

The “Bolsa-Família” Program and the Food Insecurity in Brazilian household between 2009 and 2013

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RESUMO:

Insegurança alimentar é um fenômeno global; mais frequente entre os países mais pobres, mas também presente entre os mais ricos do mundo. Mais frequente entre as famílias mais pobres, mas também uma preocupação para algumas das que se localizam distantes da linha de pobreza. Entender como as famílias lidam com esse fenômeno, e como elas tomam suas decisões sobre a alocação de suas rendas e tempo, e como essa decisão se reverte em satisfação, é uma etapa importante na tentativa de acabar com a fome e com a insegurança alimentar. Esse entendimento pode ajudar na elaboração de programas de bem-estar, cujos objetivos sejam diminuir a insegurança alimentar. Usando dados transversais para um processo de amostragem repetido do Brasil (PNAD/IBGE) para os anos de 2009 e 2013, este é o primeiro trabalho a avaliar o impacto do Programa Bolsa-Família (PBF) na insegurança domiciliar, usando para isso um modelo que controla para o viés de seleção de variáveis observáveis e não observáveis. Estimativas do método diff-in-diff, com e sem pareamento, são comparadas com as estimativas do modelo logit ordenado. As comparações mostram o quanto a endogeneidade pode mascarar os resultados, se ela não for tratada adequadamente. De acordo com as estimativas do modelo diff-in-diff com pareamento, o PBF é responsável por uma redução de 0.076 no índice de insegurança alimentar.

ABSTRACT:

Food insecurity is a global phenomenon; more frequent in poor, but also present in the world's richest countries. More frequent among the poorest, but also a concern for some families even distant from the poverty line. Understand how families deal with this phenomenon, and how they make their decisions on the need to allocate their income and time, and how this decision is reversed in a sense of satisfaction is an important way to end hunger and food insecurity. This understanding can give a support to the welfare programs, whose objectives are to diminish food insecurity. Using repeated cross-section data from Brazil (PNAD/IBGE) for the years of 2009 and 2013, this is the first work to evaluate the impact of the Bolsa-Familia Program (BFP) on households' food insecurity using a model that controls for the selection bias from observable and unobservable variables. The diff-in-diff estimates, with and without matching, are compared with the estimates of the ordered logit model. The comparisons show how much endogeneity can mask the results, if it is not treated properly. According to the estimates of the diff-in-diff results, the BFP is responsible for a reduction of 0.076 in the food insecurity index.

Key Words: Food Insecurity; Bolsa-Familia Program; Brazil; Diff-in-Diff.

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1 INTRODUCTION

The total number of the world's undernourished decreased from 19% in 1992 to 12% in 2013, what shows a good progress but still not enough to meet the hunger targets defined by the World Food Summit. According to the FAO (2013), meeting the hunger targets requires an additional and particular effort because the determinants of undernourishment go beyond monetary poverty and solving it requires more than economic growth, whose benefits may not even reach everyone.

Undernourishment is a chronic hunger condition and an extreme consequence of a food insecurity situation, as an idea of accessibility to food². There are less extreme consequences of food insecurity, which reveals different levels of malnutrition, just as there are different levels of food insecurity. Understanding its nuances and causes is an important challenge to scholars, because its consequences can lead to a vicious cycle of poverty.

Alongside the health and growth specific problems (Kreider et al., 2009), malnutrition in children can prompt long-run negative effects through its impacts on labor productivity, which in turn can determine the level and composition of employment (Strauss and Thomas, 1998). Despite few empirical studies considering this relationship, theoretically it can be explained first by improved physical performance as a consequence of calorie and vitamin intake; and second, through the effects on the cognitive and behavioral development, and social functioning (Swindale et al. 2013; Schultz, 2005). According to Cook and Frank (2008), children suffer these consequences even when they are exposed to the mildest levels of food insecurity.

Food Insecurity (FI) has a particular importance in developing countries (FAO, 2013), but its incidence in developed economies is also fairly high. Coleman-Jensen et al. (2014) reported that 14,3% of the American households were food insecure in 2013; Loopstra e Tarasuk (2013) revealed that in Canada, in 2011, there was around 12% of household food insecurity; Loopstra et al. (2015) registered a prevalence of 11% of food insecurity among European households in 2012; and Martin-Fernandez et al. (2013) estimated that 6% of households in the Paris region had experienced food insecurity. Pfeiffer et al. (2015) revealed that, in 2012, food insecurity was greater than 14% for Greece, was more than 9% for UK Great Britain, and for Germany was 8%.

According to Loopstra et al. (2015), after 2010, the food insecurity in Europe has grown certainly triggered by the austerity policies. However, they point out that there must be ways to tackle the crisis without food losses, because even though Portugal has been strongly affected by this crisis, its proportion of food insecurity households has decreased in the same period. Nord Andrews and Carlson (2004) complement this evidence at the microeconomic level and show, intriguingly, the strong presence of food insecurity even for households that are far from the poverty line³.

The study of this phenomenon is important because it can also help in understanding the role that assistance programs can play in alleviating food insecurity. These programs have been adopted by different countries, such as Brazil, Chile, Mexico, Canada and the United States. Especially in the case of the latter, the effectiveness of these policies has been highly discussed in the economic literature.

In this literature, the food insecurity determinants can assume the role of control variables in an analysis that primarily aims to investigate the impacts of the Program on food insecurity. The proposed models consider increasingly the endogeneity of income transfers. This means that both the eligibility to assistance programs is influenced by the fact that the household is food insecurity, as the household food insecurity condition is influenced by the cash transfer program (Ratcliffe et al., 2011). In other words, there is a bias selection which is driven by non-unobservable characteristics.

² For a more detailed discussion about the various concepts and measures of Food Insecurity, see Bertelli and Marcour (2014). This article adopts the idea of accessibility and use a measure based on a psychometric scale.

³ These studies are not comparable, because they are based on different concepts of food insecurity.

Some few studies have used matching method. In particular, to the best of our knowledge, all of them have used the propensity score technique (Gibson-Davis and Foster, 2006, Camelo et al., 2009; Almeida et al., 2013). However, the propensity score matching, or any other matching technique, take into account just the selection bias due to observable variables, but not to the unobservable or omitted ones.

A very common strategy for dealing with this endogeneity has been the use of the instrumental variables models (IV), mainly by the use of geographic and time differences in the programs design (Ratcliffe et al., 2011). The IV models are powerful tools and have the advantage that they may be applied for cross-section data⁴, but they are very dependents on finding a good instrument. In this sense, they cannot be completely generalized, especially when the program does not find differences in application in a regional perspective, as is the case of Brazil, for example.

This paper seeks to address these issues by proposing the propensity score matching (Rosenbaum and Rubin, 1983) to correct the selection bias caused by the observable variables. And to deal with the bias caused by omitted variables, it proposes the difference in differences method (Khandker et al., 2010).

In particular it seeks to investigate the impact of the “Bolsa-Familia Program” (BFP) on the Food Insecurity index of Brazilian households between the years of 2009 and 2013. The BFP is the Brazilian conditioned income transfer, which serves approximately 14 million households⁵. It has been pointed out as the main responsible for taking Brazil away from the hunger global map⁶. But on the other hand, there are not nationally designed studies, which have investigated its efficacy in such a robust way.

All the studies summarized by Cotta e Machado (2013), Martins et al. (2013) or Soares et al. (2010) sought to identify a relationship between BFP and food insecurity in Brazil, however, all of them had either problems of bias selection or were restricted for just a small sample. In addition, at the national level, Camelo et al. (2009) and Almeida et al. (2013) corrected the analysis for selection bias using the Propensity Score Matching (PSM), but they did not consider the potential bias of omitted variables⁷.

Section 2 is devoted to a literature review, discussing first the main determinants of food insecurity, second the identification of strategies and finally presenting the main features of BFP in Brazil. Section 3 describes the conceptual method, the data, and the empirical strategy used. Section 4 brings the results and the section 5 the main conclusions.

2 REVIEW OF LITERATURE

Food and nutritional security requires that the individuals have access to enough and healthy food in order to have an active and healthy life (FAO, 2013). This concept brings a simple idea, but its implementation in the form of an indicator is a bit complex, and as a consequence there are various measures of food insecurity in the literature. Perez-Escamilla and Segal-Corrêa (2008) summarize that the main types are based either on the: daily intake of calories per capita; estimation of a minimum income; frequency and amount of food consumed; household expenditure with food; anthropometric measurements; or psychometric scales of the household access to food⁸. And beyond that, borrowing money for food could also be a sign of food insecurity (Chang et al., 2014)⁹, which has increasingly been used as a measure of food insecurity by economists.

⁴ Although in the case of cross section data, it cannot allow for time varying selection bias (Khandker et al., 2010).

⁵ <http://mds.gov.br/area-de-impressao/noticias/2016/janeiro/bolsa-familia-14-milhoes-de-familias-terao-renda-complementada-em-janeiro> - accessed in 2016 1st February.

⁶ Rasella et al. (2013), for example, using a binomial model of fixed-effects found that the Bolsa-Familia Program (BFP) had contributed to decrease childhood mortality in Brazil. They concluded that this decrease was due to the positive effects of BFP on nutrition and health.

⁷ Camelo et al. (2009) and Almeida et al. (2013) used different measures of food insecurity. The findings of these studies will be discussed in the results section.

⁸ The empirical analysis of this work will be based on the Brazilian psychometric scale of the household access to food.

⁹ The papers presented in the next session are based on any of these measures.

These are all measures related to the person or household, who suffers from the lack of food. That is, they are indicators of consumption decision. Certainly each of these has its advantages and limitations, they are not complete measures. Some of them depend on how food is allocated within the household, others on how it is used, and others even on which kind of food is bought (Costa et al., 2014). The choice of an indicator generally depends on the purpose of the work and on the availability of a database.

Beyond the measure, there is a growing literature seeking to understand the determinants of food insecurity, in which it is possible to identify two types of concerns. The first are the efforts to expand the explanatory variables; and the second are the efforts to estimate the impact of social welfare programs on it and deal with the endogeneity between them. The two following sessions are about these two subjects. And the third session describes the “Bolsa-Familia” Program in Brazil.

2.1 Food Insecurity Determinants

There is an extensive literature about food insecurity determinants both in health and nutrition and economics areas, which has evolved over time¹⁰. The need to identify all possible covariates is important because it reduces the bias of omitted variables (Heckman et al., 1997).

The main determinants of food insecurity are availability and accessibility (Dean and Sharkey, 2011). Availability is clearly a condition of the food supply side, covering production itself, imports (if necessary), distribution and commercialization. On the other hand, accessibility is a physical and economical condition of the demand side, which means the ability to get food in sufficient quantity and quality (PNAD, 2010).

From the standpoint of availability, at the micro level there are some direct measures, as the production for own consumption (Cock et al., 2013; Gertler, 2004), and the proximity to sales and distribution points (Thomas, 2010). At the meso level, the local production of food and the differences between the economics dynamics (Bartfeld and Dunifon, 2006) are the alternatives measures used. In this context, however, there is the understanding that production increase is a necessary condition, but it is not sufficient to ensure food security (Sidhu et al., 2008).

These direct measures are in the meantime relatively rare in the empirical literature. At the micro level, it happens perhaps due to limitations of its applicability to a broader analysis. The studies which evaluated the production for own consumption, for example, are restricted to the rural areas, because the majority of the urban households doesn't produces food for own consumption.¹¹ The proximity to sales and distribution points brings the analysis to more restricted samples, due to the difficulty of taking the distances of each residence to them. At the meso level the differences can also been seen as state or regional fixed effects (Bartfeld and Dunifon 2006; Coleman-Jensen et al. 2012)¹².

Thus, the solution to these limitations has been found in the use of some indirect measures, as proxies of the food availability. The mainstream has been the spatial explanation of the household location in terms of its area (rural or urban) and region (if a metropolitan one). It is expected that urban areas and metropolitan regions have greater availability of food. And the relation is absolutely intuitive: the greater food availability the smallest food insecurity (Nord et al., 2009).

Concerning access, there is already a consensus about some variables which are present in almost every discussion about food insecurity. These variables are divided into two levels. At the level of the head of household, some characteristics of her (his) profile are highlighted, like age, race (being black), gender (being a man), and education. At the level of household the most used characteristics are income and the number of children. The positive correlation of all this variables with food insecurity is also a consensus in

¹⁰ This revision doesn't have the intention to be exhaustible, indeed it will just to highlight the most important aspects of the discussion.

¹¹ The idea of producing food here doesn't include the cooking process differentiating frozen food from fresh food. It is referred just to the process of growing it.

¹² The state or regional fixed effects are also used to represent the accessibility to federal nutrition programs, and income supports.

the literature, some with more direct and intuitive reasonable and some with a more indirect and less intuitive explanation.¹³

Some authors, however, have expanded the importance of household assets in determining food security. The idea is based on the Friedman's work of 1957, which has tested the hypothesis that there is a positive relation between the ownership of assets and food expenditures (Chang et al., 2014), and the relationship is not simply a matter of income effect.

For most poor people, the decision to have good nutrition can compete with the decision of living secure. So, homeownership becomes an important variable, being negatively related to food insecurity (Chang, 2014; Omidvar et al., 2013; Gertler, 2004; Gundersen and Gruber, 2001; Rose, Gundersen e Oliveira, 1998). However, a high burden for housing payment has a positive correlation with it (Omidvar et al., 2013; De Marco and Thorburn, 2009), probably due to the available income.

The importance of assets holdings in cushioning food insecurity has been studied just by some few authors and they were mostly qualitative studies (Chang et al., 2014). In the quantitative literature, Guo (2011) argued that in the presence of household assets, especially savings, the power of income in explaining food insecurity was decreased. But Fitzpatrick (2013) found that this happened just for those having banking accounts, but not for those related to the alternative financial services. For her, credit transactions lead to worse results of food insecurity than liquidity. Chang and their colleagues studied the importance of having a minimum level of savings and of not borrowing beyond a suggested maximum. They concluded that the liquidity constraint and asset inadequacy were positively associated with food insecurity, mainly among poor households. In an analysis for Toronto, in Canada, Tarasuk (2001) also met that the need to additional and unusual expenditures and accumulated debts were negatively related to food security.

Vehicle ownership is also an asset to be considered by households, but it affects food insecurity by a slightly different way. According to Clifton (2004),¹⁴ it can be used as a mobility strategy to facilitate the access to food, to Locher et al. (2005) as an indicator of social isolation, and to Fitzpatrick and Ploeg (2010),¹⁵ it can help to avoid the more expensive and less healthy solutions from the neighborhood. The evidences have supported the idea that vehicle ownership could help lower food insecurity (Chang et al., 2014; Fitzpatrick and Ploeg, 2010; and De Marco and Thorburn, 2009).

Martin et al. (2004) shows that social capital, both at the household and at the community levels, is positively related to food security. Being a measure of trust, reciprocity and social networks, it can improve the households' ability of having access to food. Dean and Sharkey (2011) have also negatively associated social capital with food insecurity, but their measure of the social capital was a very subjective one, based in the individual perception. According to Tarasuk (2001), socially isolated women also relate more food insecurity. And the number of years since immigration to Toronto for Loopstra and Tarasuk (2013) or the duration of residency of Afghan immigrants in Iran for Omidvar et al. (2013), both seen as a proxy of social networks, is also negatively related to food insecurity.

Neighborhood socio-economic status is an important measure to Martin-Fernandez et al. (2013) and to Omidvar et al. (2013). These authors associated socio-economic status of location to the food insecurity and found that living in low and middle income neighborhoods increases insecurity when compared to the higher ones. The poorer neighborhood, the larger will be the impact on food insecurity.

But social disparities are also important to explain food insecurity according to Dean and Sharkey (2011). The authors used a measure of the perceived personal disparity in a region of Central Texas in USA and

¹³ Although not all variables were statistically significant in all studies.

¹⁴ They did qualitative analyses.

¹⁵ The authors have controlled for endogeneity between vehicle ownership and food insecurity through an instrumental variable model.

found a positive relation. They argue that these feeling can reflect the personal experiences with the unequal distribution of all food-related resources.

Due to the importance of the informal employment to less developed countries (Faye et al., 2011) some studies have used this category of work as explicative to food insecurity. It is expected that formal employment increase food security through the stability of the household finances (IBASE, 2008; PNAD, 2010; and Cotta e Machado; 2013). Evaluating Brazilian data, Hoffman (2008) finds this positive relationship. Cock et al. (2013) makes reference to a formal salary being important for food insecurity in a province of South Africa, but they don't regress on it. Some authors have also considered the socio-occupational category, as did Martin-Fernandez et al. (2013).

There are just few studies addressing state or regional demographic and socio-economic characteristics. Bartfeld and Dunifon (2006) developed a hierarchical model in which the second level of explainable variables was at the state dimension, termed as the state food security infrastructure. The food security infrastructure is defined as the state context of the economic and social attributes that affect the accessibility¹⁶ to food.

2.2 The effects of programs on food insecurity and the identification strategy

There are different assistance programs around the world, with explicit objectives of alleviating hunger and food insecurity. They have different characteristics and conditionality, what may lead to different outcomes. The majority of the studies seeking to understand the effects of these programs on food insecurity are about the American programs, especially among those which have adopted more robust analysis. But the identification questions are relatively the same.

There are two key identification questions in this kind of analysis. The first is related to the misreporting of participation status;¹⁷ and the second is the endogenous selection into participation (Kreider et al., 2012). Some identification strategy should then be used to cope with both, because both can lead to biased results. Referring to misreporting, Gundersen et al. (2011) consider that because the omission errors are more likely than the commission errors (as had been proved by Bollinger and David, 2001) there is a tendency to understate the program impact. Kreider et al. (2012) is the only food insecurity study to consider both problems, through extended partial bounding methods, and found a negative effect of the program participation on food insecurity.

The endogenous selection into participation can happen in both temporal and cross-section analysis. In temporal analysis, bias can come from household characteristics that are unobserved and changeable over time, like the head of household's efforts to ameliorate food insecurity, or from the changing food market availability conditions, or even from any of other unobservable factors that can affect food insecurity (Gertler, 2011). From the point of view of cross-section analysis, it is expected that the households that are more likely to be eligible to the Bolsa-Famila Program (BFP) are also probably the most food insecure. This means that there is a positive association between food insecurity and the eligibility to the BFP, what can result in an underestimation of the BFP's effects. On the other hand, it is likely that those families who enrolled in the Program are better organized than those who qualify but didn't get enrolled; this leads to a negative association between food insecurity and the Program, what in turn can lead to overstate the program's effects (Gibson-Davis and Foster, 2006). Therefore, the statistical model to be estimated has to deal with this.

¹⁶ In truth, they say that it affects also the availability and affordability of food. However, at the way they have defined it, it is similar to the definition of accessibility used here.

¹⁷ Gundersen and Kreider (2008) bring the possibility that misreported food insecurity exacerbates uncertainty. However, this will not be treated in this article, because there is not empirical research on this subject.

Among the works which have controlled for endogeneity, some didn't find any relations evidence between the program and food insecurity (Gundersen and Oliveira, 2011), and others found a negative effect, what means that the program has been successful in alleviating food insecurity (Van Hook and Ballisteri, 2006; Yen et al., 2008; Nord and Prell, 2011; Ratcliffe, 2011; Bonanno and Li, 2015). Ratcliffe et al. (2011) was the first study to control endogeneity taking into account a nationally representative sample of the United States of America from the late 1990 and early to mid 2000. Their work was followed by Bonanno and Li (2015), in methodology and results.

All of them used some kind of dummy endogenous variable model with instrumental variables. The instruments were generally the state differences in the program implementation, like if they use biometric technology, if there is none, partial, or full immigrant eligibility, or the outreach spending per capita. For temporal analysis, a temporary increase in the benefits was used.

Gibson-Davis and Foster (2006) balanced treatment and comparison groups on the observable socioeconomic characteristics of households in a cross-section analysis. They adjusted the propensity score matching method and found that the food stamp program in USA did not decrease the probability of being food insecure for children. However, they didn't control the unobservable variables and they recognize that there are some limitations inherent to the method and that more studies would have to be done.

Chang et al. (2014) did not control endogeneity at all, but they found different effects depending on the program evaluated. They have estimated a negative association with a cash transfer program (Temporary Assistance for Needy Families), and a positive association with the directed food assistance programs. They believe that endogeneity problems should have biased the analysis of the second group of programs.

2.3 The Bolsa-Familia Program¹⁸

The Bolsa-Familia Program (BFP) was created in the year of 2004. It has incorporated all the pre-existing smaller programs¹⁹ and since then, each year, it increases the number of attended people. It is under the supervision of the "Ministry of Social Development and Fight against Hunger" which define the rules of eligibility, maintain the register²⁰ of all the eligible families, and decide how much can be given to each family according to each criterion.

The municipalities are responsible to register their poor families according to the stipulated rules. The program's implementation is done by the "Caixa Econômica Federal", that is a financial institution of the federal government. It receives the information from the Ministry and calculates how much each family has to receive, prepares the program cards, and makes the monthly payment.

BFP is a cash transfer program and all its grants are transferred through the "Bolsa-Familia card". In 93% of cases the card is in the name of the family's reference woman, however, anyone can pick up the money at any ATM, provided they have the card and its password.

The program's objectives are: fight hunger and promote food security; fight poverty and other forms of deprivation; and promoting access to public services network, in particular health, education, food security and social assistance.

The eligibility to the Program is related to the definition of two poverty lines, both based on the monthly household per capita income. For both years of the sample, the reference value of the extreme poverty line was US\$19.8 and the poverty line was US\$39.6.²¹ The extremely poor families can receive two kinds of benefits, a fixed of US\$19.8, and a variable one, which is the same for the poor families. The variable benefit

¹⁸ This section is partially based on the information of the Ministry portal: www.mds.gov.br, accessed in 15th April 2016.

¹⁹ The Programs' names were: "Fome Zero", "Bolsa Escola", "Auxílio Gás" e "Cartão Alimentação".

²⁰ The register is called "Cadastro Único".

²¹ The values in Brazilian currency are R\$70,00 and R\$140,00. They were converted by a tax of 1US\$=R\$3,93, quoted at 15/02/2016.

depends on the number of children (0 to 15 years old), teenagers (16 to 18), and pregnant women in household. The maximum possible value a family can receive is US\$94.1.

The BFP conditions the receipt of the benefit over the fulfillment of certain requirements of health monitoring and school attendance. Under the Program, children (between 0 and 7 years old) and women (between 14 and 44) have to report to be systematically evaluated by a family health program team. And all the pregnant women have also to follow a schedule of visits to the health team. The terms of the education-related condition are targeted at children and young people between 6 and 17 years. They must be properly enrolled in school and have a minimum school attendance.

Currently there are approximately 14 millions of beneficiary families scattered throughout the national territory. The food insecurity mean and the proportion of the total beneficiaries are shown by region in Table 1.

Table 1 – Proportion of BFP's beneficiaries and Food Insecurity mean by Brazilian regions - 2013

	North	Northeast	Midwest	Southeast	South
Proportion of Beneficiaries	10.51%	40,10%	17,06%	18,13%	14,20%
Food Insecurity Mean	0.5583	0.5457	0.2471	0.2152	0.2040
Population	16,983,484	55,794,707	14,993,191	84,465,570	28,795,762

The BFP has been evaluated in different aspects in Brazil. Some scholars are interested in knowing its impacts on the women fertility (Cechin et al., 2015); on the female labor supply (Tavares, 2010); on the income inequality (Peña et al., 2015); on education (Glewwe e Kassouf, 2012); on presidential election (Canêdo-Pinheiro, 2015); childhood mortality (Rasella et al., 2013), among others.

There are also some studies concerning food insecurity. Cabral et al. (2014) performed an analysis for a beneficiaries' small sample of two municipalities of the northeast region. But despite using longitudinal data, they made just a descriptive analysis and recorded an increase in food security and mild food insecurity, at the expense of moderate and severe food insecurity. Camelo et al. (2009) controlled the observable variables using the propensity score matching technique. They used secondary data of a national sample of more than 4 thousand children and found significant influences of the program on turning household food secure (against insecure). but none has controlled for endogeneity problems.

3 METHODS

3.1 Conceptual Approach: difference-in-differences technique

Food is a normal good, whose income elasticity is possibly close to one for low-income populations. Maybe that's why the Bolsa-Familia Program (BFP) does not impose restrictions on the spending of the received benefits. That is, it is expected that the benefit will be spent on food, alleviating hunger and food insecurity, which is one of the explicit Program's objectives.

Thus, it has to be tested if the program's benefit is really allowing a greater access to food, regardless of the household characteristics, and whether this access is being enough to affect the state of household food insecurity. But it is not a simple matter of observing household food insecurity changes before and after the household was benefited by the program (temporal analysis) because changes can be due to other temporal factors affecting this household. And it is not even a matter of just comparing the food insecurity of households that received and did not receive the benefits (cross-section analysis), because the differences can

be due to individual and socioeconomic differences between them, which can be easily observable or not. All these views can under- or overstate the program's effect (Gibson-Davis and Foster, 2006).

However, it may be a case of combining these two methods into one (Gertler et al., 2011). A before-and-after analysis may be done for the beneficiaries group (called first difference) and for a control group that was not benefited by the Program (called second difference). The impact of the program would be then the difference between these two differences, what is the Difference-in-Differences Method. Doing this, the time varying factors which are seen as confounders in the temporal analyses are eliminated. The result would be the same if two cross section analyses were done in two different times and a difference of these two differences was taken. In this case, the bias selection, present in each of both cross section estimations, is eliminated of the analyses when the difference of the two differences is taken.

The Equation 1 brings the relation stated above.

$$(1) \quad \hat{\beta}_{DD} = (\bar{Y}_1^T - \bar{Y}_0^T) - (\bar{Y}_1^C - \bar{Y}_0^C) = (\bar{Y}_1^T - \bar{Y}_1^C) - (\bar{Y}_0^T - \bar{Y}_0^C)$$

Where $\hat{\beta}_{DD}$ is a difference-in-differences estimator, which gives the impact of the treatment on the outcome of interest; Y represents the outcome of interest to be evaluated; T is the treated group; C is the control group; and 1 and 0 represent the years of the baseline and follow-up, respectively.

It is important to note that what is being compared is the change in outcomes, supposing that both groups are subjected to the same changes in time. That is, they are subjected to the same exogenous changes. Of course it is more reasonable as much comparable are the units.

3.2 The Empirical Strategy

Formally, and taking into account the discussion raised above, food insecurity can be described as in the Equation (2).

$$(2) \quad Food_Ins = f(BFP, X, ST, T)$$

where $Food_Ins$ represents an indicator of Food Insecurity, BFP represents the Bolsa-Familia Program, X is a vector composed by the socioeconomic characteristics of the household and of the head of household raised above, ST symbolizes dummy variables for the Brazilian states and T a dummy for the year of 2013.

The question then becomes how to specify this function in order to estimate the impact of the BFP on $Food_Ins$. Focusing on the identification issues, the following sections address the existing endogeneity problems.

The proposed model by this work is the difference-in-differences approach with the propensity score matching technique. The first controls for the unobservable variables and the second for the observable ones.

3.2.1 The difference-in-differences approach

The difference-in-differences approach to estimate the impact of a program on an outcome of interest in the case of repeated cross section data without matching, can assume the form of the Equation 3.

$$(3) \quad Food_Ins_{ht} = \beta_0 + \beta_1 BFP + \beta_2 T + \beta_{DD}(T * BFP) + \beta_x X_{ht} + \beta_z Z_s + \varepsilon_{ht};$$

where h denotes household and t denotes time period (2009 or 2013). FI is the food insecurity indicator; T is the time trend equal to 1 if the observation is in the follow-up period (2013); BFP is an indicator equal to one

if the household is beneficiary of the program; X represents the control variables related to the household; and Z represents the fixed effects for the states (there are 27 states). β_{DD} is the coefficient for the DD estimator; in other words, β_{DD} represents the change in food insecurity, which is attributable to the BFP.

The difference-in-differences (*diff-in-diff*) approach can be also done with matching on the set of observable variables, X_{ht} . The *diff-in-diff* matching estimator sums the advantage of removing the effects of common shocks, imposed by the linear functional form (Blundel and Costa Dias, 2000). It estimates the conditional expectation of the FI reweighting the observations according to the weighting functions used by the matching estimators (Smith and Todd, 2004). The *diff-in-diff* matching estimator for repeated cross section data assumes the form of the Equation 4.

$$(4) \quad \hat{\beta}_{DD} = \sum_{i \in B_1} [(FI_{it_1} - \sum_{j \in B_0} W_{ijt_0}^B FI_{it_0}) - (\sum_{j \in C_1} W_{ijt_1}^C FI_{jt_1} - \sum_{j \in C_1} W_{ijt_0}^C FI_{jt_0})] w_i$$

where B_0 , B_1 , C_0 e C_1 stand for the beneficiaries and non-beneficiaries (control) groups for the years of 2009 and 2013, respectively. $W_{ijt_0}^B$, $W_{ijt_1}^C$ and $W_{ijt_0}^C$ are the weight attributed to individual j in group B and C in 2009 (t_1) and 2013, when comparing with treated individual i . And finally w_i is the reweighting that reconstructs the outcome distribution for the treated sample.

As it can be seen, three matching proceedings have to be done in this case for each treated individual of the year of 2013. The second term of the first parenthesis in the Equation 2 results from the matching process of them with the treated individual of 2009. In the second parenthesis, the first term comes from their matching with the non-beneficiaries of 2013 and the second term comes from their matching with the non-beneficiaries of 2009. The matching method used was the Propensity Score.

3.2.2 Propensity Score Matching

The basic idea of matching is to impute counterfactual outcome for the program participants using eligible nonparticipants with the same propensity score. The Propensity Score Matching is given by the Expression 5:

$$(5) \quad P(X_i) = \Pr(D_i = \frac{1}{X_i}).$$

Where D is a dummy variable which assumes the value 1 when it is in the treatment group, i.e., it is a beneficiary of the BFP, and 0 otherwise. X_i is a vector of the household and of the household head socioeconomic characteristics. The propensity score ($P(X_i)$) is the probability of a household with certain characteristics (X_i) to participate of the BFP.

Once obtained the propensity score, a matched group is constructed for the group of reference, based on proximity criteria. Considering the neighborhood criterion, for each $i \in N_1$ a $j \in N_0$ should be chosen, subject to Expression 6.

$$(6) \quad \{j: |P_i - P_j| = \min_{k \in N_0} |P_i - P_j|\}$$

3.3 Data and Variables

The household level data come from the 2009 and 2013 PNAD/IBGE/Brazil. PNAD is an annually repeated household survey, which contains a nationally representative sample of more than 100,000 households each year. The PNAD's Food Security Supplement, however, was taken just in the years 2004, 2009 e 2013, but due to the lack of some variables of interest; year 2004 was removed from the analysis. The final full sample

yield approximately 228,170 observations altogether. In addition to the household' and individual's demographic and socioeconomic characteristics, the PNAD collects many others thematic questions related to migration and violence.

In the PNAD, each household member is an observation, but this study only keeps the observations of the household heads. The PNAD was not designed to be representative below the state level; because of this, the fixed effects were used just at the state level.

Table 2 summarizes the determinants of Food Insecurity (Food_Ins) considered in this work in terms of mean or proportion, depending on if it is a continuous or categorical variable, respectively, and standard deviation.²² As can be seen, households are classified into 4 levels of food insecurity, depending on the result of the scale shown before. When all the household members have a regular and permanent access to food,²³ it is said that the household has food security. The mild food insecurity level is for those household where there is some concern or uncertainty about the access to food and where quality has been diminished in order not to diminish quantity. The moderate level is attributed for those households where food quantity has been diminished among adults or there was a rupture in the alimentation pattern. And finally the severe food insecurity, that is associated with those cases in which the household members feel hungry, and at least one of them has gone for a whole day without food, due to lack of money.

Table 2
Description and Descriptive Statistics of Variables for the whole sample

Variable	Definition	Mean/Prop	Std. Dev
Household (HH)			
Food_Ins	0 = Food Security (FS); 1 = Mild Food Insecurity (MiFI); 2 = Moderate Food Insecurity (MoFI); 3 = Severe Food Insecurity (SFI)	0.4040	0.7756
BFP	1 = If the HH receive the bolsa-familia; 0 = otherwise.	0.1645	0.3707
ln_income	Ln of the monthly household's per capita income.	6.2414	1.2748
rel_income	The household' income relative to the mean income.	1.1336	0.9924
child_memb	The total number of children (less than 18) in the household.	0.4667	0.7839
internet	1 = if there is a computer with access to the internet; 0 = otherwise.	0.3445	0.4752
urban	1 = if the domicile is located at the urban area; 0 = otherwise.	0.8499	0.3571
metrop_reg	1 = if the domicile is located at the metropolitan region; 0 = otherwise.	0.3108	0.4628
home_owner	1 = if the domicile is located at the metropolitan region; 0 = otherwise.	0.7380	0.4397
auto_owner	1= if someone at the household has an auto or a moto; 0 = otherwise.	0.5098	0.4999
home_burd	1 = if housing costs (provision or rental) exceeds 30% ²⁴ of income; 0 = otherwise	0.0907	0.2872
reside	1 = if the length of time in the residence is >=10 years; 0= otherwise.	0.9206	0.2703
ST	Dummy for each of the 27 Brazilian states	-	-
T	Dummy for the Year of 2013	-	-
Head of Household (HHH)			
age	HH head's age	48.2111	15.8288

²² The same determinants were used to explain the probability of participation in the "Bolsa-Familia" Program for the Propensity Score Matching.

²³ Quality, in sufficient quantity, without compromising access to other essential needs.

²⁴ The 30% reference line is suggested by every article to have an affordable housing planning:
http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/affordablehousing/.

gender	1 = female; 0 = otherwise.	0.3565	0.4790
race	1 = If the HHH is black, ; 0 = otherwise.	0.5188	0.4997
mar_status	1 = If the spouse at the HH lives at household; 0 = otherwise	0.6528	0.4761
mother	1 = If the mother of at least one child lives at the household; 0 = otherwise.	0.6208	0.4852
study_y	HHH's years of study	7.0496	4.7379
unempl	1 = If the HHH was unemployed at the reference week; 0 = otherwise.	0.0168	0.1285
employ_15	1 = If the HHH begun to work before he was 15 years old; 0 = otherwise	0.4198	0.4935
informal	1 = If the HHH work is informal; 0 = otherwise.	0.3306	0.4704

The food insecurity measure used in this work is derived from the psychometric scale with 14 items of the PNAD's survey, the Brazilian Scale of Food Insecurity (BSFI). The BSFI is an adapted and validated version of that proposed by the Agricultural Department of the United States. According to Pérez-Escamilla and Segall-Corrêa (2008) the psychometric scales are the most directly related to the lived and perceived experience of lack of food and have an excellent cost-effectiveness relation. They have been used since the years 1990 by several countries.

The questions seek to capture the perception of the household experience over the past 90 days with regard to access to food (PNAD, 2010). The only possible responses are yes or no, whose values correspond to one and zero, respectively. The household's score is given by the simple sum of the values obtained in each of the 14 questions, and the classification is according to Table 3²⁵.

Table 3 – Food Insecurity classification considering households with and without children under 18 years old – PNAD (2010).

Classification	Households' scores	
	With children under 18	Without children under 18
Food Security (FS)	0	0
Mild Food Insecurity (MiFI)	1 - 5	1 - 3
Moderate Food Insecurity (MoFI)	6 - 9	4 - 5
Severe Food Insecurity (SFI)	10 - 14	6 - 8

The BFP is a dummy variable that takes the value 1 (BFP=1) if the household receives some cash transfer from the Program, or zero, if do not (BFP=0). However, while PNAD 2004 does provide direct information about the household's participation in the BFP, the PNADs 2009 and 2013 do not provide this direct information. So, this article has used the method proposed by Souza et al. (2011)²⁶ to estimate it; and to certify if this procedure has given non-biased results, the 2004 estimations (BFP) were compared to the households' given responses in PNAD. Table 4 provides a summary of this comparison for the 104,572 valid observations of PNAD 2004.

Table 4
Comparison between the classifications of families benefiting from the Bolsa-Familia Program according to PNAD and the method adopted – in %

	PNAD as the base		BFP as the base		
	PNAD = 1	PNAD = 0	PNAD = 1	PNAD = 0	Total
BFP = 1	93.9	6.1	85.9	14.3	100

²⁵ The questionnaire is in the Apendice.

²⁶ See Barros (2006), Barros, Carvalho and Franco (2006) and Soares et al. (2006) for the tipical values measure;

BFP = 0	2.8	97.2	1.1	98.9	100
Total	100	100	-	-	-

Note: PNAD=1 means that the household's head has answered yes when asked if she or he had received some benefits from the BFP, and PNAD=0 if he or she had answered no. BFP =1 means that the method used has estimated that the household is a beneficiary of the program, and BFP=0 otherwise.

According to Table 4, the method worked pretty well: it recognized 93.9% of the beneficiaries who styled themselves as such; and among those designed as being beneficiaries by the method, 85.9% self-declared beneficiaries. On the other hand, the method recognized as non-beneficiaries 97.2% of those who have declared themselves as being non-beneficiaries, and among the non-beneficiaries estimated by the method, 98.9% have recognized they didn't receive some benefit from the Program. On average, the method hit 96.6%.

A possible explanation for this combination of results could be the misreporting status by the households. As Bollinger and David (2001) have proved for the American case, the omission errors are more likely than the commission errors.

4 RESULTS

4.1 Preliminary results of Food Insecurity

Table 5 summarizes and compares the proportion of the beneficiary (B) and non-beneficiary (NB) households of the Bolsa-Familia Program by food insecurity situation for the full sample and for households below and above the poverty line. The beneficiaries represent approximately 16.5% of the full sample (228,827 observations); around 50.1% of households below the poverty line (21,727 observations); and 43.9% of households below the extreme poverty line (9,631 observations).

Table 5²⁷ - Proportion (%) of beneficiaries by food insecurity status - Brazil - PNAD 2009/2013

Food_Ins	Full Sample		Below Extreme Poverty Line		Below Poverty Line		200% of the Poverty Line		400% of the Poverty Line	
	NB	B	NB	B	NB	B	NB	B	NB	B
0	78.3	48.7	50.0	27.4	45.2	30.9	83.1	63.5	88.2	76.9
1	14.3	29.5	20.4	30.3	24.8	32.3	12.1	25.3	8.9	17.1
2	4.3	12.2	13.1	20.0	14.2	18.6	3.0	7.1	1.8	3.8
3	3.1	9.6	16.5	22.2	15.8	18.2	1.8	4.1	1.1	2.2

The proportion of households that are food secure is higher among the non-beneficiaries than it is for the program's beneficiaries in every considered sample of the Table 5. For the full sample, while 21.7% of nonparticipating households are food insecure, 51.3% of BFP-beneficiaries households are food insecure. This result reveals that the Program has had a good focus, and that these households are perhaps more needy and more likely to self-select into BFP, as has been suggested by Ratcliffe et. al. (2011) for their own study.

Data still show that even for the households with a per capita income four times higher than the poverty line, *Food_Ins* is a threat to 23.1% of the Program's beneficiaries and 11.8% of non-beneficiaries. And surprisingly, 50% of the extremely poor non-beneficiaries households are food secure. As Nord Andrews and Carlson (2004) have told, households find some strategies to deal with the lack of access to food.

4.2 Estimations of the effect of the Bolsa-Familia Program (BFP) on Food Insecurity

In order to test for robustness, three different models were estimated: pooled ordered logit and difference-in-differences (with and without matching). The Table 6 brings the results for the impact of the Bolsa-Familia

²⁷ Estimates were done with the sampling weight given by PNAD.

Program on Food Insecurity for all this models. They used the same control variables and dummies of state and time.

Table 6 – Results of the BFP impacts on Food Insecurity – 227,472 observations

	Pooled Ordered Logit	Diff-Diff	
		no match	match
BFP	0.4022***	-0.1298***	-0.076***

Note: *** $p \leq 0.01$.

As it can be seen, the relation between the BFP and food insecurity is positive in the pooled ordered logit but negative in the diff-in-diff models. These results confirm the suspicion that there is an endogenous component in the analysis and that it has to be taken into account at the most appropriate way.

Both results of the diff-in-diff models reveal negative impacts of the program on food insecurity, even though in the matching model the size's impact is quite small. But because it is expected that the matching method bring more precision to the diff-in-diff's results, it is possible that the diff-in-diff without matching is overestimating the program's impact. Table 7 presents the estimation results for both models.

Table 7 – Difference-in-difference estimation results

Outcome Variable	Diff-in-diff without matching ^a		Diff-in-diff with matching	
	Food_Ins	Std dev	Food_Ins	Std dev
Baseline				
Control	0.751		0.796	
Treated	1.007		0.982	
Diff (T-C)	0.256***	0.006	0.186***	0.011
Follow up				
Control	0.698		0.602	
Treated	0.823		0.711	
Diff (T-C)	0.126***	0.006	0.109***	0.008
Diff-in-diff	-0.130***	0.008	-0.076***	0.014
Rsquare	0.20			

Note: *** <0.01 . a. Regressions are OLS.

4.3 The other determinants of Food Insecurity

Table 8 brings the results for the parametric analysis of the diff-in-diff regression and the ordered logit model. All the variables were significant at 1% for both models. The coefficients signs were consistent in both estimations, with the only exception of *mar_status*, that showed a positive effect on the ordered logit and negative on the diff-in-diff model. This variable was thought as a proxy to the household head's marital status, but without worrying about the formal aspect of marriage. It only indicates whether the spouse (he or she) lives in the residence or not. Yen et al. (2008) and Depolt et al. (2009) found a negative coefficient, such as that estimated by the diff-in-diff model; i.e., living as a couple helps in reducing food insecurity.

Table 8 – Estimates of being Food Secure, Mild Food Insecure, Moderate Food Insecure and Severe Food Insecure

Variable	Ordered Logit		Diff-in-Diff	
	Coef	st dev	coef	st dev
BFP	0.4022***	0.0128	0.256***	0.008
TBFP	-	-	-0.130***	0.008

ln_income	-0.2396***	0.0053	-0.097***	0.002
home_owner	-0.1924***	0.0121	-0.060***	0.004
auto_owner	-0.4462***	0.0118	-0.141***	0.004
home_burd	0.1440***	0.0186	0.052***	0.006
rel_income	-0.2344***	0.0091	-0.017***	0.002
child_memb	0.1345***	0.0064	0.051***	0.002
internet	-0.3477***	0.0142	-0.063***	0.004
urban	0.2653***	0.0151	0.088***	0.005
metrop_reg	0.0727***	0.0135	0.027***	0.004
reside	0.0543***	0.0204	0.018***	0.006
age	0.0316***	0.0019	0.012***	0.001
age ²	-0.0004***	0.0000	-0.000***	0.000
gender	0.2977***	0.0128	0.067***	0.004
race	0.2654***	0.0114	0.058***	0.003
mar_status	0.0383***	0.0133	-0.021***	0.004
study_y	-0.0619***	0.0014	-0.016***	0.000
unempl	0.5754***	0.0327	0.255***	0.012
informal	0.1818***	0.0116	0.069***	0.004
employ_15	0.1525***	0.0117	0.036***	0.004
T	-0.2894***	0.0104	-	-

Note: ***p≤0.01

As was expected, the household asset variables *ln_income*, *home_owner* and *auto_owner* were negatively related and *home_burd* positively related to food insecurity. That is, the stability aids in driving the food decisions. However, the share of income committed to the purchase or rental of the house where they live may not exceed 30% of family income.

Households located at *urban* areas and in *metrop_regions* (metropolitan regions) were more propense to be food insecure. Because it is expected that in these places there is a greater availability of food, it would be expected a negative relationship. However, Hoffman (2008) and Gubert et al. (2010) have found the same positive relation concerning to urban areas when analyzing Brazilian data. Production for own consumption in rural areas may have an important role explaining these relation, suggesting a closer study of these differences in rural areas.

Live in the same residence for less than ten years (*reside*) was thought as a measure of social capital, because at this period people couldn't construct more deep relationships. It was expected that in such circumstances the household members couldn't have developed a social network, with trust and reciprocity, helping them in having access to food. In both model, households with less than 10 years of residence were more food insecure.

The household's head characteristics were important in determining food insecurity, which increases with age, until some point and then decreases; if the household's head is a woman, or if s(he) is black, brown or indigenous. All these types of behavior are similar to the conducted studies for the US; an important difference, however, is the fact that in the US, the black and brown people represent a minority, whereas in Brazil they represent approximately 50.7% of the population according to the Census 2010.

The number of years of education has a negative relationship with food insecurity, meaning that the formal schooling system helps in establishing strategies to address food insecurity. Similarly, being employed and, more than that, being employed in a formal job, clearly contributes to reduce food insecurity.

Another general observation noteworthy is the fact that all the diff-in-diff's coefficients were smaller than the logit ordered's coefficients.

5 CONCLUSIONS

This article examined the PNAD repeated cross-section data from the years 2009 and 2013 in Brazil and provided evidences that the Bolsa-Familia Program (BFP) has been successful in diminishing the households' food insecurity (FI). However, the diff-in-diff with matching estimations showed that this impact is quite small, around -0.076.

At the household level, food insecurity was seen as a four level measure: food security and mild, moderate and severe food insecurity. It was based in the subjective measure of the Brazilian psychometric scale of food insecurity, through which people recognize whether they had any difficulty in accessing food.

Model's robustness was tested through its comparison with ordered logit and diff-in-diff without matching models, showing that the results are quite consistent and that they can be biased if an identification strategy is not used in the analysis. Without taking into account the endogeneity, a positive relationship between the BFP and FI is identified (ordered logit model), which becomes negative in the proposed diff-in-diff models. The diff-in-diff without matching, however, captures a greater impact than that accomplished with the matching technique. But because it is supposed that the matching technique improves the estimation of the diff-in-diff model, it means that the diff-in-diff without matching overestimates the results.

Some alternative ideas can be thought to explain this difference and the relative small program's impacts. In this context, the analysis can be separated into two main lines: first by discussing the model limitations; and second, assuming the result as true, by nominating the possible problems in implementing the program.

Behavioral differences between households with different levels of food insecurity or income can explain the differences between the two diff-in-diff models. It is possible that a quantile model can solve this problem and that the differences decrease with its use. Moreover, the difference between the differences of the two models was estimated using a linear model. Perhaps the use of an ordered logit would be more appropriate.

On the program implementation, it must be remembered that there is no supervision over the money's use, so that it may be being used for other purposes. In this regard, however, Duarte et al. (2009) and Almeida et al. (2013) identified a positive impact of the program on food spending, although these studies cannot be generalized at all.

There may be a gap between the satiated hunger in the period and its perception as a permanent condition. In addition, scale on food insecurity reveals an absolute condition of lack of resources to buy food, not a comparison to a previous condition. Therefore, it is possible that access to food has been improved, but a definitive solution has still not been achieved due to the small value of Program's transfer.

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