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Evidences on multidimensional poverty in the northern region of Brazil

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This paper aims to present new perspectives for the understanding on multidimensional poverty in northern Brazil in the years 2006-13, in order to assist the government in developing policies focused on fighting poverty and advancing the development process. The study used a methodology built by Bourguignon and Chakravarty (2003), which presents an alternative way of measuring the multidimensionality of poverty. The data was collected from the National Household Sample Survey (PNAD) and the results of six dimensions analyzed revealed a reduction in the proportion of multidimensional poor of the northern population, from 30.71% in 2006 to 25.79% in 2013. As for isolated analysis of metropolitan regions in urban and rural areas, it was found that poverty was more intense in rural areas.

Keywords: multidimensional poverty; deprivation; gap.

Evidências sobre a pobreza multidimensional na região Norte do Brasil

O presente artigo tem como objetivo apresentar novas perspectivas para a compreensão da pobreza multidimensional na região Norte do Brasil nos anos de 2006 a 2013, com a finalidade de auxiliar a administração pública no desenvolvimento de políticas focadas no combate à pobreza e na aceleração do processo de desenvolvimento. Foi utilizada uma metodologia construída por Bourguignon e Chakravarty (2003), que apresenta uma forma alternativa de medir a multidimensionalidade da pobreza. Por meio de dados construídos da Pesquisa Nacional por Amostra de Domicílio (PNAD), os resultados das seis dimensões analisadas revelaram uma redução da proporção de pobres multidimensionais da população nortista, de 30,71% em 2006, para 25,79% em 2013. Para as análises isoladas das regiões metropolitana, urbana e rural, verificou-se que a pobreza foi mais intensa na região rural.

Palavras-chave: pobreza multidimensional; privação; *gap*.

Pruebas en pobreza multidimensional del norte de Brasil

Este artículo tiene como objetivo presentar nuevas perspectivas para la comprensión de la pobreza multidimensional en el norte de Brasil, en los años 2006-13, con el fin de ayudar al gobierno en el desarrollo de políticas centradas en la lucha contra la pobreza y la aceleración del proceso de desarrollo. Se utilizó una metodología construida por Bourguignon y Chakravarty (2003), que presenta una forma alternativa de medir la multidimensionalidad de la pobreza. Construido a partir de datos de la Encuesta Nacional de Hogares por Muestreo (PNAD), los resultados de las seis dimensiones analizadas revelaron una reducción en la proporción de pobres multidimensionales de la población del norte, 30,71% en 2006 a 25,79% en 2013. Para el análisis aislado de las regiones metropolitanas, urbanas y rurales, se encontró que la pobreza es más intensa en el campo.

Palabras clave: pobreza multidimensional; la privación; *gap*.

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1. INTRODUCTION

Since the start of the years 2000 some Brazilian regions have revealed an increasing rise in the Gross Domestic Product (GDP). The Southeast, South, Midwest and Northeast regions of Brazil were outstanding in the participation of the Brazilian GDP formation in 2000, while the North only contributed with 4.6% (Ipea, 2014). It was noted that the Northern region's small share reflects its economic and social reality.

According to Silva and partners (2014), the regions with the highest percentage of multidimensional poor are North and Northeast Brazil for the period 2006-12. In 2012, North Brazil had 26.2% of its population in a state of multidimensional poverty, even when this region showed the highest reduction rate of 4.51% over this period. Lacerda (2009) states that in Brazil the poverty rate has a strong regional component since, regardless of the indicators used, poverty is worst in the North and Northeast.

Since the mid-1980s, having as a reference the economist Amartya Sen, poverty is regarded as a multidimensional phenomenon; in other words, it defines who are the poor of a certain population or region. In addition to analyzing data revealed by the income of those people, cultural, political and social characteristics that influence the individuals' wellbeing should also be considered. The need now arises to extend the scope of the analyses of poverty in the North region, not only from the income viewpoint, but also focusing on the study of the basic needs and increasing the definition of the multidimensional nature of poverty.

The methodology addressed herein is originally found in Bourguignon and Chakravarty (2003) and detailed by Mideros (2012). It is an alternative for measuring poverty specifying a poverty line for each dimension. The differential of this study is that it considers — in addition to the various indicators measuring multidimensional poverty, for example the education dimension — the prerogatives of the Education Guidelines and Framework Act (Law nº 9.394/1996), which determines a period of minimum number of years of study for each age group. The study also updates the longstanding discussion on poverty in the North region, but from a fresh original viewpoint.

With regard to the database, the data was taken from the National Household Sample Survey (PNAD) for the years 2006 to 2013. The reason for choosing this period was because of the data published by the Institute for Applied Economic Research (Ipea), which revealed that in 2013 the proportion of individuals in dire poverty in Brazil increased for the first time in 10 years, estimating that more than 10 million people lived in a situation of abject misery, although in recent decades the Brazilian public administration has designed and implemented different anti-poverty programs in Brazil, with emphasis on formulating and implementing policies to redistribute income.

The main purpose of this article is to evidence the current levels of multidimensional poverty in North Brazil for the years 2006-13, while the study is designed as a tool to assist public administration to develop policies focusing on fighting poverty and advancing the development process.

When Ottonelli and partners (2011) considered dimensions other than income, it would result in a more complex idea of poverty, since that by analyzing multidimensionality it is possible to identify the real precarious situations of the population, which would assist policymakers to more efficiently adopt public policies against poverty and use public funds more effectively and adequately.

The article is divided into five sections. First, in addition to this introduction, section 2 will address the concepts of multidimensional poverty and approaches to it. The third section provides the database, construction of the dimensions used and specification of the methodology. In the fourth section the results of the model are analyzed and finally, the last section addresses the final main considerations.

2. MULTIDIMENSIONAL POVERTY: ADDRESSING THE BASIC NEEDS AND CAPABILITIES

Poverty is a topic that has been increasingly discussed in social sciences and particularly in economic science. Its study, linked to the question of economic development, has advanced towards a more complex view of the concept and measurement of methods. All definitions of poverty contain some discretionary and subjective element. Different concepts require different methods and measurement indicators and, therefore, result in identifying different individuals as poor. It is based on the principle that the idea of poverty refers to some kind of deprivation, which could only be material or include cultural and social elements, in terms of a person or household's available resources.

Thus, since the 1970s investigations have proliferated on the adoption of the one-dimensional attitude to the study of poverty. Since then the idea was to incorporate non-monetary and particularly political and social dimensions to poverty to its measurement methods (Salama and Destremau, 1999). This shift intensified, which naturally permitted the multidimensional focus on poverty to gain space in the debate, albeit not predominant.

Bourguignon and Chakravarty (2003) say that the concept of multidimensional poverty came into being, in fact, when the individuals, social observers and policymakers intend to define a limit of poverty in each dimension, such as, for example, income, health, education and so on. Therefore, poverty may be considered a failure in achieving an acceptable minimum level of different monetary and non-monetary attributes essential for a sustainable standard of living.

In the multidimensional study of poverty, it is worth stressing the importance of two approaches, namely: addressing the basic requirements and capabilities. The first came to the fore in the mid-1970s, showing different concepts in a wide variety of areas, meaning not only the idea of hardship or shortage, but also what is indispensible or inevitable.

In the concept of Gough and Doyal (1991), the approach to the basic needs is consolidated in the occurrence of serious harm to the material life of humans. "Serious harm" is understood to be the possibility that it is an impediment to human beings both in their physical life and social participation.

Likewise, Max-Neef (1998) states that the basic need is an essential condition in the natural functioning of life and what happens around it. The author claims that human beings share the same needs, both material and immaterial, but each in their own culture or different historic period. Thus, it is necessary to differentiate the basic requirements of the strategies adopted in order to fulfill them.

In these terms, Salama and Destremau (1999) described in detail the approach to the basic needs in the definition of poverty when considering essential the access to some assets, without which citizens

would be unable to enjoy a remotely decent life, namely: drinking water, sewage network, garbage collection, access to public transportation and education, which are indispensable commodities for individuals to be able to lead a healthy life and have chances to be included in society.

Rocha (2006) states that this approach involves going beyond those definitions of food or nutrition to, thus, include a more widespread notion of human needs, such as education, sewage and housing, for example. This idea of poverty covers other aspects of individuals' daily lives by the mere fact that they not only feed but also relate and work, having therefore a social life.

In relation to the approach to capabilities, the 1980s marks the start of this discussion. Lacerda (2009) highlights the works by economist Amartya Sen, which are a point of inflection in formulating this theory. Sen (1993) explores a particular line of welfare, demonstrating its advantages for human beings to accomplish valuable actions or perform appropriate states of existence, being evident the concern of this approach against poverty. It therefore brings major contributions to the theory of social wellbeing and socioeconomic development, based on the principles of freedom and equality.

Since it is emphasized as a non-utilitarian approach to poverty, the approach to capabilities is a particular angle of development, according to which freedom is a basic substantive element in people's lives. It is understood that individuals have the right to practice their freedom and make their rights respected, and it looks to analyze the different forms of access to private and collective resources; in other words, emphasis is not only on social rights but also on civil and political rights (Silva, 2009).

According to Kuklys and Robeyns (2005), the approach to capabilities clearly operates at two levels. The first concerns achieving wellbeing, which is measured in terms of "functionings". Functionings reflect a variety of happenings or commodities that an individual may consider valuable to do or have. The latter concerns the potential of wellbeing that is estimated in terms of "capabilities". The target must be the capability of individuals to fulfill minimally appropriate important functionings to a certain level, and also to meet the human needs beyond the historical cultural differences (Silva, 2009). Bourguignon and Chakravarty (2003) believe that wellbeing is intrinsically multidimensional from the viewpoint of capabilities and functionings. This is because functionings are precisely motivated by attributes such as the capability to read and write, life expectancy, and so on, and not only by income.

The approach to capabilities is nothing but an approach regarding development, which transfers the focus of analyzing accumulation of capital to the analysis of individuals and their set of capabilities. And income is now only one of the means and not the end of development.

Lastly, the approach to basic needs (pioneer in this discussion) and to capabilities (discussion on the basic needs, functionings and capability) reinforced the focus of the study of multidimensional poverty. In other words, they emphasize that social needs go beyond monetary conditions and, therefore, policies must be designed to extend individual freedoms and thereby provide the population with better living conditions. The scope of this approach is not restricted to analyzing poverty but also raises major contributions to the theory of social wellbeing and the theory of socioeconomic development, relating not only to the economic but also to the cultural and political variables.

In this context and considering the importance of the approaches to basic human needs and capabilities to eliminate poverty and advance the development process, this study will address a number of indicators to define multidimensional poverty in North Brazil in the period 2006-13.

3. METHODOLOGY

3.1 DATABASE AND BUILDING DIMENSIONS

The source of data used for building the indicators and compound dimensions in multidimensional poverty was PNAD for the years 2006 to 2013, except 2010, a census year. This paper considers six dimensions in the preparation of a multidimensional indicator, as shown in table 1. Added to the six dimensions are are 22 variables derived from the original variables taken from the PNAD. They were chosen based on the review of the literature on the subject of poverty.

Table 1 shows the indicators $X^{l}_{i,k}$ constructed for i={1,2,...,n} people, j={1,2,...,h} households and k={1,2,...,m} dimensions. All indicators have a maximum value of 1 (not deprived) and a minimum of 0 (total deprivation). The indicators are defined between 0 and 1 to reduce the problems of discontinuity, but are restricted by the available information. In order to obtain different sets of categorical data different equidistant levels are established (that is, the indicators are ordinal).

TABLE 1 DIMENSIONS AND INDICATORS OF MULTIDIMENSIONAL POVERTY

Dimensions	Derived Variables	Indicators
Food & Water	Water in household	$X^{1}_{i,1} = \begin{cases} 1, \textit{ if yes} \\ 0, \textit{ if not} \end{cases}$
	Food procurement capacity	$X^{2}_{i,1} = \min \left\{ 1, \dfrac{\textit{income per capita j;i} \in j}{\textit{poverty line}} \right.$
Communication & Information	Telephone	$X^{1}_{i,2} = \begin{cases} 1, \textit{ if yes} \\ 0, \textit{ if not} \end{cases}$
	Television	$X^{2}_{i,2} = \begin{cases} 1, \textit{ if yes} \\ 0, \textit{ if not} \end{cases}$
	Computer	$X^{3}_{i,2} = \begin{cases} 1, \textit{ if yes} \\ 0, \textit{ if not} \end{cases}$
	Internet	$X^{4}_{i,2} = \begin{cases} 1, \textit{ if yes} \\ 0, \textit{ if not} \end{cases}$

Continue

Dimensions	Derived Variables	Indicators
Education	Primary Education	$X^{1}_{i,3} = \begin{cases} 1, \textit{if } 1-5 \textit{ years schooling at the proper age} \\ 0, \textit{if not} \end{cases}$
	Incomplete Elementary Education	$X^{2}_{i,3} = \begin{cases} 1, \textit{if } 4-9 \textit{ years schooling at the proper age} \\ 0, \textit{if not} \end{cases}$
	Complete Elementary Education	$X^{3}_{i,3} = \begin{cases} 1, \textit{if } 8-14 \textit{ years schooling at the proper age} \\ 0, \textit{if not} \end{cases}$
	Incomplete Secondary Education	$X^{4}_{i,3} = \begin{cases} 1, \textit{if } 12-15 \textit{ years schooling at the proper age} \\ 0, \textit{if not} \end{cases}$
	Complete Secondary Education	$X^{5}_{i,3} = \begin{cases} 1, \textit{if over } 15 \textit{ years schooling at the proper age} \\ 0, \textit{if not} \end{cases}$
	Proportion of children in school	$X^{6}_{i,3} = \begin{cases} 1, \textit{se proporção} > 1 \\ 0, \textit{if not} \end{cases}$
Living Conditions	Type of dwelling	$X^{1}_{i,4} = \begin{cases} 1, \textit{if own house} \\ 0{,}5, \textit{if still paying for own house} \\ 0, \textit{if other} \end{cases}$
	Lighting	$X^{2}_{i,4} = \begin{cases} 1, \textit{if adequate} \\ 0, \textit{if not} \end{cases}$
	Wall material	$X^{3}_{i,4} = \begin{cases} 1, \textit{if adequate} \\ 0, \textit{if not} \end{cases}$
	Roof material	$X^{4}_{i,4} = \begin{cases} 1, \textit{if adequate} \\ 0, \textit{if not} \end{cases}$
	No, people per bedroom	$X^{5}_{i,4} = \begin{cases} 1, \textit{if} > 3 \\ 0, \textit{if not} \end{cases}$
Health	Sewage system	$X^{1}_{i,5} = \begin{cases} 1, \textit{if adequate} \\ 0, \textit{if not} \end{cases}$
	Sanitary condition	$X^{2}_{i,5} = \begin{cases} 1, \textit{if adequate} \\ 0, \textit{if not} \end{cases}$
	Waste disposal	$X^{3}_{i,5} = \begin{cases} 1, \textit{if adequate} \\ 0, \textit{if not} \end{cases}$
Labor and Demography	Casual labor	$X^{1}_{i,6} = \begin{cases} 1, \textit{if not} \\ 0, \textit{if yes} \end{cases}$
	Dependency ratio per household	$X^{2}_{i,6} = \begin{cases} 1, \textit{if proportion} < 1 \\ 0, \textit{if not} \end{cases}$

Source: Elaborated by the authors based on PNAD data.

Dimension 1 — Food and water: the water variable measures if the home has a proper water supply. The second, however, indicates the food purchasing power,[1] using the monetary conditions, making a ratio of the individual's *per capita* income with the income poverty line. The poverty lines used were from the Institute for Labor and Society Studies (Iets), prepared by Sonia Rocha based on the National Household Budget Survey (POF).

Dimension 2 — Communication and information: considers as private individuals those without information media for life in today's society. The variables adopted in the study are telephone, television, computer and Internet.

Dimension 3 — Education: is addressed as an innovation for measuring multidimensional poverty in North Brazil. It takes into consideration the Education Guidelines and Framework Act (Law nº 9.394/1996), providing the guidelines and framework of national education, in which it states that there is a minimum schooling level required for a certain age group.

The education dimension is divided into six variables, referring to the appropriate age for each learning stage: primary education, incomplete and complete elementary education, and incomplete and complete secondary education. These categories took into account the minimum number of years required to complete the levels of education. When including this variable in the indicator the idea was to record not only the average school year per student but also the "educational context" in which the student is included. The proportion of children at school refers to the total number of children in the household attending school. According to art. 2, Law nº 8.069/1990, someone not yet 12 years old is considered a child and someone between 12 and 18 years of age is an adolescent.

Dimension 4 — Living conditions: in its analysis the following variables were used: type of dwelling, lighting, wall material, roof material and number of people per bedroom. Although these variables may be discussed regarding their use in the poverty analysis, it is found that the absence of proper living conditions is configured as an important deprivation type, as well as abusing the social rights guaranteed by the Brazilian Constitution.

Another relevant point of the study raised in this section is dimension 5 — Health. Since there are no specific variables able to provide information regarding this dimension. Proxies will be used to study it, as follows: sewage system, sanitary condition and waste disposal. The reason for this choice was to understand that the lack of access or inappropriate access to any of these variables could cause serious harm to the individual's health, especially with regard to basic health.

Lastly, dimension 6 — Labor and demography: analyzes casual labor and dependency ratio per household. The status of casual labor was classified when the worker was not insured under social security or contributed to another social security institute and, for this reason, had no protection against so-called social risks (unable to work).

3.2 SPECIFICATION OF METHODOLOGY

According to Bourguignon and Chakravarty (2003), a simple way of defining poverty and counting the number of poor is to consider the possibility of being poor in any dimension of poverty. A multidimensional focus defines poverty through a vector of particular characteristics (Tsui, 2002).

[1] However, this indicator has some restrictions, namely: it does not guarantee measuring the access to sufficient quality food, since the household may have expenses with medication, or rural households may have a low income, but are able to produce their own food.

Broadly speaking, an index of multidimensional poverty can be addressed as a function:

$$P\,(X,z)\colon M \times z \rightarrow R_{+}^{1} \tag{1}$$

where $X \in M$ is a matrix of attributes, such as income, education, health, (n x m), for $i = \{1,2, ..., m\}$ people and k = {1,2, ... m} dimensions, and $z \in Z$ is a vector of limits or "minimally acceptable levels" for different attributes (Bourguignon and Chakravarty, 2003).

An index can be built using at least three different methodological approaches: the axiomatic approach, the fuzzy group theory and the theory of information (Maasoumi and Lugo, 2008).

Based on Bourguignon and Chakravarty (2003), a general multidimensional index can be broken down and fulfills the necessary axioms; it can be defined as $P(X,z)=\frac{1}{n}\sum_{i=1}^{n} f(X_{i,1}, ..., X_{i,m})$. By a binding approach to define $f(\cdot)$ and using a variation in the index of Foster, Greer and Thorbecke (1984) to capture the severity of poverty, multidimensional poverty can be measured as follows:

$$P\,(X,z) = \frac{1}{n}\sum_{i=1}^{n} f\left[\frac{1}{m}\sum_{i=1}^{n} X_{i,k^2}\right] \tag{2}$$

In (2) it is assumed that the dimensions are not replaceable but interrelate with the general level of poverty, which is consistent with an approach based on dimensions of wellbeing. At the individual level, more weight is given to the dimensions that show a wider deprivation gap and, subsequently, more weight is attributed to people with higher levels of deprivation. This causes the index to be sensitive to the distribution of poverty. Poverty at an individual level is defined by: $P_i \frac{1}{m}\sum_{i=1}^{n} X_{i,k^2}$, , with a maximum value of 1 (total poverty) and a minimum of 0 (no poverty).

For each dimension the incidence indices (proportion of poor) and the deprivation levels for different regions and demographic groups can be estimated. For the incidence index it is considered that anyone below the limit in at least one variable endures deprivation (focus of unity), based on the following rule:

$$Endures\ deprivation = \begin{cases} Yes;\ if\ X_{i,k} > 0 \\ No;\ if\ X_{i,k} = 0 \end{cases} \tag{3}$$

The deprivation level for each person in each indicator is measured directly by $X_{i,k}^{l}$, although the individual deprivation level in each dimension is determined by the function of aggregation g_k as follows:

$$X_{i,k} = \frac{1}{p}\sum_{l=1}^{p} X_{i,k}^{l} \tag{4}$$

where the indicators cluster for each dimension with the following function: $X_{i,k} = g_k\,(X_{i,k}^{l}, ..., X_{i,k}^{p})$ for variables $l = \{1, ..., p\}$, where function g_k (.) is specific for each dimension k. All indicators have the maximum value of 1 (achieved level) and a minimum value of 0 (total deprivation), this definition being used to reduce the problems of discontinuity.

Finally, the level of overall deprivation that can be broken down for each dimension is:

$$\hat{X_k} = \frac{1}{n}\sum_{i=1}^{n} X_{i,k} \quad (5)$$

The level of overall deprivation ($X_{i,k}$) is measured using (4) in each dimension and is defined as the level of average deprivation between the variables. To identify the level of deprivation of each dimension, the indices are reformulated using the formula: $X_{i,k} = 1 - X_{i,k}$, where the level of deprivation $X_{i,k}$ is interpreted as the relative difference between the individual level of $X_{i,k}$ and the limit of deprivation $Z_k = 1$, with a maximum value of 1 (total deprivation) and a minimum of 0 (no deprivation). By using (5) it is possible to break down the deprivation level per region and demographic group.

4. RESULTS AND DISCUSSION

At first, the results of the degrees of deprivation in each indicator and respective dimensions are analyzed from 2006 to 2013. The gaps, meaning how far the poor are from a poverty limit, will also be addressed for each dimension in North Brazil, between the areas (metropolitan, urban and rural) and groups: gender, age group and race. Then, multidimensional poverty is analyzed within the region and the groups in the study.

4.1 INCIDENCE OF DEPRIVATION IN NORTH BRAZIL: INDICATORS AND THEIR DIMENSIONS

Table 2 shows the incidence of deprivation in the northern region of Brazil, from 2006 to 2013, among the indicators and dimensions. The water and food dimension is defined by two variables: water in the home and food purchasing power. Considering that water in the home is defined as a basic need for human survival, its provenance in households measures the deprivation, or otherwise, of the population. If the supply is from the general distribution network, the household is considered not deprived. However, if it comes from a well or spring, or other source, it is called asset-deprived. The percentage of people who do not have a drinking water supply from the general distribution network in their homes has dropped from 38.86% in 2006 to 31.75% in 2013.

On the other hand, the food purchasing power variable measures the monetary deprivation (that is, income) as a substitute for food deprivation. Households, with a *per capita* income below the poverty line, are considered deprived since they are unable to consume the minimum nutritional needs. Thus, the percentage of people with monetary deprivation rose from 5.79% to 6.6% over the same period. It is worth noting that, in the dimension as a whole, the impact of the reduction was greater altogether than when the indicators are analyzed separately. There was a 5.79% drop from 41.81% in 2006 to 36.02% in 2013 in multidimensional poverty in North Brazil in the water and food dimension.

This trend towards poverty in the above dimension was also verified in Brandolini and D'Alessio (1998), Carvalho, Kerstenetzky and Del-Vecchio (2007), Ottonelli and Silva (2014). So, even when the results differ by adopting different methodologies, they corroborate with the study to the extent that they reached the conclusion that the lack of access to water and income is one of the main causes of poverty, while income is the worst deprivation suffered by the people.

Next is the communication and information dimension, which is measured by four variables at household level: owning a phone (including landline or mobile), television (black and white or color), computer and Internet access. It is stressed that most of these accesses to data do not mean real

deprivation, nor inform anything about the quality of data that the households access. Although a full analysis of these criteria is necessary, it is beyond the scope of this investigation.

Table 2 shows that, between 2006 and 2013, the poverty incidence trended downward in all indicators. Those showing the highest downward impacts of deprivation were: telephone with a 26.47% drop from 2006 to 2013; computer, a 23.13% drop for the same period; and Internet access down 19.26%. In 2013, the highest indices of deprivation recorded were for Internet access (74.58%) and computer (66.63%), while the lowest levels of deprivation are the telephone (10.95%) and television (4.83%). As can be seen, when addressing deprivation of Internet and computers, although the degrees of both have shown a fall in the period, even so they are still considerably high. It is, therefore, possible that the drop in deprivation is correlated to the technology spread in recent years, which made it easier to access new communication technologies.

The highest deprivation indicators concentrate on the education dimension. Precisely because the survey takes into consideration the adoption of the Education Guidelines and Framework Act (Law nº 9.394/1996), which provides the guidelines and framework of national education. In primary school, as the Act determines, children under five years old could attend five years maximum of preschool attendance. In incomplete elementary education, children in the 6-10 age group should have four to nine years attendance in order not to be considered deprived. In complete elementary education, 11 to 14-year olds would be completing elementary school after around eight to 14 years' attendance. However, in incomplete secondary education pre-adolescents around 15-17 years old would be completing secondary school with 12-15 years attendance. Lastly, in complete secondary education young adults over 18 years old should have at least 15 years schooling to be able to achieve a good education and skills to enter the labor market and not be considered education-deprived. Finally, the proportion of children at school refers to all children in the household attending school.

In the education dimension, as can be seen in table 2, there is a slight drop in deprivation: it dropped from 84.93% in 2006 to 83.10% in 2013. The schooling that dropped most in deprivation was complete elementary education, 3.04% down from 2006 to 2013. Close behind was incomplete and complete secondary education with 3.04% and 2.94%, respectively.

This evidence corroborates the analyses by Sousa (2015), Ottonelli and Silva (2014) and Silva (2015), who studied multidimensional poverty in the Northeast, Paraíba state and Brazil, respectively. The above studies found that education is one of the dimensions that most contribute to the propensity of poverty. Thus, according to Sen (2000), people need relevant functionings and these do not happen only at the income level but rather through access to health, education, living conditions and other relevant aspects.

To measure the housing deprivation five indicators are considered. Table 2 shows the percentage of a population with housing deprivation. Approximately, one fifth of the population in 2013 did not own a paid-up home of their own. There was quite an unsteady variation during the years analyzed in relation to the type of housing, but comparing 2006 to 2013, it is found that there was a slight 0.7% rise in deprivation. With regard to lighting, wall quality and number of people per bedroom, there was a relatively significantly drop in the incidence rates, which already show low deprivation. In 2013, only 13.03% of the population lived in a home with more than three people per bedroom. Likewise, Silva and partners (2014) state in their results that the lack of access to proper living conditions is one of the aggravating factors of multidimensional poverty.

TABLE 2 INCIDENCE OF DEPRIVATION IN NORTH BRAIL, 2006-13 (%)

Dimensions/Variables	2006	2007	2008	2009	2011	2012	2013
Dimension 1: Water & Food	41.81	43.18	39.48	38.53	39.32	36.24	36.02
Water at home	38.86	39.23	36.34	34.80	35.92	32.70	31.75
Food purchasing power	5.79	6.90	5.70	6.38	6.04	5.54	6.60
Dimension 2: Communication & Information	93.86	91.73	89.24	86.79	78.96	75.81	74.93
Telephone	37.42	34.06	25.60	22.91	15.20	12.85	10.95
Television	13.42	8.51	7.40	6.54	6.27	4.83	4.83
Computer	89.76	85.72	81.67	78.70	71.54	68.20	66.63
Internet	93.84	91.59	89.14	86.62	78.70	75.44	74.58
Dimension 3: Education	96.71	96.03	95.79	95.28	94.68	94.45	93.79
Primary education	81.97	81.63	81.91	81.62	81.20	81.31	81.60
Incomplete elementary school	94.21	93.67	93.27	93.08	92.10	91.91	91.51
Complete elementary school	95.71	95.00	94.61	94.31	93.37	93.23	92.67
Incomplete secondary school	96.62	95.90	95.64	95.15	94.44	94.29	93.58
Complete secondary school	96.71	96.02	95.78	95.26	94.65	94.44	93.77
Proportion of children in school	7.92	6.59	5.38	5.68	4.67	4.13	3.94
Dimension 4: Living Conditions	61.20	58.50	56.61	55.85	56.30	54.22	53.16
Type of dwelling	21.35	19.57	19.58	20.52	20.85	21.22	22.05
Lighting	6.74	4.21	3.54	2.64	2.68	1.99	1.57
Wall material	41.78	39.57	38.10	36.02	35.69	33.53	30.95
Roof material	7.80	8.32	5.13	4.69	7.47	6.50	5.42
No. of people per bedroom	15.72	15.90	14.89	14.57	14.92	13.42	13.03
Dimension 5: Health	90.83	85.54	85.56	86.98	80.18	81.92	80.85
Sewage system	90.24	85.01	85.06	86.59	79.41	81.39	80.41
Sanitary condition	23.50	20.30	19.60	17.25	21.81	20.73	19.78
Waste disposal	3.49	3.16	3.11	2.69	2.92	2.63	2.13
Dimension 6: Labor & Demography	75.39	74.98	72.99	72.37	70.31	69.37	68.22
Casual labor	68.95	67.60	66.40	65.61	64.14	62.92	61.98
Dependency ratio per household	22.06	22.31	21.32	21.11	19.40	19.38	18.99

Source: Elaborated by the authors based on PNAD data.

An interesting aspect in the next dimension to be analyzed is that the basic sanitation conditions were used as proxy to analyze the health dimension. The reason was that the lack of access, or inappropriate access, to any of these sanitary variables could cause serious harm to a person's health, especially concerning basic health. Table 2 shows that this dimension decreased in its deprivation from 90.83% in 2006 to 80.85% in 2013, that is, a 9.98% drop in the period analyzed. This decrease can, therefore, be explained because there was also a drop in all indicators of the dimension. In sewage, the indicator with the highest impact on the reduced deprivation was 9.83% down. Moreover, the sanitary condition and waste disposal showed a drop of 3.72% and 1.36%, respectively, from 2006 to 2013. Studies by Brandolini and D'Alessio (1998), Carvalho, Kerstenetzky and Del-Vecchio (2007), Diniz and Diniz (2009) also confirm these results.

Lastly, in the labor and demography dimension casual labor was described for the worker not insured under social security or not contributing to another social security institute. Demography refers to the dependency ratio of members of a household, namely those under 14 and over 60 years old. Table 2 shows the deprivation rate for each indicator. When analyzing the dimension in general, more than 50% of the population suffers deprivation of a decent job, that is, 61.98% in 2013 worked as casual laborers. Although there has been a 6.97% decrease from 2006 to 2013, quite a high deprivation rate still remains. On the other hand, the dependency ratio shows a deprivation rate considered low, 18.99% of the population in 2013 showing some dependency ratio.

Along the same lines, Souza, Salvato and França (2013) studied income inequality among the groups in Brazil and regions. However, they used PNAD data for the period 2001-2011. The results showed that, in fact, there is still wage discrimination between gender and ethnicities. With regard to the age group, children and the elderly were also included, with a higher level of deprivation in this dimension. When race is analyzed there was greater exclusion from the labor market in the non-white population.

4.2 DEPRIVATION GAPS

The deprivation gap is shown in table 3 by dimensions and demographic groups. Figures show the average difference for different areas and population groups. As discussed in section 4, which addressed methodology, the deprivation gaps represent the distance between the poor and a certain limit of total poverty, varying between 0 and 1 and calculated for each dimension.

It is noticeable that poverty in the food and water dimension (table 3) is a problem, especially in the metropolitan areas of North Brazil. In 2013, the deprivation gap in the metropolitan area was 19.06%, and even wider when compared to the rural and urban regions, in which there was a gap in deprivation records of 18.25% and 18.05%, respectively, for the same period.

With regard to the analysis among the states, table 3 also provides figures showing the average difference for the seven states in North Brazil. Although a decrease in the deprivation gap did not occur in all the states, they still show a high deprivation in the dimension. Amapá, Pará and Acre were the states with the widest deprivation gap in 2013, with rates of 23.88%, 22.57% and 20.7%, respectively. The state, however, with the smallest deprivation gap in 2013 was Tocantins with only 3.91% of its population considered deprived of the water and food dimension. It was found that, concerning the

population groups, the gap in relation to poverty was not so significant. However, there was a decrease in all groups studied, from 2006 to 2013.

In the communication and information dimension in table 3, the gap was narrowed in all states, areas and groups between 2006 and 2013. Concerning the states, Pará, Roraima and Amazonas showed the widest deprivation gaps for communication and information in 2013 — 42.87%, 37.8% and 36.34%, respectively, and the state of Acre highlighted with the smallest deprivation gap of 34.5%. Similarly, both in 2006 and 2013, the deprivation gap of the rural population in North Brazil was much wider than in the metropolitan and urban regions. In 2013, the rural area had a deprivation gap of 58.16%, while the metropolitan and urban regions had 29.84% and 34.5%, respectively. It is also found that deprivation among men is greater than among women in relation to this dimension. Looking at the age group, deprivation was highest among the elderly and children, 46.99% and 42.36%, respectively in 2013. The deprivation gap in relation to the race group was 41.61% in 2013, and wider for the non-whites.

In relation to the education dimension, as shown in table 3, concerning the northern states, emphasis was on Pará, 84.83%, Rondônia, 83.91%, and Roraima, 81.62%, with the highest deprivation rates in 2013, and Amapá with the smallest deprivation gap (80.26%). In terms of areas, a wider gap is found in the rural area, when compared to the metropolitan and urban areas, no different from what was stressed in the other dimensions. It showed a deprivation gap from 87.12% in 2006 to 86.78% in 2013. And in the metropolitan and urban areas a decrease in deprivation was also observed in education, over the period under study. There was also a decrease in the number of men and women: women showed a smaller deprivation of 81.6% in 2013 compared to the men at 84.59%. It is noted that the average deprivation gap in education is 2.99 times higher for men than for women. With regard to the age groups, they all decreased in deprivation, and the young adult group having the greatest decrease of 4.25% from 2006 to 2013, and the children's group with the smallest gap. In the race group, deprivation among whites was 79.19%, and among non-whites 84.27%. It is found that the impact of the drop from 2006 to 2013 also occurred in the white race group, with 3.69% down compared to only 1.32% in the non-white race.

With regard to the gaps relating to the dimensions of living conditions in table 3, in 2013 the states with the largest deprivation gap in terms of living conditions were Acre 18.49%, Amazonas, 17.53% and Rondônia with 16.02%. In contrast, the smallest gap was found in Tocantins with 8.49% and Roraima 12.35%. Rural areas had a sharper drop in the deprivation gap in the housing dimension, from 29.46% in 2006 to 20.94% in 2013. However, the rural area in the living conditions dimension was no different from the others. In this dimension the rural area had the widest deprivation gap among the metropolitan (7.84%) and urban (13.35%) areas in 2013. In the gender group, women showed less deprivation than men, this difference being only 0.67% in 2013. Also in this same period, among the age groups, the elderly had the least deprivation with only 9.52% and highest deprivation was with the children's group with 18.25%. The non-white populations had a larger deprivation gap than the white race. In 2013 non-whites had a deprivation gap of 3.08% more than the whites in 2013.

TABLE 3 NORTH: DEPRIVATION GAP PER DIMENSION, 2006 AND 2013 (%)

States/Area/Group	Water & Food		Communication & Information		Education	
	2006	2013	2006	2013	2006	2013
Northern region	21.51	18.23	58.61	39.24	84.93	83.10
Rondônia	21.42	18.06	55.89	34.92	84.96	83.91
Acre	30.69	20.77	52.63	34.50	82.74	80.37
Amazonas	13.95	14.68	58.33	36.34	84.48	81.03
Roraima	9.70	5.88	56.65	37.80	83.83	81.62
Pará	28.01	22.57	60.62	42.87	85.67	84.83
Amapá	17.94	23.88	56.58	36.01	83.29	80.26
Tocantins	7.29	3.91	56.10	36.21	84.25	81.17
Metropolitan	21.61	19.06	48.35	29.84	84.01	83.15
Urban	19.21	18.05	54.20	34.50	84.28	81.79
Rural	27.40	18.25	75.91	58.16	87.12	86.78
Men	21.35	18.23	59.25	40.17	85.57	84.59
Women	21.67	18.22	57.96	38.32	84.29	81.60
Children	24.51	20.52	62.34	42.36	77.91	77.56
Adolescents	22.80	19.26	59.49	40.01	84.79	84.11
Young adults	21.55	18.97	57.40	37.37	90.52	86.27
Adults	19.34	16.78	55.94	37.06	85.55	82.52
Elderly	16.35	14.47	60.84	46.99	93.09	93.91
White	18.81	16.77	51.97	31.40	82.88	79.19
Non-white	22.38	18.67	60.75	41.61	85.59	84.27

States/Area/Group	Living Conditions		Health		Labor & Demography	
	2006	2013	2006	2013	2006	2013
North region	18.52	14.35	39.07	34.10	45.50	40.48
Rondônia	18.05	16.02	40.43	36.99	36.13	34.53
Acre	26.01	18.49	31.86	26.17	45.48	39.28
Amazonas	23.19	17.53	40.47	26.51	43.82	38.13
Roraima	14.99	12.35	35.90	28.84	45.24	37.75

Continue

States/Area/Group	Living Conditions		Health		Labor & Demography	
	2006	2013	2006	2013	2006	2013
Pará	17.55	13.25	39.49	38.07	48.41	43.45
Amapá	17.49	15.23	36.33	36.10	44.51	40.54
Tocantins	9.63	8.49	37.07	32.61	46.60	38.90
Metropolitan	10.60	7.84	25.26	20.64	43.76	37.28
Urban	16.05	13.35	34.22	27.78	45.40	39.84
Rural	29.46	20.94	59.57	59.86	46.75	44.13
Men	18.87	14.68	39.76	34.94	45.25	40.33
Women	15.17	14.01	38.38	33.26	45.75	40.62
Children	22.41	18.25	41.01	35.83	53.77	47.26
Adolescents	19.39	15.68	40.61	35.77	43.81	39.79
Young adults	18.43	14.76	38.07	32.80	40.33	34.79
Adults	16.02	12.24	37.79	33.23	41.02	36.34
Elderly	12.62	9.52	38.02	34.40	63.65	64.04
White	15.19	11.98	36.14	29.88	41.68	37.02
Non-white	19.60	15.06	40.02	35.37	46.74	41.52

Source: Elaborated by the authors based on PNAD data.

Within the health dimension (table 3), specifically, the states of Pará and Rondônia showed a rise in the deprivation gap over the analyzed period. The analysis reveals a catastrophic situation, principally in Pará, where only 38% of the population in 2013 had proper access to basic sanitation. Of all the northern states, Acre and Amazonas are the states with the largest adequate coverage of sanitation services; they also have the smallest reduction rates. All other states in the region had a fall in the deprivation rate. It is also found that the major difference in deprivation of all areas was in the rural area; in 2006, the deprivation gap was 58.57%, gaining a slight increase in 2013 to 59.86%, indicating that more than half the rural population endured basic sanitation deprivation. Consequently, the rural area is also the most sensitive region in terms of health. However, the Brazilian metropolitan (20.64%) and urban (27.78%) areas had the lowest deprivation in 2013. In the gender group, women had a lower deprivation of 33.26% in 2012 compared to the men, who had 34.94% deprivation for the same period. In the age group, it is the group of adolescents that had the highest health deficit, with 35.77% in 2013. The lowest was the young adult group with 32.8%. The non-white populations had higher deprivation gaps at a rate of 35.37% in 2013, much higher compared to the white race, which was only 29.88%.

Lastly, considering the deprivation gap in the labor and demography dimension, every state in North Brazil showed decreases in the deprivation gap in table 3. However, the data also point to a high percentage of workers who do not have a decent job. The states of Pará, Amapá and Tocantins had the highest deprivation gap in the labor and demography dimension. Rondônia and Roraima, on the other hand, are those with the lowest rates in the analysis. The rural area was highlighted among the others for having increased the labor and demography gap from 46.75% in 2006 to 44.13% in 2013, showing a 2.62% drop in the period in question. The metropolitan area also had a 6.48% drop between 2006 and 2013. Likewise, the urban area dropped from 45.4% in 2006 to 39.84% in 2013. In contrast to all other dimensions, in the labor and demography dimension, women this time around presented a larger deprivation gap than the men, evidencing moreover the difference in the labor market between men and women. Despite the decrease, the deprivation among men and women in 2013 is still considered high at 40.62% for women and 40.33% for men. In the age group dimension, the results were expected, the largest deprivation for children and the elderly, since they are dependents and do not work; children with a 47.26% deprivation and the elderly with 64.04%. The group of young adults had the smallest gap, with 34.79% in 2013. The white population has a smaller deprivation gap compared to the non-whites, and has a 4.5% smaller gap, while both groups had a drop in the period 2006-13.

5.3 MULTIDIMENSIONAL POVERTY

In general, the data taken from the PNAD survey shows an improvement in the living conditions of the population in North Brazil in the period 2006-13. This improvement, however, did not occur homogeneously among the states in the region, or among the area, gender, age and race groups.

Table 4 addresses the multidimensional poverty by states and groups in North Brazil (2006-13). The results suggest a reduction in multidimensional poverty in the North from 30.71% in 2006 to 25.79% in 2013, depending on the adopted methodology, with a variation of 4.92%. In the period in question, the level of multidimensional poverty declined at an annual average rate of 0.7%. This behavior reflects the recent dynamics of the poverty indices nationwide. According to Silva (2015), between 2006 and 2012, the observed reduction in the levels of multidimensional poverty was 3.01% and 4.51% for Brazil and the South, respectively. In particular, North Brazil may be worth mentioning as one of the regions where poverty had the sharpest drop during this period, although it is still the region with the highest proportion of multidimensional poor in Brazil for the period analyzed.

TABLE 4 MULTIDIMENSIONAL POVERTY PER STATE AND GROUP IN NORTH BRAZIL, 2006-13 (%)

	Multidimensional poverty							Variation
	2006	2007	2008	2009	2011	2012	2013	
North	30.71	29.48	28.33	27.74	27.01	26.20	25.79	-4.92
Rondônia	28.95	29.02	28.58	26.66	26.24	25.13	25.12	-3.83

Continue

	Multidimensional poverty							Variation
	2006	2007	2008	2009	2011	2012	2013	
Acre	30.52	28.33	28.50	27.01	25.71	25.53	24.36	-6.16
Amazonas	30.18	28.41	26.86	26.17	26.68	24.87	24.02	-6.16
Roraima	28.22	27.68	25.74	25.62	22.86	22.17	23.09	-5.13
Pará	32.23	30.88	29.91	29.63	28.37	28.00	27.64	-4.59
Amapá	28.41	28.06	25.72	26.35	26.15	24.96	25.26	-3.15
Tocantins	28.08	26.92	25.20	24.47	23.80	23.18	22.79	-5.29
Metropolitan	26.09	25.22	24.61	24.80	22.49	22.61	22.60	-3.49
Urban	28.21	27.29	26.22	25.60	25.01	24.07	23.65	-4.56
Rural	39.86	37.91	36.19	35.42	35.74	34.90	33.71	-6.15
Men	30.96	29.87	28.73	28.06	27.42	26.59	26.26	-4.70
Women	30.47	29.09	27.93	27.42	26.61	25.80	25.32	-5.15
Children	31.58	30.26	28.89	28.28	27.49	26.47	25.78	-5.80
Adolescents	30.59	29.38	27.87	27.65	26.77	25.78	25.69	-4.89
Young adults	30.87	29.46	28.33	27.59	26.85	26.19	25.54	-5.05
Adults	29.36	28.14	27.27	26.53	25.92	25.20	24.79	-4.57
Elderly	35.77	35.42	34.71	34.77	33.65	33.05	33.50	-2.27
White	27.87	26.64	25.75	25.42	24.65	23.85	23.03	-4.84
Non-white	31.64	30.43	29.11	28.47	27.77	26.88	26.62	-5.02

Source: Elaborated by the authors based on PNAD data.

With regard to the states in the region, the results of the proportion of multidimensional poor in North Brazilian states have shown a decrease over the period in question. Acre and Amazonas were the states that obtained the widest variation, 6.16% down from 2006 to 2013. Amapá state, however, has the lowest variation rate (-3.15%). And is also the Northern state with the highest proportion of multidimensional poor in 2013, affecting 25.26% of its population, while the states of Amazonas (24.02%), Roraima (23.09%) and Tocantins (22.79%) had the lowest proportional rates of multidimensional poor in North Brazil.

According to the study by Silva and partners (2014), the Northern region had 26.2% of the population in a situation of poverty, followed by the Northeast with 24.18%, and the Southeast, South and Midwest regions with smaller proportions. Therefore, Silva and partners (2014) corroborate the results of this study herein.

Also in table 4, when specifically analyzing the rural area, the region has a much larger proportion of poor compared with the metropolitan and urban areas. In 2013, the North had a poor population in the rural area of 33.71%, thereby corroborating Silva and Neder (2010), who studied multidimensional poverty in the rural areas of Brazil in 1995 and 2004.

The aforementioned authors stress the importance of measuring poverty taking not only income into consideration, but also housing, water supply, basic sanitation, education and the labor market. Nationwide, the proportion of poor in the rural zone in 2004 was 25.45% while in the urban zone had 19.41%. This convergence suggests that the population living in this area improved the levels of wellbeing associated with the multi-dimensions reflecting the degree of poverty. Nonetheless, even with better living conditions, the disparities still remain between the areas, although to a lesser extent, since the dynamics of distributing the effects on poverty occurred heterogeneously in the timeframe.

On average, there is no major difference in poverty between the gender and age group dimensions. However, there has been a decrease in every group. Multidimensional poverty among men in 2013 was 26.26%, compared to women with 25.32%, there being a wider variation (drop) between women of 5.15% (table 4), and a largely unnoticed difference between children, adolescents, young adults and adults. The children's group had a stronger impact on the decrease with a 5.8% drop from 2006 to 2013. The group of the elderly, however, had a small decrease of 2.27% in proportion, and was the group with the highest multidimensional poverty of 33.5% in 2013. The non-white populations had the highest levels of multidimensional poverty, 26.62%, in 2013, despite presenting the highest variation rate of 5.02% from 2006 to 2013.

5. FINAL CONSIDERATIONS

This article intends to portray the current levels of multidimensional poverty in North Brazil between 2006 and 2013. The purpose of the study is for it to act as a tool to assist public administration in developing policies focusing on fighting poverty and advancing the development process in the region.

Therefore, the study has shown that, when considering the measurement of multidimensional poverty from the viewpoint of the six dimensions analyzed, it was found that it revealed a downward trend over the period in question. The results of the study suggest a drop in multidimensional poverty from 30.71% in 2006 to 25.79% in 2013. In view of the above, it is believed that this scenario occurred due to the growing investment in public policies to redistribute income, implemented by the federal government in that period.

For the separate analyses of the metropolitan, urban and rural areas, the poverty level was more intense in the rural region, where the intensities of poverty were considerably greater. There are several hypotheses for this conclusion, such as: existence of the elderly in the household, but without a pension at all; and although it is in the rural area, the household may not have land for its subsistence; or perhaps the households may receive from some federal government program, but not enough to take them out of poverty. On the other hand, this situation is less serious in the metropolitan area of North Brazil. In the analysis of poverty in the group there is almost no difference between men and women, but it is worth mentioning that the persistent deprivation is concentrated more among men.

The strongest impact on poverty would be on the elderly group; they are considered the most deprived compared to the other age groups. In contrast, ongoing inequalities continue for the white and non-white populations, thereby showing a significant difference in comparing multidimensional poverty, since that of non-whites is shown to have a higher rate of deprivation.

Although multidimensional poverty has decreased in North Brazil between 2006 and 2013, in accordance with the six dimensions, the poverty situation is worse in the states of Pará and Amapá, while the better poverty situations are to be found in the states of Amazonas, Roraima and Tocantins.

Therefore, this study, measuring the multidimensionality of poverty in North Brazil, evidenced the dimensions that cause this population to lead a more deprived life. But the information presented herein is not a rigid condition to be adopted, but rather seeks to highlight this problem more and somehow demonstrate to policymakers the different needs of the Northern population.

Thus, the conclusion is that in order to reduce multidimensional poverty, public administration must adopt public policies directed specifically to the dimensions that most strongly impact poverty in the northern region, namely: education, labor and demography, communication and information, and health, and to distribute these resources between the states in that region, seeking better living conditions and social inclusion, and thereby reduce regional disparities.

Lastly, for further analyses it is believed that studies should be carried out on poverty in North Brazil, seeking to investigate the particularities of each state in the region. For example: why are there differing degrees of poor within the state itself? What is the particular feature of each state whose population is in better situations compared to the other states in the same region? Which policies or public actions differ from state to state?

Therefore, the index used in the present research pinpoints such regional disparities. However, a more in-depth theoretical study should be made to evidence the peculiarities of poverty within each state in the northern region of Brazil.

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