per capita in the first and last decile.
Source: IBGE data, various years.

4.2.2. Results Found to Achieve Objective "C"

The results presented in Table 4 show that the relationship between the GDP per capita of the municipalities positioned in the first decile and the annualized minimum wage experienced a modest increase of 0.6% per year over the period studied. This suggests that, on average, these incomes in the municipalities in the first deciles were above the minimum wage adjustments. As the annual adjustments to minimum wages take inflation in the previous year, it can be seen that the GDP per capita of these municipalities experienced a slight improvement in purchasing power over the period evaluated (Table 1 and Figure 7).

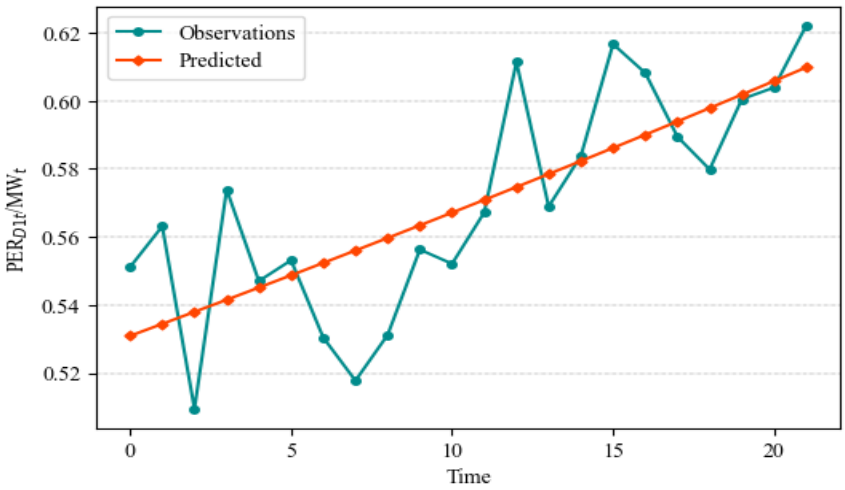


Figure 7. Geometric growth rate of the ratio between GDP per capita and minimum wage in the first decile.
Source: IBGE data, various years.

The municipalities in the richest deciles (deciles 10) saw an average annual decline in GDP per capita of 1.0%. This result suggests that there was a slight drop in the average purchasing power of the income of the populations living in the municipalities in this group (Table 1 and Figure 8).

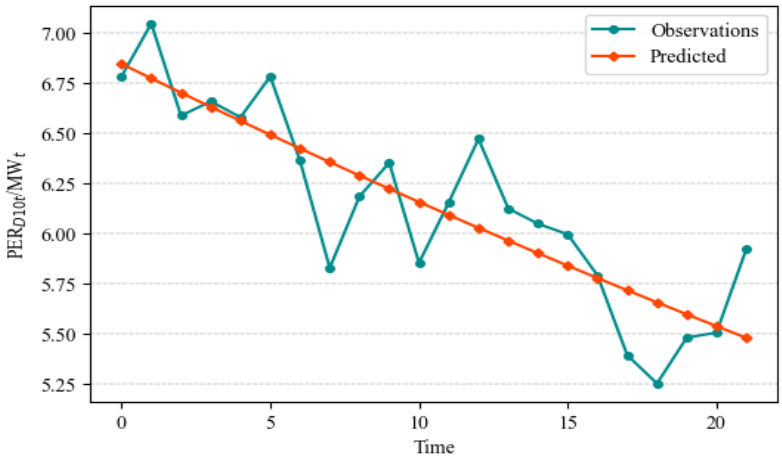


Figure 8. Geometric growth rate of the ratio between GDP per capita and minimum wage in the tenth decile.
Source: IBGE data, various years.

4.2.3. Results Found to Achieve Objective "D"

To this end, the study sought to evaluate the annual evolution of the share of agricultural GDP in relation to total GDP for each decile studied (first and tenth decile). In the first decile, the average share of agricultural GDP in total GDP during the studied period was 16.3%, ranging from a minimum value of 11.0% to a maximum value of 23.5% with a CV of 24.3%. In the tenth decile, the average share of agricultural GDP/total GDP ranged from 1.3% to 4.2%, with an average of 2.2% and CV=34.1%. Therefore, as expected, the relative shares of agricultural GDP in total GDP are much higher and more stable in the first decile than in the tenth decile.

The results shown in Table 4 suggest that in both deciles there was a drop in the agricultural GDP/total GDP ratio. However, this drop was much more significant in the municipalities that were part of the first deciles (3.5% per year) than in those grouped in the richest decile (0.7% per year).

We can assume that the sharper drop in the municipalities belonging to the first decile is due to the fact that the most of the municipalities are located in the Northeast. In 2010 and between 2012 and 2017, there was a period

of drought, which possibly led to a reduction in agricultural production in practically all the municipalities in this region (Table 4 and Figure 9).

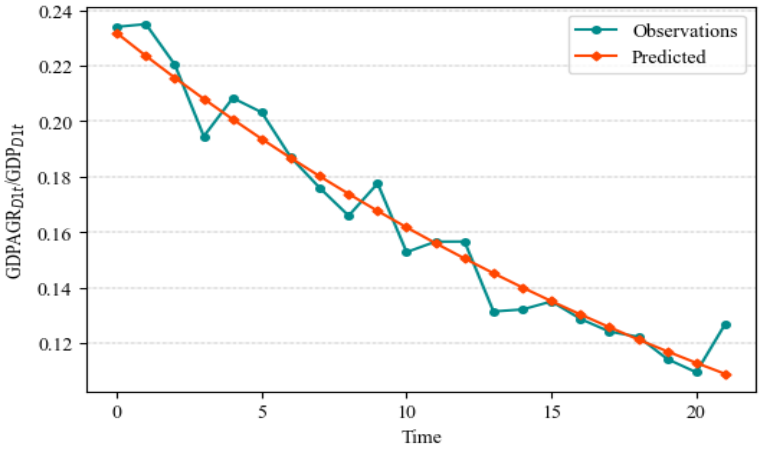
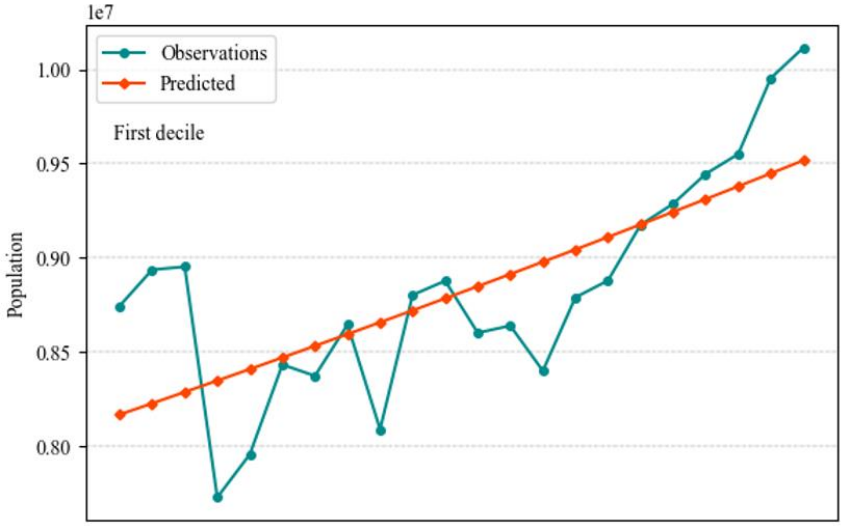


Figure 9. Geometric growth rate of the ratio between agricultural GDP and total GDP in the first decile.
Source: IBGE data, various years.

4.2.4. Results Found to Achieve Objective "E"

The aim was to show the average annual evolution of populations in the first and last deciles. It can be seen that the populations observed in the first decile experienced a GGR of 0.7% per year, slightly higher than that estimated for the populations in the tenth decile where the GGR was 0.4% per year.

These results suggest that, over the 22 years evaluated, there was an average increase in the populations of the lowest-income municipalities. The government's special programs implemented in the country during the evaluated period provide the largest transfers to these municipalities. This suggests that these transfers were unable to reduce or, at least, contain the population contingents of Brazil's lowest-income municipalities between 1999 and 2020 (Table 4 and Figure 10).



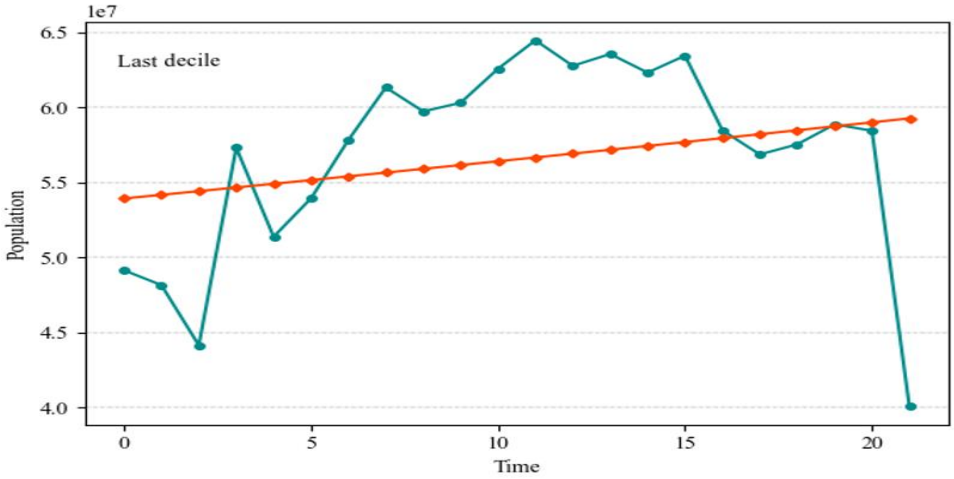


Figure 10. Geometric growth rate of populations in the first and last decile.

Note: 'le7' is a shortened way of expressing a value in the tens of millions. For example, 6 le7 is equivalent to 60 million.

Source: Prepared by the authors based on IBGE data, various years.

5. CONCLUSIONS

The evidence found by the research confirmed the existence of two Brazils, in terms of the appropriation of wealth generated in their municipalities, as was the assumption that anchored this research. These results confirmed that the vast majority of municipalities with the lowest total GDP and the lowest GDP per capita are located in the states that are part of the North and Northeast regions of Brazil. On the other hand, the municipalities with the highest total GDP and highest GDP per capita are located predominantly in the Southeast and South regions of Brazil. The percentage of municipalities and populations whose GDP per capita is less than the minimum wage ranged from 14.10% to 16.6%, with populations representing between 4.4% and 5.1% of the Brazilian population between 1999 and 2020. Despite the disparities between total GDP and GDP per capita observed in the first and last deciles, the research showed that the ratios of both, both in the first and last deciles, showed a downward trend over the period analyzed, which means a slight drop in inequalities between the municipalities with the highest wealth in relation to those with the lowest wealth. The research indicates a slight annual increase of 0.6% in GDP per capita in the first decile in relation to the minimum wage. Given the positive growth of the minimum wage, we can conclude that these municipalities saw average gain in wealth accumulation per person. On the other hand, a decrease (-1.0%) in this ratio was observed in the municipalities of the tenth decile, the wealthiest ones. The research confirms that in the poorest municipalities, the share of agricultural GDP in total GDP is much higher, although there has been a downward trend in this ratio, especially since 2010. This is because that year and the years from 2012 to 2017 saw drought in the Northeast, where most of the municipalities with the lowest GDP per capita are located. The general conclusion of the research is that, between 1999 and 2020, there was a reduction in the populations inhabiting the decile where the municipalities with the highest GDP per capita were located, consequently a greater concentration of the wealth generated in that group of municipalities, and an increase in the populations where the municipalities with the lowest GDP per capita were located, therefore an increase in the number of poor people, in the relative sense, in Brazil between the years 1999 and 2020.

Funding: This research is supported by Commission for the Improvement of Higher Education Personnel (CAPES); National Council for Scientific and Technological Development (CNPq) and the Federal University of Ceará (UFC).

Institutional Review Board Statement: Not applicable.

Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.

Competing Interests: The authors declare that they have no competing interests.

Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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