Household vulnerability to poverty: an empiric analysis of six metropolitan regions (2002 to 2011)

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Abstract

With studies on poverty displaying methodological and concept complexity, and in light of works on the factors responsible for the poverty phenomenon, researchers of the issue have reached a consensus about the multidimensional character and the complexity of this social problem. Many studies have, besides this, cast light on the dynamic character of the poverty phenomenon – i.e., that poverty cycles propagate themselves, as well as that individuals and households both enter and exit a situation of deprivation. In this context, studies about vulnerability to poverty emerge. Vulnerability to poverty is the current likelihood of falling into poverty in the future. This paper intends to contribute to the literature on vulnerability to poverty in Brazil by estimating the probability, in a given period, of households entering poverty in the subsequent year, based on data from the Monthly Employment Survey (Pesquisa Mensal de Emprego – PME (IBGE)), for the 2002 to 2011 period. We carry out analyses for six metropolitan regions: São Paulo, Rio de Janeiro, Belo Horizonte, Porto Alegre, Salvador and Recife. Household income is defined as an indicator of well-being. The results reveal a decrease in vulnerability over the analysed period. Additionally, this decrease is even more pronounced when other earnings – such as pensions, private and public transfers, earnings from investments and rent – are added to labour income. Furthermore, it is possible to verify that the vulnerability associated with labour income is more connected to permanent poverty, while the vulnerability related to total earnings is better distributed amongst the poverty categories. Being male, having higher education and a successful insertion in the formal labour market are characteristics of heads of household associated to a lower likelihood of household income falling below a certain poverty line in the next period. Thus, the results suggest that public policies aiming at better access to formal education and vocational training programmes are important to decrease household vulnerability to poverty in the Brazilian metropolitan regions.

Keywords

Vulnerability, poverty dynamics, chronic poverty, transient poverty

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1   Introduction

With studies on poverty displaying methodological and concept complexity, and in light of works on the factors responsible for the poverty phenomenon, researchers of the issue have reached a consensus about the multidimensional character and the complexity of this social problem. Many studies have, besides this, cast light on the dynamic character of the poverty phenomenon – i.e., that poverty cycles propagate themselves, as well as that individuals and households both enter and exit a situation of deprivation.

In this context, studies about vulnerability to poverty emerge. Although there is no theoretical or methodological consensus regarding the concept of vulnerability, we have chosen to herein employ the most widespread approach. The latter defines vulnerability to poverty as the likelihood, calculated in the current period and employing or not information from previous periods, of individuals or households undergoing a decrease of their well-being in the future.

The main difference between studies that aim at comprehending the phenomenon of poverty and those that attempt to measure household vulnerability is in the intrinsic properties of their respective objects of study. Poverty is, essentially, a static, non-probabilistic concept. Which is to say, it deals with a deprivation condition individuals or households experience in the current period. On the other hand, measures of vulnerability (implicitly) take into account the uncertainty of future events and assess, in the current period, the likelihood of adverse future occurrences.

The observed level of poverty can thus be seen as an *ex post* measure of well-being (or lack thereof), and it is not necessarily a good indicator of a household's expected poverty. This is due to the fact that it does not allow one to analyse whether currently non-poor households are likely to become poor or whether, alternatively, currently poor households might leave this condition of deprivation. Measures of vulnerability are in turn seen as an *ex ante* assessment of well-being, for they are mainly built to offer future perspectives of well-being, and not so much on the current situation of a household.

The first reason for exploring the vulnerability to poverty of Brazilian households is related to the paucity of studies on this issue, as compared to the profusion of existing works on situations of well-being deprivation focusing on observed poverty (including absolute, relative or subjective, static and even dynamic approaches).

The second reason behind studying household vulnerability is related to the informative character that *ex ante* analyses might have in developing forward-looking policies that aim at reducing poverty. In other words, reducing vulnerability to poverty has an instrumental function in decreasing future poverty.

The last motivation for this paper is the potential size of the vulnerable population in Brazil, as well as the presence of regional disparities in the level and the determinants of vulnerability. Osorio *et al.*'s (2012) work is relevant here. The authors approach the issue by means of a descriptive indicator and do not calculate the probability of households entering poverty. The data they present, nevertheless, suggest that there is a huge population little above the poverty line, with characteristics that make it likely for them to become poor in the future. In this work, the authors classify households according to their income; thus, they are vulnerable if their income is close to, but slightly above, the poverty line. They estimate that in 2009 the vulnerable segment of the Brazilian population comprised, approximately, 21 million households. For the sake of a simple comparison, this same study shows that the extremely poor and poor amount to six million households[1].

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[1] The classification of households as poor and extremely poor is based on the eligibility conditions of the *Programa Bolsa Família* (PBF) in 2003. In 2009, individuals considered extremely poor had a maximum household income *per capita* of R$ 67, while the income of poor ones was between R$ 67 and R$ 134. Households are classified as vulnerable by ascertaining the position in the income distribution that makes them most likely to enter poverty. This is the group with an income *per capita* between R$ 134 and R$ 465.

Given the importance of a study on this issue, this paper intends to contribute to the literature on vulnerability to poverty in Brazil by estimating the probability, in a given period, of households entering poverty in the subsequent year. The estimations are based on data from the Monthly Employment Survey (*Pesquisa Mensal de Emprego* – PME/IBGE), from 2002 to 2011. We also build a database with information on the households in two different moments, with a 12 months interval in between observations. We carry out estimations for the six metropolitan regions (hereafter MRs) the survey covers – São Paulo, Rio de Janeiro, Belo Horizonte, Porto Alegre, Salvador and Recife – and use the monthly income of the households as an indicator of well-being.

Besides calculating the number of households vulnerable to poverty, this paper lays out a profile of the latter in the studied regions. This profile comprehends demographic and socioeconomic characteristics of vulnerable and non-vulnerable households; a comparison of a classification based on observed poverty and one based on the calculated probability, in order to assess whether non-poor groups in the current period have got a chance of entering poverty in the future and whether, on the other hand, poor households might not be vulnerable; and regions where the vulnerable group is a large parcel of the population. The last aim of this study is to analyse the evolution of vulnerability to poverty in Brazil during the last decade.

It is important to notice that, in the period, there was an expansion of social policies which highly contributed to favourable behaviour of well-being indicators. In the field of wage policies, the minimum wage was attached not only the general index variation of prices but also to PIB variation. The latter increased in this period, so what minimum wage received substantial gains i.e. 59% from 2002 to 2011. There was also an expansion of loans to maintain small business and to stimulate the consumption, reaching mainly who are at the bottom of income distribution. Furthermore, the transfers programme *(Bolsa Família)* which also unified similar programs contributed to reduce poor headcount to 34.38% in 2002 to 18.42% in 2011.

This work is divided in six sections, besides this introduction. The second presents the theoretical and methodological approaches chosen to calculate the vulnerability to poverty. The third describes the database and the treatments applied to the sample, while the fourth presents the empirical strategy. The fifth, in turn, deals with the construction of the variables and the choices for the poverty line, for the limit that defines vulnerability and for the FGT measure[2]. We present the results in the sixth section and the conclusions in the last.

2 Theoretical and methodological approaches chosen to assess vulnerability

2.1 Vulnerability and poverty dynamics

There are some basic principles related to the general concept of vulnerability that help understanding the structure and nature of the problem at hand: a) vulnerability is forward-looking, which is to say, it is a way of analysing the social issue of poverty beforehand; it can be defined as the probability of undergoing, in the future, a decrease in some standard of well-being; b) a household can be considered vulnerable to a future decrease of well-being, and this vulnerability is determined by uncertain events; c) the degree of vulnerability depends on the characteristics of the risk and on the ability of the households to respond to risk; d) vulnerability depends on the time horizon considered, since households can be vulnerable to risks along the next month or year and the responses to risk also occur over time; e) the poor and quasi-poor households tend to be vulnerable due to restricted access to resources and their limited ability in responding to risk.

The economic literature usually defines vulnerability as the result of a process through which households respond to risk, given a set of underlying conditions. Hence, vulnerable are those households that move towards a state of poverty or destitution (or are likely to do so) as the result of a cumulative process of risk and responses to risks (ALWANG; SIEGEL; JORGENSEN, 2001, p. 1-5).

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[2] Foster-Greer-Thorbecke (1984) measures of poverty.

Nevertheless, even in the economic literature there is no consensus regarding the definition of vulnerability to poverty and the factors the lead to it. In a study on the different economic approaches to vulnerability, Alwang, Siegel and Jorgensen (2001) built a classification of these approaches according to the relationship between the issue and its possible determinants. These authors mention studies that relate individual vulnerability to the dynamics of poverty – i.e., chronic and transitory poverty –, studies that approach vulnerability as a cause and consequence of the possessions of goods/assets, and works that relate vulnerability to the possession of means of subsistence or to food safety.

Our main goal is to conduct a longitudinal analysis of household vulnerability and the factors associated to this condition of deprivation, making use of information on the dynamic process that determines the well-being of the households. Hence, we relate household vulnerability to the dynamics of poverty. Besides this, given the limitations of the database (PME) regarding the possession of assets and means of subsistence, the alternative approaches cannot be used as our theoretical basis.

The main result of the extensive literature on the dynamics of poverty is that this is a phenomenon that must be approached with consideration of its temporal nature. Although this literature focuses on a static result of vulnerability – the *ex post* movement into or out of poverty –, it emphasises that the phenomenon is the result of a dynamic process (ALWANG; SIEGEL; JORGENSEN, 2001, p. 7). Amongst the works that establish a relationship between the dynamics of the level of well-being, the average level and the variance of well-being over time, and household vulnerability, Chadhuri's (2003) paper is worth highlighting. According to this author, vulnerability can be associated either to a long-term perspective of low consumption or to a high volatility of consumption. It is thus necessary, when analysing the proximate causes of vulnerability, to distinguish between households that are only vulnerable in face of volatility of consumption (households vulnerable to transitory poverty) and those that are structurally poor.

2.2 The quantitative approach: vulnerability as expected poverty (VEP)

Regarding the possible quantitative approaches to vulnerability, there are, at least, three known ways to measure this social problem: vulnerability as expected poverty (VEP); vulnerability as expected utility (VEU); and vulnerability as exposure to risk (VER) (HODDINOTT; QUISUMBING, 2008).

In the vulnerability as expected poverty (VEP) approach, herein employed, vulnerability (V_h) is defined as the probability of a household falling into poverty in the future (HODDINOTT; QUISUMBING, 2008). This approach has been employed by, amongst others, Ravallion (1988), Pritchett *et al.* (2000), Christiaensen and Boisvert (2000), Christiaensen and Subbarao (2004), Suryahadi and Sumarto (2001), Chaudhuri *et al.* (2002), Chaudhuri (2003), Bourguignon and Goh (2004), Kuhl (2003), Zhang and Wan (2009), Cruces *et al.* (2010) and Landau *et al.* (2012). It refers to a standard for the well-being indicator, z, and calculates the probability that the household well-being level (p_h) will fall below z. Thus, $V_h = f(c_h, z, p_h)$, where c_h is consumption, but it could also be income or any other well-being indicator and f is a general function. Consequently, the vulnerability of household h in period t is the probability that its consumption level in $t+1$ (c_{ht+1}) will be below the poverty line, z: $V_{ht} = \Pr(c_{ht+1} < z)$.

This indicator adapts the standard Foster-Greer-Thorbecke (1984) measures of poverty to a non-deterministic environment and estimates the expected value of P_α. In this sense, works that use this approach can be divided according to the value of α [3]. The papers can also be grouped according to the time horizon defined for the measure. Given a VEP for n years, household h is

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[3] In the literature on measures of poverty, the parameter α reflects the household risk preferences.

vulnerable if the probability of its income (or consumption) falling below the poverty line exceeds, for at least one of the following n years, a certain pre-defined value.

One of the main problems of the VEP approach, pointed out by, amongst others, Chadhuri (2003) and Ligon and Schechter (2004), is that it can lead to adverse results if a household's consumption/income is slightly above the poverty line, it is averse to risk and it receives an intense, low-probability shock. In this case, it is expected for its income/consumption to lie a little below the poverty line and for the household to choose a lower expected consumption level that might reduce its vulnerability. In other words, according to the VEP measure a greater risk can reduce the vulnerability level of households with mean consumption levels below the poverty line.

2.3 The process of building the household vulnerability to poverty indicator

According to Chaudhuri (2003), estimating household vulnerability to poverty comprehends four main steps. The first step concerns specifying the process that generates the consumption data (or income data, which is the well-being indicator used in this work). In the second, information on the income and other characteristics of the households is used to estimate the parameters necessary to calculate the indicator. The third step, in turn, consists in determining the hypotheses for the statistical distribution that are needed to make inferences about the future income perspectives of the households. It thus advances from the income determination process to producing vulnerability estimates. The last step is using these estimates to conduct relevant public policy analyses.

In the first step of the vulnerability estimation process it is necessary to determine the reduced form of the household income equation. This expression, in general terms, can be written as:

$$y_{ht} = g(X_{ht}, \beta, e_{ht}) \tag{1}$$

where y_{ht} represents the income of household h in a given period t; X_{ht} is the vector of observable characteristics, both time-variant and -invariant, of household h and of the metropolitan region where the household h lives in period t; β is a parameter that describes the relationship between the intrinsic characteristics of households or the characteristics of metropolitan region where the household lives, and their income; e_{ht} are the model residuals, that capture shocks or deviations from the expected income of the households; and g is a general function[4].

Given the specification decided in the first step, we estimate the parameters of the income data-generation process. These parameters allow us to obtain the *ex ante* probability distribution of each household's future income, which in turn makes it possible to calculate the households' vulnerability to poverty.

However, as Chaudhuri (2003) points out, vulnerability does not depend solely on the mean of the household's well-being indicator, but also on its variability during a certain timeframe. Given this, in the estimation process one must also investigate the variance of the indicator.

The hypothesis that variance is equal for all households can be overly restrictive, for it requires the mean and variance estimates to be monotonically related. Besides this, erroneously presupposing homoscedasticity leads to biased vulnerability estimates, since the standard deviation of the error term directly enters the estimates (CHAUDHURI, 2003).

By allowing for heteroscedasticity, it is possible to estimate the variance of the error term e_{ht} as a function of the characteristics of the households:

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[4] In the first step, we investigate and compare five specifications presented in Landau *et al.* (2012) and one specification for panel data. It is worth mentioning that the analysed models are not causal models for the income generation process, but rather correlation-based ones. Their objective is limited to estimating or forecasting the future income of the households (LANDAU *et al.*, 2012).

$$\sigma_{e_{ht}}^2 = X_{ht}\lambda + u_{ht} \tag{2}$$

Having estimated the mean and variance of income, denoted by $\hat{\mu}_{y_{ht}}$ and $\hat{\sigma}_{e_{ht}}^2$, the third step consists in determining a parametric probability distribution for the future income of the households. Usually, income is assumed to follow a normal or log-normal distribution. Under the hypothesis of normality or log-normality, the mean and the variance of income are sufficient to characterise the *ex ante* probability distribution of future earnings.

One can, by means of the probability distribution of the future income of households, estimate the probability of a household with characteristics X_{ht} being poor – i.e., estimate its level of vulnerability. Given the choice to use the theory that approaches vulnerability to poverty as expected poverty (VEP), and according to Chaudhuri's (2003) framework, the expression for household vulnerability can be written as:

$$\upsilon_{\alpha,ht} = E[p_{\alpha,ht}(y_{ht}) \mid F(y_{ht} \mid X_{ht}, \beta, e_{ht})] \tag{3}$$

where $p_{\alpha,ht}$ denotes a formulation for the poverty indicator of household h in period t with a parameter α, and F represents a general cumulative distribution function. This indicator, for a period t and with α assuming values 0, 1, 2 etc., can be reduced to the known set of Foster-Greer-Thorbecke (1984) poverty measures:

$$p_{\alpha,ht} = \left(\max\left\{ 0, \frac{z - y_{ht}}{z} \right\} \right)^{\alpha} \tag{4}$$

where z is a certain poverty threshold or line. Equation (4) can be substituted in (3), to define a final expression for household vulnerability. The latter is then measured as the probability of falling below the poverty line z, multiplied by a conditional weighted-probability function of falling below this line.

Under the hypothesis of normally distributed household income, the estimated vulnerability of household h in period t can be described by the expression:

$$\hat{\upsilon}_{ht} = \hat{\Pr}(y_{ht+1} < z \mid X_{ht}) = \Phi\left(\frac{z - X_{ht}\hat{\beta}}{\sqrt{X_{ht}\hat{\lambda}}} \right) \tag{5}$$

where $\Phi(\cdot)$ denotes the cumulative density of the standard normal and $\hat{\beta}$ and $\hat{\lambda}$ are respectively related to equations (1) and (2).

3 Database and sample treatments

Some studies on household vulnerability state that estimates based on a single cross-section – thus lacking intertemporal information on the households – can be problematic. Landau *et al.* (2012) estimate a model including income from the previous year as an explanatory variable to predict income in the following year. They find evidence indicating the importance of this variable and conclude that forecasts based solely on cross-section data can be less precise than those that employ panel data or, somehow, use information from previous years.

In view of the problems mentioned above, we have chosen the Monthly Employment Survey (*Pesquisa Mensal de Emprego* – PME/IBGE) for our database. This is a monthly household

longitudinal survey that investigates characteristics of the population that resides in the urban areas of the metropolitan regions of Recife, Salvador, Belo Horizonte, São Paulo, Rio de Janeiro and Porto Alegre. In the PME, data collection follows a method according to which each selected household is surveyed for four consecutive months and then left out the survey for eight months. After this period, it re-enters the survey for another four months and is, finally, excluded from the sample (IBGE). It is thus the case that, when the household is interviewed more than once, data from previous interviews allow for greater precision in calculating the vulnerability to poverty associated to the individuals' access to education, qualification and the labour market.

As we intend to estimate the annual household vulnerability to poverty, we create a panel with two observations for each household, with a twelve-months interval in between them[5].

However much the PME might have rich micro-level data, which allow for investigating dynamic phenomena, it presents, nevertheless, certain limitations. The first regards its coverage, which is restricted to six metropolitan regions. This means it accounts for approximately 25% of the Brazilian population and does not encompass rural regions. The second refers to the impossibility of observing all individuals of the sample in the eight interviews – the PME is an unbalanced panel. The geographic mobility of the individuals, refusals to participate in the interviews and imprecise declarations regarding the identification information used to reconstitute the panel (the PME does not record codes for the individuals in the household) are the main reasons for the attrition of the panel, according to Ribas and Soares (2008).

To minimise these problems, we apply three treatments to the data. The first is a method to recuperate the individuals in the sample, by means of a pairing algorithm (more advanced than the ordinarily used one, based on the day, month and year of birth, as well as the sex of the person) developed by Ribas and Soares (2008). In the second place, we attempt to minimise exclusion from the sample due to changes of address[6]. This is done by keeping the households that substitute or exclude up to half its total members in an observation. The third treatment corrects for the selection bias due to the exclusion of the sampling units.

As it aims at investigating labour market and workforce conditions, the PME questionnaire explores matters concerning labour income. It does not, therefore, take into account other sources of income such as pensions, unemployment benefits, rent, earnings from investments and public and private transfers, which are essential to analyse the well-being of the households and their vulnerability to poverty. In order to deal with this problem, we apply a method for imputing, in the PME, the other various household earnings available in the National Household Sample Survey (*Pesquisa Nacional por Amostra de Domicílios* – PNAD/IBGE). We follow an adaptation of the Elbers, Lanjouw and Lanjouw (2003) method of transposing variables from one database to the other, as developed by Ribas and Machado (2008).

In this study, we chose to analyse the period that extends from 2002 (starting on March) to 2011 (December)[7]. The units of analysis are the households present in the housing units. The final sample, after the treatments, contains 386,255 households, observed in two different moments in time.

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[5] The sample only keeps the households for which there are observations for the first and fifth, second and sixth, third and seventh and/or for the fourth and eighth interviews.

[6] According to the PME methodology, if during the period that the housing unit is part of the sample the household changes its address, and another comes to inhabit this household, the information then refers to this new household for the remainder of the period. In this article, we thus use two criteria to indicate a possible change of address of the household: i) the decrease (or increase) of the size of the households to less (more) than half the members of the initial observation; or ii) the substitution, between the two interviews, of more than half the members of the household by individuals with different characteristics. To reveal the substitution of individuals, we verify their calculated age and exclude those households in which more than half of their members present an age difference greater than two years in between the first and the second observation.

[7] We use 16 PME panels (groups of household units): C, D, E, F, G, H, I, J, K, L, M, N, O P. It is worth mentioning that, from panel P, we only use households that have their fifth interview in, at least, December 2011.

4   Empirical strategy for estimating household vulnerability to poverty

We follow the empirical strategy proposed by Suryahadi and Sumarto (2001), Chaudhuri *et al.* (2002) and Chaudhuri (2003), and apply Chaudhuri's (2001) estimator. Ligon and Schechter (2004) test and compare the chosen estimator to those of Ligon and Schechter (2002) and Pritchett *et al.* (2000), as well as to a cross-section estimator. These authors conclude that Chaudhuri's (2001) estimator, which assumes independent and normally distributed consumption and takes into account the heterogeneity of the households (by using the regression for the variance of consumption), displays the best performance in a stationary environment.

In order to estimate the relevant parameters for the income data-generating process, we perform three procedures. We firstly estimate the correction term for the selection bias, due to the exclusion of some households from the sample, with a probit model[8]. In the second procedure, we estimate the income model, incorporating the correction term as an explanatory variable. We choose one of Landau *et al.* (2012) specifications, in which the lagged dependent variable is used as an explanatory variable in the model. The functional form for the income equation can thus be described by the following equation:

$$\ln y_{ht} = X_{ht}\beta + Z_{ht}\psi + e_{ht} \tag{6}$$

where y_{ht} is one of the possible dependent variables; X_{ht} is the vector of explanatory variables, which contains the lagged dependent variable; Z_{ht} is the vector that contains the control variables and the estimated correction term; β and ψ are the parameters; and e_{ht} is the error term that captures (idiosyncratic) shocks that contribute to making observationally-equivalent households display different levels of *per capita* income. Equation (6) is then estimated by Ordinary Least Squares (OLS), in order to obtain the equation residuals.

The third procedure regards the joint (or simultaneous) estimation of the equations for the mean (6) and the variance (2) of income, using the residuals obtained in the second procedure:

$$\hat{e}^2_{OLS,ht} = X_{ht}\lambda + \eta_{ht} \tag{7}$$

In this step we employ the Three-Step Feasible Generalised Least Squares (FGLS) method that Amemiya (1977) suggests. In this method, the predicted values obtained in equation (7) are used to transform the equation itself:

$$\frac{\hat{e}^2_{OLS,ht}}{X_{ht}\hat{\lambda}_{OLS}} = \left(\frac{X_{ht}}{X_{ht}\hat{\lambda}_{OLS}}\right)\lambda + \frac{\eta_{ht}}{X_{ht}\hat{\lambda}_{OLS}} \tag{8}$$

The transformed equation (8) is estimated by OLS, to obtain an asymptotically efficient FLGS estimator: $\hat{\lambda}_{FGLS}$. It is important to notice that $X_{ht}\hat{\lambda}_{FGLS}$ is a consistent estimator of $\sigma^2_{e_{ht}}$, the variance of the idiosyncratic component of household income. The estimates for $\hat{\sigma}_{e_{ht}} = \sqrt{X_{ht}\hat{\lambda}_{FGLS}}$ are then used to transform equation (6):

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[8] For more details on selection equations with a probit model, see Wooldridge (pp. 560-571, 2002).

$$\frac{\ln y_{ht}}{\hat{\sigma}_{e_{ht}}} = \left(\frac{X_{ht}}{\hat{\sigma}_{e_{ht}}}\right)\beta + \left(\frac{Z_{ht}}{\hat{\sigma}_{e_{ht}}}\right)\psi + \frac{e_{ht}}{\hat{\sigma}_{e_{ht}}} \qquad (9)$$

Under the hypothesis of log-normally distributed earnings, the parameters ($\hat{\beta}$, $\hat{\psi}$ and $\hat{\lambda}$) generated can be used to estimate the probability of a household with characteristics X_{ht} being poor – i.e., an estimate of the household's vulnerability level. Letting $\Phi(\cdot)$ denote the cumulative density of the standard normal, the estimated probability is given by:

$$\hat{\upsilon}_{ht} = \hat{\Pr}(\ln(y_{ht}) < \ln(z) \mid X_{ht}, Z_{ht}) = \Phi\left(\frac{\ln(z) - (X_{ht}\hat{\beta} + Z_{ht}\hat{\psi})}{\sqrt{X_{ht}\hat{\lambda}}}\right) \qquad (10)$$

5   Construction of the variables and choices for the poverty line, for the vulnerability threshold and for the FGT measure

To compare the results of the regressions, we test two dependent variables. The first is the natural logarithm of the sum of actual household income (*per capita*)[9] and the imputed earnings (also *per capita*). The imputations are for retirement benefits, pensions, interest income, rents, investments and public and private transfers. The second variable is the natural logarithm of actual household income (*per capita*). It does not, therefore, consider the imputed non-labour earnings. By comparing the estimations with these two dependent variables one can verify whether the imputed earnings impact the results[10].

The variables used in the estimations are divided into two groups: 1) variables related to the household; and 2) variables related to the head of household. Groups 1 and 2 can be subdivided according to the nature of the variables into three subgroups: demographic, socioeconomic and labour market insertion variables[11].

The group of demographic information about the households comprises seven variables: number of household members; a dummy for the number of members above the average sample value; proportion of children, seniors and working-age members (between 18 and 65 years of age, including the limiting values); proportion of white individuals; and proportion of men amongst the household members. The demographic variables for the head of household are: age and age squared; a dummy for heads of household older than the sample average; a dummy for white and a dummy for male head of household. Including demographic variables is justified by the argument that the asymmetries between households, as regards their rights and duties and based on the gender, age and race/colour of their members, can translate into different ways of dealing with economic difficulties (MOSER, 1998).

The socioeconomic group of variables aims at capturing the household's human capital because this is, according to the extensive microeconomic and macroeconomic literature, the main determinant of labour income (wages). The variables thus are: proportion of adults (older than 18 years of age) with basic education (8 or 9 years of education); proportion of adults with secondary education (11 or 12); proportion of adults with higher education (15 or more years of education); proportion of workers with jobs of low-, middle- and high-qualification levels; education of the

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[9] The actual income is the PME variable *Income actually received from all jobs during the reference month*. It can be defined as the income the person actually received during the reference month (PME, IBGE). Which is to say, it takes into account (positive or negative) shocks that the households experience in their usual earnings.

[10] The values of these dependent variables are corrected with the Deflator for the PME earnings (PME-INPC) available in *http://www.ipeadata.gov.br/*. Additionally, the imputed non-labour earnings, from the PNAD, which are only available for the month of September in each year, are transformed into monthly values.

[11] The detailed description of some of the variables can be had in Table A1 of the Appendix.

head of household; job qualification level of the head of household. There is, additionally, a dummy for the marital status of the head of household, owing to its impact on both the household composition (size) and on his or her participation in the household earnings and decisions.

Lastly, the group of variables related to the labour market insertion of the members and the head of household contains eleven variables. The head of household's access to, and insertion in, the labour market is seen through the following variables: occupational status (a categorical variable that assume value 1 if the person is occupied, 2 if the person is unemployed and 3 if the person is inactive); a dummy for being in the current job for more than one year; and a dummy for jobs in the formal segments of the labour market. As to the remaining members, their insertion is described by the following: proportion of workers (occupied persons) amongst household members in working-age; proportion of workers who have held their current jobs for more than one year; proportion of unemployed (unoccupied) individuals amongst members in working-age; proportion of workers in formal segments; dummy for the presence workers on sick-leave; average weekly work hours of the household; a dummy if the household's average work hours are above the sample average.

The reason for including variables measuring the access to, and insertion in, the labour market is directly related to this paper's main objective – estimating household vulnerability to poverty in certain metropolitan regions of Brazil. These are households located in urban areas. Given an approach to vulnerability centred on urban areas, to be working (having a job) can be considered the most important asset of poor individuals. Besides this, in a context of economic problems, the portfolio of the household can be managed in order to increase the number of workers, by mobilising additional work from the members (MOSER, 1998).

Besides the independent variables, we also estimate a model with the presence of control variables for the MRs. They allow us to control for socioeconomic differences between the spatial location of the households (CHRISTIAENSEN; BOISVERT, 2000). This group comprises the following variables: natural logarithm of the population; dummies for the years and months; average yearly labour force participation ratio; yearly mean rate of unemployment and ratio of occupied persons to the total working-age population; four binary variables that aim at describing how formal workers with active employment relations are distributed amongst the different sectors of the labour market; natural logarithm of the total value of credit transactions (*per capita*) and of the number of bank agencies[12]; the number of *Programa Bolsa Família* benefits[13]; and the proportion of total agricultural output referring to permanent and temporary crops[14]. It is worth mentioning that the control variables are yearly.

For the selection equations, we also include an additional vector of exogenous variables in addition to the already listed independent and control variables. The hypothesis behind using them is that they have no impact on the dependent variable of interest while, on the other hand, they are correlated to the sample selection mechanism – i.e., they are important in explaining the exclusion of households from the sample. The exogeneity hypothesis is based on the fact that the three chosen selection variables are related to the interviewing and data collection process, and are thus external to the determination of household income. The vector of selection variables is composed of dummies for: the number of the household interview; the week of the interview; and the rotational group (the division of the sectors chosen for the survey) to which the household belongs.

In the third step of the vulnerability estimation process, it is necessary to determine a poverty line (z). This is a value against which the expected income of each household is compared, so as to

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[12] These variables are calculated using the *Saldos Estban* for the municipalities in December of each year. These are monthly files generated with information from the Monthly Banking Statistics (*Estatística Bancária Mensal* – ESTBAN) of the Central Bank of Brazil – BACEN (available in: *http://www4.bcb.gov.br/fis/cosif/estban.asp*).

[13] *Programa Bolsa Família* (PBF) was established by law only in 2004. The variable measures the number of households that receive aid from the programme in December of each year. For 2002 and 2003, the MRs have a value of zero for this variable.

[14] These variables are based on data of the Municipal Agricultural Output (*Produção Agrícola Municipal* – IBGE) (Available in: *http://www.sidra.ibge.gov.br/bda/pesquisas/pam/default.asp?o=18&i=P*).

calculate the probability that its well-being will decrease. We use an absolute, administrative poverty line – the eligibility threshold the federal government defined for the *Programa Bolsa Família* (PBF)[15]. Osorio *et al.* (2011) defend using a "political-administrative" poverty line, such as the PBF threshold. They sustain that, in a public policy context, the perception of researchers regarding poverty and their normative decisions cannot take the place of well-established perceptions arising from a consensus.

In estimating vulnerability, besides choosing a poverty line, one must also determine a limit or bottom value for the probability. Above this value, a household is deemed vulnerable. In this work, we used the absolute value of 0,5 to identify vulnerability, which means that households presenting a greater than 50% chance of falling below the poverty line are considered vulnerable. Chaudhuri (2003) argues that a bottom value of 0,5, used by most authors (such as Christiaensen and Boisvert (2000), Suryahadi and Sumarto (2001), Zhang and Wan (2009)), is a plausible limit because a household whose vulnerability is higher than 0,5 has got a greater chance of becoming poor than otherwise.

The last choice to be made regards the FGT measure that will be used – the α parameter that reflects household risk-preference. We chose the expected number of poor individuals, or the "Headcount" ($\alpha = 0$). This is a simple measure that varies according to the wealth of the households, but is not sensitive to risks.

5 Results of the estimations for household vulnerability to poverty

The results of the joint estimation of the equations for mean earnings and their variance, using the residuals derived from the first step of the estimation and applying the three-step FGLS method, are presented in Table 1. The explanatory power (adjusted-R^2) of the first model (M1) is 0.49, whereas that of the second model (M2) is 0.73. Estimating the equation for mean earnings reveals that there are differences in the significance of some variables when the dependent variable changes. It should be highlighted that the correction-factor for the selection bias is only significant in the estimations of actual income, without imputed values. The lagged variable is significant in both cases, which shows that earnings depend on the initial conditions of the households.

Generally speaking, the signs of the variables accord to their expected values and to the results other theoretical and empirical works point out. The following characteristics are associated to a higher mean household income: a greater proportion of household members or the head of household being white, male, more educated and in the same job for more than one year; a greater proportion of active members (working) and of members in formal segments, as well as longer weekly work hours; and the head of household being married. On the other hand, a larger number of members and a higher proportion of workers unemployed or on leave reduce average household income. The effect of the head of household's age also follows the expectations: it is positive, but decreases with older ages.

The following results differ between the estimations for the two dependent variables: the number of members above the sample average and the proportion of children, the results of which have the expected values for the variable with imputations; proportion of elderly members, that negatively impacts labour income but positively affects total earnings, which include imputations (possibly a positive effect of retirement benefits and pensions on household income); and the variables for the occupational status and the position/sector (formal or informal) of the head of household. The results for the latter are more coherent in the model without imputed values. A point worth mentioning is that the proportion of members in working-age, which is expected to positively

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[15] As the *Programa Bolsa Família* was only implemented in 2004, for 2002 and 2003 we use the eligibility criteria for the *Programa Bolsa Escola*. These values are corrected on a monthly basis by the National Consumer Price Index (*Índice Nacional de Preços ao Consumidor* – INPC, available in *http://www.ipeadata.gov.br*). We highlight the fact that the government readjusted the PBF criteria in 2007 and 2009.

impact earnings, displays a negative and significant parameter, notwithstanding its reduced value. This might indicate the need for future treatments of this variable.

Lastly, it is important to highlight that most of the educational categories of the head of household do not significantly impact labour income (only the presence of head of household with 9 and with15 years of education is shown to be significant). Nonetheless, the effect of the proportion of household members with each level of education is significant and increases for both dependent variables.

The parameters generated in the joint estimation of the equations for the mean and the variance of income, under the hypothesis of normally distributed earnings, are used to construct the indicator of household vulnerability to poverty. Given this indicator, we calculate the percentage of vulnerable households in the whole sample and for each analysed year. One can, firstly, observe that the amount of vulnerable households varies with the dependent variable. Table 2 shows that this percentage is of 13,4% in the sample, if non-labour earnings are taken into account, and of 25,2% when the dependent variable is the simple labour income, without imputations.

Table 1 – Results of the estimation of the parameters of interest

Variables	Equation for the mean		Equation for the variance	
	M1	M2	M1	M2
Lagged income	0,117***	0,0625***		
	(0,00)	(0,00)		
Selection bias correction-term	0,07	3,854***	0,00316***	0,00608***
	(0,31)	(0,43)	(0,00)	(0,00)
Members	-0,0660***	-0,0933***	0,0000119***	0,0000240***
	(0,00)	(0,00)	(0,00)	(0,00)
No. of members > average	-0,0412***	0,0331***	-0,0000121***	-0,0000234***
	(0,01)	(0,01)	(0,00)	(0,00)
Proportion of children	-0,298***	0,03	-0,00000997***	-0,0000227***
	(0,02)	(0,02)	(0,00)	(0,00)
Proportion of seniors	1,024***	-0,300***	-0,00000195***	0,00000242**
	(0,01)	(0,02)	(0,00)	(0,00)
Proportion in working-age	-0,0408***	-0,0393***	0,0000128***	0,0000239***
	(0,01)	(0,01)	(0,00)	(0,00)
Proportion of whites	0,106***	0,0926***	-0,0000145***	-0,0000288***
	(0,01)	(0,01)	(0,00)	(0,00)
Proportion of males	0,109***	0,120***	0,0000148***	0,0000290***
	(0,01)	(0,01)	(0,00)	(0,00)
Proportion w/ basic educ.	0,103***	0,0953***	0,0000120***	0,0000236***
	(0,01)	(0,02)	(0,00)	(0,00)
Proportion w/ second. educ.	0,248***	0,261***	-0,0000167***	-0,0000338***
	(0,01)	(0,02)	(0,00)	(0,00)
Proportion w/ higher educ.	0,681***	0,694***	0,0000202***	0,0000391***
	(0,01)	(0,02)	(0,00)	(0,00)
Prop. of manual workers	0,876***	4,803***	0,0000508***	0,0000997***
	(0,01)	(0,02)	(0,00)	(0,00)
Prop. of mid-qual. workers	0,925***	5,009***	0,0000572***	0,000113***
	(0,01)	(0,02)	(0,00)	(0,00)
Prop. of high-qual. workers	0,982***	5,028***	0,0000516***	0,000101***
	(0,01)	(0,02)	(0,00)	(0,00)
Proportion of workers	0,372***	0,248***	-0,0000329***	-0,0000627***
	(0,01)	(0,02)	(0,00)	(0,00)
Prop. > 1 year in current job	0,0263*	0,0691***	-0,0000223***	-0,0000425***
	(0,01)	(0,02)	(0,00)	(0,00)

Variables	Equation for the mean		Equation for the variance	
	M1	M2	M1	M2
Proportion of unemployed	-0,637***	-0,165***	0,0000813***	0,000159***
	(0,02)	(0,02)	(0,00)	(0,00)
Proportion of formal workers	0,186***	0,336***	-0,0000119***	-0,0000234***
	(0,01)	(0,01)	(0,00)	(0,00)
Prop. of workers on leave	-0,328***	-0,316***	0,00183***	0,00359***
	(0,04)	(0,06)	(0,00)	(0,00)
Household work hours	0,00975***	0,0167***	0,000000934***	0,00000183***
	(0,00)	(0,00)	(0,00)	(0,00)
No. of work hours > average	0,0937***	0,256***	-0,00000627***	-0,0000123***
	(0,01)	(0,01)	(0,00)	(0,00)
Age of the head of household	0,0264***	0,0149***	-0,00000342***	-0,0000067***
	(0,00)	(0,00)	(0,00)	(0,00)
Age of the head of household^2	-0,0499***	-0,149***	0,0000355***	0,0000714***
	(0,01)	(0,01)	(0,00)	(0,00)
Age group of the HoH	0,0192**	0,00	0,00000267***	0,00000512***
	(0,01)	(0,01)	(0,00)	(0,00)
White HoH	0,0178*	0,0327**	0,0000102***	0,0000201***
	(0,01)	(0,01)	(0,00)	(0,00)
Male HoH	0,0470***	0,0258**	-0,0000132***	-0,0000258***
	(0,01)	(0,01)	(0,00)	(0,00)
Married HoH	0,207***	0,138***	-0,00000566***	-0,0000099***
	(0,01)	(0,01)	(0,00)	(0,00)
Manual-qual. HoH	0,01	0,0250*	-0,00000263***	-0,0000059***
	(0,01)	(0,01)	(0,00)	(0,00)
Mid.-qual. HoH	0,0297**	0,0330*	0,00000846***	0,0000162***
	(0,01)	(0,01)	(0,00)	(0,00)
HoH education 1 year	0,100***	-0,0399**	-0,0000222***	-0,0000433***
	(0,01)	(0,02)	(0,00)	(0,00)
HoH education 4 years	0,195***	0,00	-0,0000381***	-0,0000741***
	(0,01)	(0,01)	(0,00)	(0,00)
HoH education 5 years	0,265***	0,01	-0,0000349***	-0,0000676***
	(0,01)	(0,01)	(0,00)	(0,00)
HoH education 8 years	0,285***	0,01	-0,0000335***	-0,0000649***
	(0,01)	(0,02)	(0,00)	(0,00)
HoH education 9 years	0,326***	0,0572**	0,0000343***	0,0000677***
	(0,02)	(0,02)	(0,00)	(0,00)
HoH education 11 years	0,407***	0,01	-0,0000401***	-0,0000772***
	(0,01)	(0,02)	(0,00)	(0,00)
HoH education 15 years	0,603***	0,0752**	-0,0000367***	-0,0000698***
	(0,02)	(0,02)	(0,00)	(0,00)
Employed HoH	0,930***	-0,468*	-0,0177***	-0,0347***
	(0,13)	(0,19)	(0,00)	(0,00)
Unemployed HoH	0,13	-0,25	-0,0176***	-0,0346***
	(0,13)	(0,19)	(0,00)	(0,00)
Inactive HoH	0,749***	-0,564**	-0,0177***	-0,0347***
	(0,13)	(0,19)	(0,00)	(0,00)
HoH > 1 year in current job	0,108***	0,393***	0,00000704***	0,0000132***
	(0,01)	(0,02)	(0,00)	(0,00)
Formal HoH	-0,0510***	0,0371***	0,00	0,00
	(0,01)	(0,01)	(0,00)	(0,00)
Constant	(0,50)	-2,863***	0,0185***	0,0363***
	(0,47)	(0,65)	(0,00)	(0,00)

Source: The authors, based on data from the PME 2002-2011 (IBGE).

Notes: control variable omitted in the table; standard deviation in parenthesis; p-value < 0.10: *, <0.05: **, <0.01: ***; M1: model whose dependent variable is the natural logarithm of the sum of the actual income *per capita* and the imputed earnings, M2: model whose dependent variable is the natural logarithm of the actual income *per capita*; HoH: head of household.

Table 2 – Percentage and number of vulnerable households in the sample
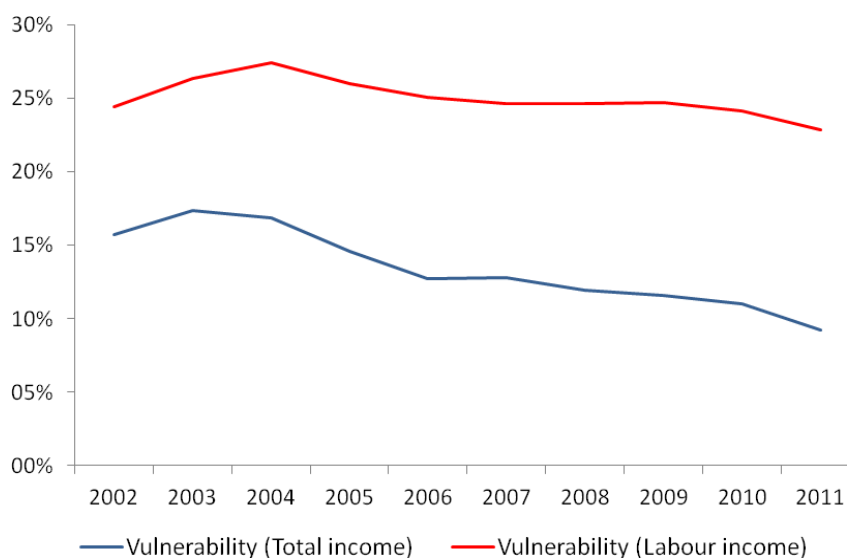
Vulnerability	Total income	Labour income
Vulnerable households	103.471	194.316
Vulnerable %	13,4%	25,2%

Source: The authors, based on data from the PME 2002-2011 (IBGE).
Note: Total income: natural logarithm of the sum of actual income *per capita* and imputed earnings, Labour income: natural logarithm of the actual income *per capita*.

Besides this, the two estimates point to a decrease of vulnerability over the analysed period (CHART 1). The steepest fall is of the vulnerability calculated for the sum of retirement benefits, pensions, transfers, interest income, rent and labour income. This might be evidence of the impact of income transfer policies (the *Programa Bolsa Família* and increases of the social security transfers) on vulnerability. By considering only labour income, vulnerability is still high in 2011, but it also decreases along the decade. This might be an effect of improvements in wage standards and in the labour market, which amounts to an impact net of transfer policies and of increases in rent or interest income.

Chart 1 – Evolution of the vulnerable percentage between 2002-2011

Source: The authors, based on data from the PME 2002-2011 (IBGE).

The last part of the results uses the vulnerability estimates to define groups with common characteristics, aiming at outlining a profile of vulnerable households. We firstly build a table to compare poverty, an established or *ex post* condition of deprivation, with the *ex ante* probability of entering poverty in the subsequent year. To build this table, we use a dynamic approach to the phenomenon of poverty. This is the categorisation Hulme and Shepherd (2003) present, based on a work of Jalan and Ravallion (2000). Table 3 thus brings, in its rows, the specific poverty categories these authors determined and, in the columns, the household vulnerability condition (vulnerable or not vulnerable).

Table 3 – Comparison between vulnerability and poverty

Hulme and Shepherd (2003) categories	Total income		Labour income	
	Vulnerable	Not vulnerable	Vulnerable	Not vulnerable
AP	26,5%	1,4%	64,7%	3,3%
UP	14,9%	1,7%	12,1%	3,6%
RP e OP	30,1%	8,5%	18,1%	11,2%
NP	28,5%	88,3%	5,1%	81,9%

Source: The authors, based on data from the PME 2002-2011 (IBGE).
Notes: Categories: AP – always poor, UP – usually poor, RP and OP – rotationally and occasionally poor, NP – never poor; Total income: natural logarithm of the sum of actual income *per capita* and imputed earnings, Labour income: natural logarithm of the actual income *per capita*.

The results for the indicator based on labour and non-labour income shows that but approximately 51% of the vulnerable households are always or usually poor, while 30% suffers from rotational and occasional poverty and 28% never are poor. On the other hand, the indicator that uses only labour income indicates that 77% of the vulnerable households are always or usually poor, while only approximately 5% are non-poor households. These data show that the vulnerability associated to labour income is more connected to a situation of permanent poverty (this income is below the poverty line for a longer period) than to variations of income, which is the main cause of transitory poverty. The vulnerability calculated taking into account all earnings (those related or not to labour) is, in turn, better distributed amongst the poverty categories. This might constitute an evidence of the role of the instability of certain non-labour earnings, such as private transfers, interest income and rent, in the degree of household vulnerability.

As regards regional disparities, it can be seen that most of the vulnerable households are in the MR of Recife. The smallest proportions are to be found in the MR of Porto Alegre, if one incorporates all earnings into the calculations, or in the MR of São Paulo, if vulnerability is based only on labour income. This might be an evidence of regional differences in the factors related to household vulnerability.

The last tables and Chart 2, in this section, relate certain characteristics of the head of household to the calculated degree of vulnerability. Following the results of works on household poverty, vulnerability is also more present when the head of household is female, regardless of how income is computed.

Table 4 – Location of the vulnerable households

MR	Total income	Labour income
Recife	24,0%	36,1%
Salvador	19,8%	28,7%
Belo Horizonte	12,3%	22,7%
Rio de Janeiro	10,7%	25,4%
São Paulo	10,2%	19,7%
Porto Alegre	9,6%	24,0%

Source: The authors, based on data from the PME 2002-2011 (IBGE).
Notes: Total income: natural logarithm of the sum of actual income *per capita* and imputed earnings, Labour income: natural logarithm of the actual income *per capita*.

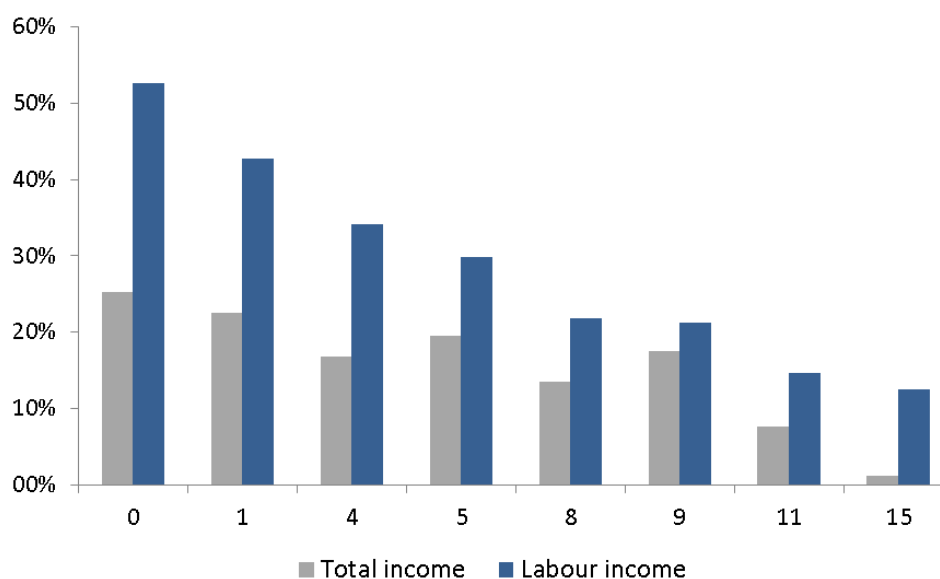Table 5 – Vulnerability and sex of the head of household

Head of household	Total income	Labour income
Female	20,1%	35,6%
Male	9,2%	18,6%

Source: The authors, based on data from the PME 2002-2011 (IBGE).
Notes: Total income: natural logarithm of the sum of actual income *per capita* and imputed earnings, Labour income: natural logarithm of the actual income *per capita*.

Regarding the education of the head of household, the lowest vulnerability percentages were registered for the households whose heads have finished secondary or higher education, whereas the highest ones are associated to the households whose heads have no formal education or have not finished basic education. Lastly, the labour market segment (formal or informal) of the heads is also related to the degree of vulnerability, for households with heads in informal segments are proportionally more vulnerable than those with heads in formal ones. This disparity is even larger if, in calculating vulnerability, one only looks at labour income. Consequently, the fact that the head of household is in an informal employment relationship – intrinsically more unstable due to the lack of legal dispositions providing constant gains for the workers – might be related to a higher probability of becoming poor in the future, if the household does not possess other sources of income.

Chart 2 – Vulnerability and education of the head of household

Source: The authors, based on data from the PME 2002-2011 (IBGE).
Note: the horizontal axis shows the years of education of the head of household

Table 6 – Vulnerability and labour market segment of the head of household

Labour market segment	Total income	Labour income
Informal	29,8%	61,2%
Formal	1,8%	2,0%

Source: The authors, based on data from the PME 2002-2011 (IBGE).
Notes: Total income: natural logarithm of the sum of actual income *per capita* and imputed earnings, Labour income: natural logarithm of the actual income *per capita*.

7   Conclusions

This paper leads to the conclusion, firstly, that in spite of the limitations of most micro-level databases in Brazil – particularly panel data ones, which collect information on households over time –, it is possible to develop research on household vulnerability to poverty, with highly informative results. It is viable to use the Monthly Employment Research (PME/IBGE), as long as one treats it for certain issues. These comprise attrition, the identification of the individuals and households and the lack of information on non-labour earnings (pensions, retirements, transfers, interest and rent).

The vulnerability to poverty estimations, in addition to allowing the determination of the number and percentage of households under risk of falling below the poverty line in the subsequent year, makes it possible to conduct heterogeneity analyses. Firstly, the research results point out that the percentage of vulnerable households in the sample is of 13,4%, when non-labour earnings are also considered, and of 25,2%, when the dependent variable only measures labour income, without imputations. Besides this, both estimates underscore that vulnerability has decreased along the analysed period. Its decline is steeper when also taking into account earnings related to retirement benefits, pensions, transfers, interest income and rent.

By comparing poverty and vulnerability, it can be seen that the latter, when only considering labour income, is connected to a situation of permanent poverty. If all earnings are taken into account, on the other hand, vulnerability is better distributed amongst the poverty categories. The investigation regarding the characteristics of the heads of household, in their connection to the degree of vulnerability, reveals three factors responsible for reducing the probability of becoming poor in the following period: having higher educational levels, being male and having a formal employment relationship.

On a last note, the results obtained suggest that public policies set up during the last decade, targeting the reduction of poverty and inequality as well as an increase of the well-being of Brazilian households – such as greater income transfers (the *Programa Bolsa Família*), consecutive increases of the minimum wage, higher employment levels and credit facilitation policies –, might have played a vital role in alleviating the vulnerability to poverty. This is true for the vulnerability associated both to labour income and to total earnings.

The greater degree of vulnerability discernible when considering only labour income, as well as the correlation between vulnerability, schooling and a formal position in the labour market, makes it possible to infer about the importance of public policies aiming at reducing the inequality of access to formal education and at increasing vocational training programmes in the Brazilian metropolitan regions.

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Table A1 – Detailed description of some variables

Variable	Description
Basic education	Adults enrolled in: the first year of regular secondary school; a general secondary school equivalency programme; regular middle school and have finished this curriculum stage; remedial middle school and have finished the fourth year of this stage. Or adults that have been through: primary school and finished it; upper school and have not finished it; secondary school and have not finished this stage.
Secondary education	Adults enrolled in: the fourth year of regular upper school; university entrance preparatory courses; the first year of higher education. Or adults that have been through: regular middle school and have finished it; remedial middle school and have finished its third or fourth year; the first year of higher education and have finished this year.
Higher education	Adults doing a MA's or PhD or that have finished higher education.
Employment in formal segments	Officially registered workers (signed work cards); military personnel or those employed in the Brazilian civil service (*regime jurídico único*); employers with more than six employees; liberal professionals (self-employed who possess higher education degrees (excluding in aerial, maritime and fluvial navigation, in arts and media and members of religious cults), professionals working in aerial, maritime and fluvial navigation and media and arts professionals).
Sick-leave	Workers on leave from their own business due to pregnancy, sickness or accidents, without income from social security; private sector officially registered workers on leave and without income.
Labour force participation rate	Ratio between the economically active population (classified both as occupied and as unoccupied) and the population in working-age, during a certain period of reference. Unemployment rate: ratio of unoccupied to economically active population. Occupied population: population that, in a given period of reference, work or have a job.
Interview number	Number of the interview in which the family is participating, from 1 to 8.
Week of the interview	Any of the month's four weeks.
Rotational group	Rotational group in which the family is, from 1 to 8.

Table A2 – Mean and standard deviation of the dependent variables

Variables	Mean	Standard deviation
Total Income	685,7	1710,3
Labour income	463,7	995,6

Source: The authors, based on data from the PME 2002-2011 (IBGE).
Notes: Total income: sum of actual income *per capita* and imputed earnings, Labour income: actual income *per capita*. The estimations use the natural logarithm of the dependent variables.

Table A3 – Mean and variance of the independent variables

Variable	Mean	Standard deviation	Variables	Mean	Standard deviation
Members	3,1	1,4	Age of the head of household	48	15
Proportion of children	10,9%	18%	White HoH	53,4%	49,9%
Proportion of teenagers	10,7%	18%	Male HoH	61,4%	48,7%
Proportion of seniors	11,0%	27%	Married HoH	61,7%	48,6%
Proportion in active age	62,9%	48%	Manual-qual. HoH	29,0%	45,4%
Proportion of whites	53,3%	46%	Mid.-qual. HoH	12,9%	33,5%
Proportion of males	46,3%	26%	High-qual. HoH	23,1%	42,2%
Proportion w/ basic educ.	62,0%	41%	HoH education 1 year	8,9%	28,5%
Proportion w/ second. educ.	44,4%	42%	HoH education 4 years	13,5%	34,1%
Proportion w/ higher educ.	11,5%	27%	HoH education5 years	15,6%	36,3%
Prop. of manual workers	29,2%	41%	HoH education 8 years	12,4%	33,0%
Prop. of mid-qual. workers	19,7%	35%	HoH education 9 years	4,2%	20,1%
Prop. of high-qual. workers	33,3%	42%	HoH education 11 years	27,8%	44,8%
Proportion of workers	35,9%	37%	HoH education 15 years	12,0%	32,5%
Prop. for > 1 year in current job	56,1%	45%	Employed HoH	65,0%	47,7%
Proportion of unemployed	6,0%	18%	Unemployed HoH	3,5%	18,4%
Proportion of formal workers	46,8%	45%	Inactive HoH	31,4%	46,4%
Prop. of workers on leave	0,2%	5%	HoH for > 1 year in current job	65,3%	47,6%
Household work hours	19	14	Formal HoH	36,7%	48,2%

Source: The authors, based on data from the PME 2002-2011 (IBGE).
Notes: HoH: head of household.