

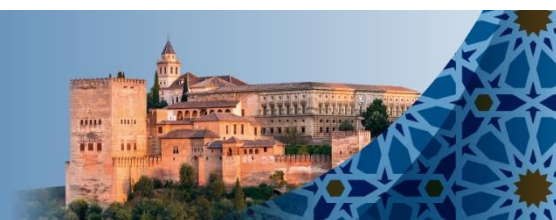
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*Desafíos, políticas y gobernanza de los territorios en la era post-covid*

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### EXTENDED ABSTRACT

**Title:** Individual-based fuzzy multidimensional poverty indexes: a comprehensive analysis of gender inequalities in Brazilian regions

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**Abstract:** This study examines gender differences in multidimensional poverty in Brazil. To properly analyze gender disparities, it addresses three problems that the literature often neglects: disregard for within-household inequalities in household-level indicators; disregard for ineligible populations in indicators that represent only a specific group; and disregard for intermediate deprivation situations in cutoff-based poverty estimations. Using data from the Brazilian Consumer Expenditure Survey 2017-2018, we create two individual-based indexes with indicators that are key aspects in gender and feminist analyses. Applying a fuzzy approach and the Alkire-Foster method, we estimate multidimensional poverty and gender differences in three perspectives: intrahousehold, interhousehold, and intracouple. We also calculate inequality among the poor and intracouple gender gaps proposing fuzzy versions for these analyses. The results suggest that women are disadvantaged in terms of work and time quality, economic security, and access to resources – which are crucial components of agency or degree of empowerment. In most specifications, individuals living in female-headed households are poorer than those living in male-headed households, but in female-headed households, women are in advantage compared to men, or at least the disparity decreases. The outcomes also confirm the usual regional and racial inequalities in Brazil, as the north and northeast regions, the rural areas, and the Black, Brown, and Indigenous people are persistently disadvantaged in many estimations' specifications.

**Keywords:** *Multidimensional poverty · Gender inequalities · Fuzzy-set approach · Alkire-Foster (AF) method · Latin America · Brazil*

**JEL codes:** I32, J16, O18, R29

## **1. Introduction**

Multidimensional methods provide ways to account for gender differences considering the complexity of the poverty phenomenon. The literature on multidimensional poverty recognizes that focusing only on income or consumption expenditure is insufficient because people potentially have simultaneous deprivations (Alkire et al., 2015). This recognition is a significant advancement, but this literature often neglects aspects that are essential to estimate gender differences in multidimensional poverty.

For example, most studies on multidimensional poverty use households as unit of identification (Deaton, 1997), which means that they define inequality within households as zero by setting the same value of deprivation among household members. The problem is that many well-being elements are a characteristic of individuals (Deaton, 1997), and several inequalities are generated/experienced inside dwellings (Nussbaum, 2000). Consequently, household-based analyses ignore personal experiences within a household and neglect inequalities among family members and subgroups (e.g., gender, generations, and degree of kinship). Klasen and Lahoti (2020) were the first to propose individual-based poverty analysis for the whole population. Their article shows that it is better to use a mix of household and individual-level indicators than only household-level ones, as the household-based index underestimates poverty differences between women and men in India.

Another issue is understanding how to address ineligible populations from indicators that represent only a specific population group. For instance, employment-related indicators tend to include only working-aged people. In this case, studies usually classify children and the elderly in pension as missing units or non-deprived, potentially underestimating poverty outcomes. Another source of complexity that receives little attention from the literature is the potential vagueness nature of indicators. Frequently, researchers treat poverty indicators as a rigid binary phenomenon (deprived or non-deprived), defining a specific cutoff to decide who is poor. This kind of approach neglects intermediate situations and can be unrealistic.

Given these problems in the literature, this paper aims to improve multidimensional poverty measurement to analyze gender differences better. The analysis focus on women's outcomes compared to men in each Brazilian region, but it also contemplates household headship, age, family composition, ethnicity/color, and area type (urban/rural).

Moreover, this study considers three different perspectives: results for the whole population (intrahousehold), household heads (interhousehold), and couples (intracouple). This paper applies the following three improvements to the problems discussed previously.

First, to partially avoid the problems of household-level analysis, we use individual-level indicators - when available - to build the multidimensional indexes. We propose two multidimensional poverty indexes. The first is the Standard Multidimensional Poverty Index (SMPI), which has similar dimensions as the Global Multidimensional Poverty Index (GMPI) (OPHI & UNDP, 2019) but adapted for the Brazilian context and data availability. This index works as a benchmark by selecting indicators commonly used in the multidimensional poverty literature. The second is the Occupation-Resources Index (ORI), which aims to understand and compare the quality of employment and time of individuals, analyze their financial situation, and have a proxy for control and administration of resources.

The two proposed indexes use information that is commonly present in household budget surveys. Therefore, we can apply these indexes, at least in parts, in studies analyzing other countries. However, most household surveys lack individual data (Deaton, 1997), so our indexes are a mix of individual and household indicators. That is the reason we also analyze multidimensional poverty among household heads. Because they usually answer all the survey questions, more indicators are available at the individual level in the interhousehold perspective.

Second, to mitigate the problem of ineligible population, we create individual composite indicators adapting the variables, when possible, to account for non-applicable populations. In this way, we can include different age groups in the same indicator to represent how they would be damaged when the eligible individuals in their household are deprived. For example, this paper considers children as deprived in employment- and financial-related indicators when every adult in their household is deprived in these indicators. Because children depend emotionally and economically on adults, the assumption is that children experience an external negative effect from the adults' deprivation situation.

Third, to account for the vagueness nature of indicators when measuring multidimensional poverty, we use a fuzzy set approach, which treats poverty as a matter of degree instead of a binary phenomenon. The approach also has the advantage of

presenting smaller standard errors, giving us more precise regional and subgroup outcomes (Betti et al., 2012; Betti et al., 2018). Besides the fuzzy set, we also use the Alkire-Foster method (AF). Even though the AF is a cutoff-based approach, it has the advantage of providing intuitive measures, vast possibilities of decompositions, and it is the current mainstream method in multidimensional poverty studies. The AF also works as a benchmarking for setting the parameters of the fuzzy analysis and gives complementary results from a distinct approach to measure poverty. Therefore, this paper considers both approaches as complementary methodologies instead of contrasting ones.

This paper also calculates a “crisp” and a fuzzy version of inequality among the poor and intracouple gender gap. To measure the crisp inequality among the poor measure, we apply the method proposed by Alkire and Seth (2014). For the fuzzy version, we propose a measure that calculates the inequality of membership degrees, considering a new benchmark for the fuzzy membership function (i.e., the incidence of extreme multidimensional poverty instead of multidimensional poverty). These inequality analyses are important for policy implications because, when inequality among the poor decrease, we know that it represents a reduction that benefited people in extreme poverty – whereas, in poverty measures, we cannot ensure that it represents a reduction that have benefited them (Alkire & Seth, 2014). As for the intracouple gender gap indexes, we apply the index proposed by Alkire et al. (2013) for the crisp measure and adapt it to create a fuzzy version. The intention is to evaluate intracouple relative differences in more detail.

The contributions of this paper are the following. Empirically, it offers a comprehensive individual-based analysis combining intrahousehold, interhousehold, and intracouple perspectives and evaluating multidimensional poverty, inequality among the poor, and gender gaps considering several subgroups and two approaches. As far as we are aware, this is the first paper to estimate individual-based multidimensional poverty and gender inequalities for the whole population in Brazil and the first paper to combine the three perspectives. Methodologically, this article creates the ORI, which uses indicators that are key aspects in gender and feminist analyses, and proposes a fuzzy version of the measures of inequality among the poor and intracouple gender gap.

## 2. Data and methodology

### 2.1 The Brazilian household budget survey

The microdata used in the paper is from the Brazilian Consumer Expenditure Survey (POF) 2017-18, collected and processed by the Brazilian Institute of Geography and Statistics (IBGE). The sample size is 69,660 households, and the data contains information at the levels of nation, major regions, states, state capitals, metropolitan regions (excluding the capital), other parts of the states (excluding the metropolitan regions and state capital), and at urban and rural areas

### 2.2 The Alkire-Foster method

In the Alkire-Foster methodology (AF) the measurement of poverty is based on the incidence, or headcount ratio ( $H$ ), which is the percentage of poor people, and intensity ( $A$ ), the percentage of deprivations an individual has on average (Alkire and Foster, 2011). The adjusted headcount ratio ( $M_0$ ) is the product of the headcount ratio and intensity,  $M_0 = H \times A$ .

### 2.3 The fuzzy set approach

Betti et al. (2006), with the Integrated Fuzzy and Relative (IFR) approach, offers a generalized form of the member function that can be exploited for monetary and non-monetary indicators in a multidimensional context. The membership function is the following:

$$m_i = \left( \frac{\sum_{\gamma} w_{\gamma} | X_{\gamma} > X_i}{\sum_{\gamma} w_{\gamma} | X_{\gamma} > X_1} \right)^{\alpha-1} \left( \frac{\sum_{\gamma} w_{\gamma} X_{\gamma} | X_{\gamma} > X_i}{\sum_{\gamma} w_{\gamma} X_{\gamma} | X_{\gamma} > X_1} \right),$$

where  $w_{\gamma}$  is the individual sample weight ranked by  $\gamma$ ,  $X$  is the monetary or non-monetary deprivation indicator, and  $\alpha$  is a parameter. The calculation of  $\alpha$  is such that the mean of the fuzzy indicator is equal to the incidence ( $H$ ) estimated in the AF method.

### 2.4 Inequality among the poor and intracouple gender gap

The analysis of inequality among the poor is important because it ensures that people in extremely poor conditions are identified in the measure and, consequentially, be properly focused on public policies (Alkire and Seth, 2014). We use two inequality measures; one of them is a positive multiple of variance as proposed by Alkire and Seth (2014), which is appropriate when using counting approaches as the AF method. The

other inequality measure is a fuzzy index we propose to be suitable when using the fuzzy-set approach.

To build this measure, we set a new  $\alpha$  in the fuzzy membership function such that the mean of the fuzzy indicator is equal to the incidence of extreme poverty (the threshold is half of the weighted deprivations instead of one-third), which gives more relative weight to the poorest centiles of the distribution. After estimating the fuzzy extreme poverty indicator, I calculate the inequality of extreme poverty membership degrees as follows:

$$I_{fz} = \frac{1}{n} \sum_{i=1}^n [m'_i - \mu(m')]^2,$$

where  $n$  is the number of the total population,  $m'_i$  is the extreme poverty membership degree of the individual  $i$ , and  $\mu(m')$  is the average value of the extreme poverty membership degree.

To explore the intrahousehold analysis further, we propose the Gender Gap Index (GGI), a variation of the Gender Parity Index by Alkire et al. (2013), measuring relative intracouple inequality between the primary female and male adults in a household. The GGI measure is also based on cutoffs, both to define the households that lack gender parity and to construct of the censored deprivation. To have an analysis that avoids this dichotomization, we adapt the GGI developing a fuzzy gender gap index measure, FzGGI, to assess the intracouple deprivation gender gap.

For this index, the computation of the percentage of disadvantaged women is the following:

$$H_{FzGGI} = \frac{h^{fz}}{z},$$

where  $h^{fz}$  is the number of households with disadvantaged women, and the average percentage gap between membership degrees of women and men in households with disadvantaged women ( $I_{FzGGI}$ ) is the following:

$$I_{FzGGI} = \frac{1}{h^{fz}} \sum_{j=1}^{h^{fz}} \frac{m_j^{fz^M} - m_j^{fz^W}}{1 - m_j^{fz^M}},$$

where  $m_j^{fz^W}$  and  $m_j^{fz^M}$  are, respectively, the poverty membership degree of the primary female and the primary male (when they are partners) in the household  $j$ .

Finally, the calculation of FzGGI is the product of the previous two measures:

$$FzGGI = H_{FzGGI} \times I_{FzGGI}.$$

### **3. Indexes and dimensions**

The first index proposed is the Standard Multidimensional Poverty Index (SMPI), which has three dimensions: education, health, and living standards. This index works as a benchmark by selecting indicators commonly used in the multidimensional poverty literature.

The second is the Occupation-Resources Index (ORI), which is an attempt to build a specific measure for individual economic autonomy. The purpose is to understand and compare the quality of employment and time of individuals, and to have a proxy for control of use and administration of resources.

### **4. Results**

The main outcomes of this paper show that multidimensional poverty is not feminized in most subgroups for the SMPI. In contrast, women are poorer in most subgroups for the ORI. Table 1 illustrates some of the results for the SMPI and ORI.

The results of inequality among the poor have this same pattern: higher among men in the SMPI and higher among women in the ORI. This pattern suggests that women are disadvantaged in terms of work and time quality, economic security, and access to resources – which are key components of agency or degree of empowerment.

The analyses of household headship reveal other situations that women are at a disadvantage. For instance, in most specifications, people living in female-headed households are poorer than in male-headed households, and, in the household head perspective, women are poorer for both the indexes. However, in female-headed households, women are less poor than men, or at least the gender differences decrease. Moreover, in the intracouple gender gap estimations, female-headed households have lower shares of women in disadvantage than male-headed ones.

In addition, the outcomes confirm the usual regional and racial inequalities in Brazil, as the North and Northeast regions (see Figure 1), the rural areas, and the Black, Brown, and Indigenous people are persistently disadvantaged in many estimation' specifications (see Tavares & Betti, 2021).

Table 1 - Multidimensional poverty estimations and gender differences by Index

	H (%)			Differences		Fuzzy			Differences	
	Total	Male	Female	Absolute	Relative	Total	Male	Female	Absolute	Relative
<b>SMPI</b>										
<i>Total</i>	18.03	18.75	17.35	-1.40***	0.93	18.03	18.25	17.82	-0.44***	0.98
<i>Regions</i>										
North	31.88	33.76	29.98	-3.78***	0.89	27.27	28.00	26.53	-1.47***	0.95
Northeast	27.53	28.90	26.25	-2.65	0.91	24.29	24.89	23.74	-1.14***	0.95
Center-west	15.23	15.85	14.63	-1.23***	0.92	15.64	15.77	15.52	-0.25	0.98
Southeast	12.62	12.88	12.38	-0.50	0.96	15.25	15.24	15.27	0.03	1.00
South	9.06	8.88	9.24	0.35***	1.04	10.01	9.80	10.21	0.40*	1.04
<b>ORI</b>										
<i>Total</i>	33.49	32.26	34.66	2.40***	1.07	33.49	32.65	34.29	1.64***	1.05
<i>Regions</i>										
North	42.28	41.81	42.75	0.94	1.02	39.97	39.33	40.61	1.28***	1.03
Northeast	42.77	42.30	43.20	0.90**	1.02	41.16	40.76	41.53	0.78***	1.02
Center-west	33.28	31.89	34.61	2.72***	1.09	32.36	31.42	33.27	1.85***	1.06
Southeast	30.08	28.23	31.77	3.54***	1.13	30.81	29.67	31.86	2.19***	1.07
South	20.73	19.25	22.14	2.90***	1.15	23.53	22.51	24.50	2.00***	1.09

Notes: Significance levels: \*p < 0.1; \*\*p < 0.05; \*\*\*p < 0.01. Fuzzy outcomes represent degrees of poverty.

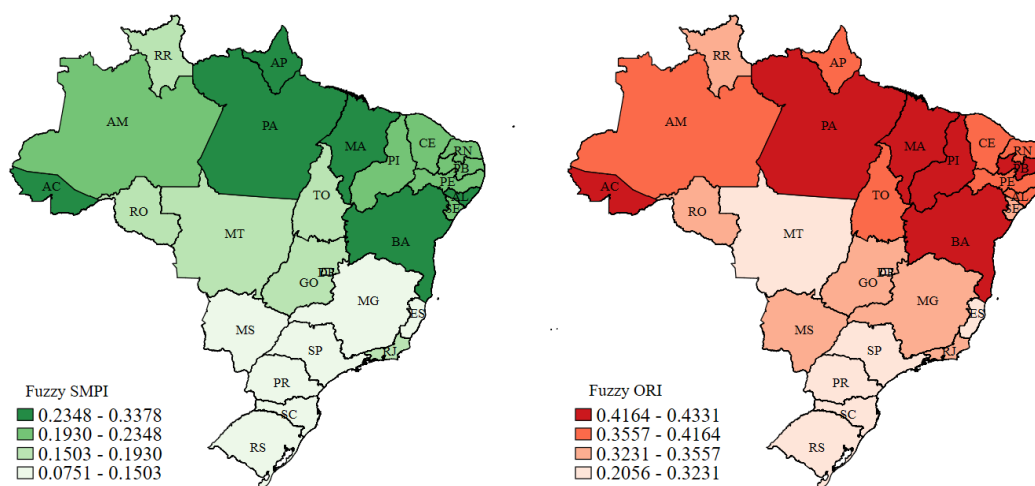


Figure 1 - Fuzzy multidimensional poverty estimations by state

Notes: *Northern region*: RO = Rondônia; AC = Acre; AM = Amazonas; RR = Roraima; PA = Pará; AP = Amapá; TO = Tocantins; *Northeastern region*: MA = Maranhão; PI = Piauí; CE = Ceará; RN = Rio Grande do Norte; PB = Paraíba; PE = Pernambuco; AL = Alagoas; SE = Sergipe; BA = Bahia.; *Southeastern region*: MG = Minas Gerais; ES = Espírito Santo; RJ = Rio de Janeiro; SP = São Paulo. *Southern region*: PR = Paraná; SC = Santa Catarina; RS = Rio Grande do Sul. *Central-western region*: MS = Mato Grosso do Sul; MT = Mato Grosso; GO = Goiás; DF = Distrito Federal.



## **5. Conclusion remarks**

The outcomes confirm the importance of comprehensive individual-based analysis to assess gender inequalities, especially by regions and subgroups. Even when female poverty is not apparent in the aggregate results, for some regions and groups, women's situation is clearly worse than men's.

As policy implications, this study suggests that social policies should concern the situation of women, especially in the dimensions of Occupation and Resources, and considering the regional and racial inequalities. However, interventions in this sense must always ensure that it does not create further disadvantages such as increasing female workload or reinforcing gender roles. Another aspect that should receive further research and policy consideration is understanding why people living in female-headed households are poorer than male-headed households and why gender disparities disfavoring women are higher in male-headed households.

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