1. Bolsa Familia Program and the creation of health opportunities for children under five years old

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Abstract: Bolsa Familia Program (BFP) has been introduced to create life chances for the most vulnerable children in Brazil. Using data from the Impact Assessment of the Bolsa Familia Program (AIBF), we used stochastic dominance to analyse the creation of health opportunities in this program on three health indicators related to child health: birth weight, height-for-age, and body mass index-for-age. Pre-existing differences between the groups were treated using propensity score weighting, and distributional effects on child health were conditioned to the parental education and racial origin. Our findings partly agree with prior studies evaluating BFP, which show that the program created health opportunities; but, they were heterogeneous among the types and health indicators.

Key words: Inequality of Opportunity, Health Inequalities, Child Health, Conditional-Cash Transfer, Bolsa Familia.
1.1. Introduction

Bolsa Familia Program (BFP) is the largest Conditional Cash Transfer (CCT) in the world (WORLD BANK; 2015), attaining nearly 70 million people living in poverty in Brazil. This program consists of regular monetary transfers to the poor families in Brazil for offering health services as well as enrolling and keeping their children in school. Like other CCTs, BFP was built on the idea of enhancing child human development by investing in their health and education in order to break the intergenerational transmission of poverty (OWUSU-ADDO; CROSS, 2014). More precisely, BFP was developed to create life chances for the most vulnerable children in Brazil (CRUZ; MOURA; SOARES NETO, 2017).

In the past decades, BFP has been widely studied to show that the program yields mostly positive effects on the schooling, household consumption, child and maternal health, and child labor reduction (FISZBEIN; SCHADY; FERREIRA, 2009). However, few empirical studies have focused on how the mechanism of intergenerational transmission of poverty is associated with the reduction in inequality of opportunity. These studies have assessed whether vulnerable families enrolled in this program evidence more equitable outcomes.

1.1.1. Inequality of Opportunity in Health

Studies regarding the inequality of opportunity have mainly focused on the negative effects of unfair inequalities on individual outcomes (ROEMER, 1993; HAM, 2014). By unfair inequalities, the authors generally mean the circumstances that are exogenous to the individual's control, such as parental socioeconomic status, life conditions during childhood, and birth characteristics including ethnical or racial origin and sex (DIAS, 2009; FIGUEROA, 2014; BARRO et al., 2008).

In order to analyse the inequality of opportunity, individuals are categorized into social groups, named as types, that are formed according to their circumstances (ROEMER, 1993; HAM, 2014). Therefore, the more a circumstance has a negative influence on a given outcome, the greater this type faces the inequality of opportunity in this area. In this perspective, equality of opportunity is achieved when opportunities are equally distributed between the social groups so that any difference in the outcomes is not due to the circumstances but due to the individual aspects alone (DIAS, 2009).
For a specific case of child health, children under five years old are more likely to face multiple health risks when living in low and middle-income countries, such as Brazil (GRANTHAM-MCGREGOR et al., 2007), because these regions have large population living in poverty and limited healthcare provision. Children living in poverty are more likely to struggle in the case of illness because they have limited access to healthcare, health information, and other means to guarantee an adequate development (WORLD BANK, 2018). For this reason, they tend to have poor health, which in turn results in lower cognitive development, poor educational attainments, and reduced productivity in later life (CASE; FERTIG; PAXSON, 2005). Besides, individuals with poor health conditions during childhood have an increased risk of chronic morbidity in later life (BLACKWELL; HAYWARD; CRIMMINS, 2001). In other words, poor child health may increase the economic and social burden of these nations by creating poverty and deprivation (BLOOM; CANNING, 2000).

CCTs have been drawing attention of health policy researchers, since they holistically address the root causes of poor child health by tackling poverty, increasing the access to health services and social rights, as well as promoting food and nutrition (OWUSU-ADDO; CROSS, 2014). From a public health perspective, CCTs combat health inequities, which are avoidable inequalities caused by the social and economic conditions (WHO, 2018). This concept is closely related to the idea of circumstances provided in the literature on inequality of opportunity; therefore, BFP should produce plenty of evidences regarding the creation of opportunities in health (CRUZ; MOURA; SOARES NETO, 2017).

1.1.2. Previous research

The growing body of literature dealing with the evaluation of social programs from an equality of opportunity perspective does not include a significant portion of discussion about the relationship between BFP and inequality of opportunity. For example, Van de Gaer, Vandenbossche and Figueroa (2013) have evaluated the creation of health opportunities for the children participating in the Mexican CCT known as Oportunidades. Focusing on the health outcomes such as BMI, height-per-age z-scores, and number of sick days of a child, their results have shown that the children with indigenous origin are substantially more benefited by the program when using an equal-opportunity framework. Figueroa (2014) has shown that the children enrolled in Oportunidades are presented with positive child development indicators,
especially the non-cognitive abilities such as behavioral problems. Moreover, Jones Roemer and Rosa Dias (2014) have indicated that reformed education policy in Britain has a modest effect in neutralizing the inequality of opportunity in health in adult life. Therefore, the main purpose of this study was to assess if BFP has created health opportunities for the children under five years old.

1.2. Methods

We used stochastic dominance with the purpose of evaluating the creation of health opportunities through the BFP on three health indicators related to child health. This technique compared the cumulative distributions of each indicator for the children in the treatment and control groups. When the treatment group stochastically dominated the control group, there was a positive distributional effect of the program; therefore, we state that the health opportunities are created by the BFP. Pre-existing differences between the groups were treated using propensity score weighting (DE BRAUW et al., 2015). The analysis is performed for sample split in two on bases of parental education and racial origin of the children.

1.2.1. Data sample

The data were collected during the Impact Assessment of the Bolsa Familia Program (AIBF) conducted by the Brazilian government in 2005 and 2009. The main goal of the AIBF was to evaluate the effects of BFP, and the survey “contained household-level questions on demographics, living conditions, assets, income, consumption, anthropometry, health, education, participation in cash transfer and subsidy programs, and women’s decision making” (DE BRAUW et al., 2015). The participants included (i) BFP participants; (ii) participants registered in CadÚnico but not in BFP; and (iii) participants not in CadÚnico and BFP.

In 2005, AIBF-1 was intended as a baseline for the longitudinal database to be constructed for the future impact evaluation, and it was implemented by the Centro de Desenvolvimento e Planejamento Regional da Universidade Federal de Minas Gerais (Fundep/Cedeplar/UFMG) [19]. During this phase, 15426 families who were representing the nation were interviewed in 269 municipalities from three macro-regions (Northeast, Urban North/Center-West and Southeast/South). Propensity score matching was conducted in order to create a counterfactual for the future impact estimation (BRASIL, 2007).
The International Food Policy Research Institute (IFPRI) and Datamétrica Consultoria, *Pesquisa e Telemarketing Ltda* carried out the follow-up phase in 2009 (AIBF-2) where they applied a similar survey that was used in 2005 (BRASIL, 2012). During this stage, 11433 households of the baseline were re-interviewed; so, AIBF-2 presented an annual attrition rate of 6.5%. Non-random effects caused by the attrition were corrected by propensity score weighting, which included attrition weights for estimating the Average effect of Treatment on the Treated (ATT) (BRASIL, 2012; DE BRAUW et al., 2012; DE BRAUW et al., 2015; DE BRAUW et al., 2014).

In the present study, stochastic dominance was conducted using cumulative distributions constructed for both treatment and control groups of health outcomes assessed during AIBF-2. Therefore, treatment group was defined as the households who received BFP in 2009 and were registered in the CadÚnico; however, this group did not receive BFP benefits or its predecessor programs in 2005. On the other hand, control group consisted of all households who were in CadÚnico in 2005 and 2009 but did not receive BFP. In this case, the impact estimation of BFP was conditioned to the registration in CadÚnico (DE BRAUW et al., 2015). We used the same comparative design proposed by the researchers of AIBF-2 (DE BRAUW et al., 2012). However, instead of average effects, we investigated the distributional effects detected by stochastic dominance.

Two factors were considered for the construction of aforementioned treatment and control groups. First, CadÚnico registration and BFP participation have not been randomly assigned, since the enrollment in CadÚnico is voluntary. Therefore, there is a possibility of self-selection, which could result in biased impact results for BFP estimations. Secondly, beneficiary households of BFP and other social programs could not be included in the final sample if the data collected in 2005 are considered as a baseline for the impact assessment.

### 1.2.2. Health outcomes, circumstances and types

Three anthropometric indicators that are directly related to child health were chosen for the analysis: Birth Weight (BW), Height-for-age (HFA), and Body Mass Index-for-age (BMI). This information was collected from AIBF-2 for the children under five years old. We focused on the child malnutrition because under and over nutrition are among the main current issues in public health (DELISLE et al., 2016). Low birth-weight (LBW) is mainly caused by the preterm birth and restricted
intrauterine growth, contributing to 60%-80% of neonatal deaths (WHO, 2004, 2017). LBW is also associated with an increased fetal and neonatal morbidity, inhibited growth and cognitive development, and chronic diseases in later life (WHO, 2004). High birth-weight (HBW), also known as macrosomia, is related to the mother’s health conditions, such as overweight, obesity, and insulin resistance (JOHNSON et al., 2015). Consequently, infants born with HBW present higher probability of childhood hypertension (DONG et al., 2017), overweight, obesity, and type 2 diabetes (DEWWEY; BEGUM, 2011; SCHELLONG, 2012; JOHNSON et al., 2015; WHO, 2016).

Stunting is known as a “process of failure to reach linear growth potential as a result of suboptimal health and/or nutritional conditions” (WHO, 2018b). Recent research has shown that stunting could cause long-term effects on the cognitive development, school achievement, and economic productivity in adulthood and maternal reproductive outcomes (NHLBI, 1998). On the other hand, children who faced undernutrition during the fetal and early childhood development tend to present a higher risk of overweight and risk of obesity (RO) when exposed to an obesogenic environment (WHO, 2017). Excessive body weight also contributes to cardiovascular disease, diabetes, and several types of cancer. It can endanger the entire life of an individual (WHO, 2016).

BW was measured in grams in the children under one year old, since it would be more feasible to relate this indicator to BFP (DE BRAUW et al., 2012), HFA and BMI z scores were constructed according to the WHO Growth Standards (WHO, 2006). In this study, stunting was detected in the children with HFA under two negative z scores deviations (HFA z score ≤ -2); whereas, the risk of overweight and obesity (RO) was related to the children with BMI above one z score deviation (BMI z score ≥1).

Two circumstances that can negatively influence child health were selected: parental education and racial origin. Historically, black population presents higher mortality rates (CHOR; LIMA, 2005), self-reported perception of negative health (BARATA et al., 2007), and prevalence of child malnutrition (REIS, 2012). In addition, previous research has shown the association between low parental schooling and children’s malnutrition in Brazil, indicating that stunted children have higher odds of having parents without elementary education (MARTINS et al., 2007). Parental
education was evaluated using the information about educational background of each member of a household, including parents. Likewise, racial origin was determined based on the answers related to declared skin color. According to the official Brazilian classification, racial origin was categorized as black if the parents declared having black or brown skin (Petrucelli; Saboia, 2013). A child was classified as having a black parent when at least one parent was declared as black or brown. Similarly, a child was classified as having parents without secondary education when at least one parent did not complete secondary education.

Following the normative model proposed by Roemer (1993), we conditioned health outcomes to parental racial origin (black and white) and educational categories (with and without secondary education); thus, forming four types for both control and treatment groups: 1) children of black origin; 2) children of white origin; 3) children of parents without secondary education; and 4) children of parents with secondary education. Indigenous people and population of Asian origin were not considered in this analysis. The details of participants are depicted in Table 7.1.

**Table 1.1 - Characteristics of participants in treatment and control groups**

<table>
<thead>
<tr>
<th>Types</th>
<th>Treatment</th>
<th>Control</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black parents</td>
<td>601</td>
<td>337</td>
<td>938</td>
</tr>
<tr>
<td>White parents</td>
<td>189</td>
<td>151</td>
<td>340</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>790</strong></td>
<td><strong>488</strong></td>
<td><strong>1150</strong></td>
</tr>
<tr>
<td>Parents without secondary education</td>
<td>732</td>
<td>418</td>
<td>1150</td>
</tr>
<tr>
<td>Parents with secondary education</td>
<td>90</td>
<td>82</td>
<td>172</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>822</strong></td>
<td><strong>500</strong></td>
<td><strong>172</strong></td>
</tr>
</tbody>
</table>

*Source: Authors.*

1.2.3. **Stochastic Dominance**

We followed previous studies that compared the cumulative distribution functions (CDF) of each health outcome conditioned to each type between the treatment and control groups for the specific case of CCT (Gaer; Vandenbossche; Figueroa, 2013; Figueroa, 2013). We performed stochastic dominance at first order to test the creation of health opportunity for the children by BFP in each type. To do this, we used Roemer’s identification axiom that says that the children in the same percentile of health outcomes distributions are conditioned to the same circumstances, and therefore, they are comparable.
Second-order stochastic dominance was not performed, since it does not aggregate much “to the conclusions drawn from first-order stochastic dominance” (GAER; VANDENBOSSCHE; FIGUEROA, 2013).

Following the previous work on inequality of opportunity (DIAS, 2009; DEVAUX et al., 2008; MAGE-BERTOMEU; MENENDEZ; JUSOT, 2017) and stochastic dominance (HIDALGO; MATA, 2009), we applied the two-sample one-sided Kolmogorov-Smirnov (KS) test in order to weakly test the existence of first-order stochastic dominance in addition to graphical analysis of the CDF curves. According to the test, $h_1$ and $h_2$ are the two random variables representing the same child health outcome in the treatment and control groups, respectively. These variables have CDFs $F_{h_1}$ and $F_{h_2}$, respectively. In the present study, KS tests compared $F_{h_1}$ and $F_{h_2}$ as follows:

$$A)\quad H_0 : F_{h_1} (H) = F_{h_2} (H), \forall H \in \mathbb{R} \quad H_A : F_{h_1} (H) \neq F_{h_2} (H), for \ some \ \forall H \in \mathbb{R}$$

$$B)\quad H_0 : F_{h_1} (H) - F_{h_2} (H) \leq 0, \forall H \in \mathbb{R} \quad H_A : F_{h_1} (H) - F_{h_2} (H) > 0, for \ some \ \forall H \in \mathbb{R}$$

Test A aims at determining if both CDFs are identical or not, while Test B aims at investing if $F_{h_1}$ first-order stochastically dominates $F_{h_2}$. Therefore, on the grounds of inference, Test A can be rejected, whereas Test B cannot be rejected. In case of graphical analysis, treatment dominance was seen when the treatment group was $(F_{h_1})$ below and to the right of the CDF of the control group $(F_{h_2})$. Taken together, results showed that the program creates health opportunities for the aforementioned types of children.
1.3. Results

Table 7.2 provides the descriptive statistics of the health outcomes for the children under five years old in both treatment and control groups. Overall, the children in BFP households presented better RO indicators than non-participants households, while LBW and HBW proportions were similar or slightly worse than their counterparts in the control group. It should be mentioned that both groups showed lower LBW prevalence in contrast to the Brazilian population (UNICEF, 2018).

Some results showed contradictory changes within types. For example, we could not identify a particular trend of RO in the types according to the racial origin or parental education. In addition to this, LBW also did not show a clear pattern, since the children of less educated parents were not likely to have low weight at birth. Actually, BFP children followed the trend that is more closely related to the literature of the Social Determinants of Health (MARMOT, 2005) in comparison to the control group, showing less favorable health outcomes for the children of both black and less educated population.

The results of the KS test for first-order stochastic dominance of the treatment and control groups for each health indicator conditioned to racial origin and parental education are displayed in Table 7.3. Graphical analysis of the cumulative distribution curves is also presented in Fig. 1-4. Positive program effect was noted when CDF of the treatment group first orderly dominated the control group. Otherwise, there was negative program effect, which means that equal opportunities were not created for that particular health outcome.
Table 1.2 – Prevalence of health outcomes for children under five years old in the treatment and control groups 2009.

<table>
<thead>
<tr>
<th>Types</th>
<th>Treatment Sample</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Controls Sample</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>zBMI</td>
<td>zHFA</td>
<td>Birth weight (&lt;1 year old)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Risk obesity</td>
<td>Median</td>
<td>Stunted</td>
<td>Median</td>
<td>LBW</td>
<td>Normal weight</td>
<td>HBW</td>
<td>Risk obesity</td>
<td>Median</td>
<td>Stunted</td>
</tr>
<tr>
<td>All</td>
<td>0.15</td>
<td>1.78</td>
<td>0.08</td>
<td>-2.62</td>
<td>0.04</td>
<td>0.73</td>
<td>0.23</td>
<td>0.24</td>
<td>1.46</td>
<td>0.07</td>
</tr>
<tr>
<td>Black parents</td>
<td>0.20</td>
<td>1.85</td>
<td>0.09</td>
<td>-2.57</td>
<td>0.06</td>
<td>0.66</td>
<td>0.28</td>
<td>0.14</td>
<td>1.50</td>
<td>0.05</td>
</tr>
<tr>
<td>White parents</td>
<td>0.09</td>
<td>1.59</td>
<td>0.09</td>
<td>-2.62</td>
<td>0.01</td>
<td>0.97</td>
<td>0.02</td>
<td>0.20</td>
<td>1.50</td>
<td>0.05</td>
</tr>
<tr>
<td>Parents without secondary education</td>
<td>0.16</td>
<td>1.78</td>
<td>0.09</td>
<td>-2.62</td>
<td>0.05</td>
<td>0.72</td>
<td>0.24</td>
<td>0.26</td>
<td>2.09</td>
<td>0.07</td>
</tr>
<tr>
<td>Parents with secondary education</td>
<td>0.26</td>
<td>2.09</td>
<td>0.07</td>
<td>-2.71</td>
<td>0.03</td>
<td>0.90</td>
<td>0.07</td>
<td>0.26</td>
<td>2.09</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Source: Authors.
Table 1.3- Tests for stochastic dominance (KS) of BMI z scores, HFA z scores and BW between treatment and control groups for each type.

<table>
<thead>
<tr>
<th>Type</th>
<th>Null: Equality of Distributions</th>
<th></th>
<th>Null: Treatment FSD Control</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P-value</td>
<td>P-value</td>
<td></td>
<td>P-value</td>
</tr>
<tr>
<td></td>
<td>zBMI</td>
<td>zHFA</td>
<td>BW</td>
<td>zBMI</td>
</tr>
<tr>
<td>Black parents</td>
<td>0.013</td>
<td>0.026</td>
<td>0.381</td>
<td>0.806</td>
</tr>
<tr>
<td>White parents</td>
<td>0.934</td>
<td>0.643</td>
<td>0.605</td>
<td>0.591</td>
</tr>
<tr>
<td>Parents without secondary education</td>
<td>0.051</td>
<td>0.272</td>
<td>0.358</td>
<td>0.892</td>
</tr>
<tr>
<td>Parents with secondary education</td>
<td>0.939</td>
<td>0.036</td>
<td>0.083</td>
<td>0.608</td>
</tr>
</tbody>
</table>

Source: Authors.

As observed in Table 7.3, the results of KS tests suggest that the effect of BFP on the distribution of BMI-per age z-scores is positive for the most vulnerable types i.e. the children of parents with black origin and without secondary education. In other words, the probability of selecting a child with RO in the treatment group is always lower as compared to the control group, meaning that BFP creates opportunities for this health outcome. Nevertheless, graphical analysis only confirmed stochastic dominance for the children of black parents (Fig.1).

According to the KS test for HFA z-scores distributions, BFP showed negative influence on the children of black parents and parents with secondary education (Table 1.3). In both cases, control group would be less likely to have stunt children, following the prevalence previously indicated per types and among groups (Table 1.2). Following the graphical analysis of HFA distributions (Fig.2), we did not confirm first-order dominance of the control group for the children of parents with secondary education and children of black parents.

CDF of BW in the treatment and control groups is displayed in Fig.3. Graphical analysis did not indicate treatment dominance; however, according to KS tests, such observation was noted only for the children of parents with secondary education. We tested for the control dominance for this indicator for the children of parents with secondary education; but, it was rejected at 10% level of significance (Appendix II). The contradictory outcomes that came from the comparison between KS test and graphical inference of BW distribution for this type could be due to its small sample size (n=31); thus, yielding conservative interpretation of the results (STATA, 2018).

1.3.1. Sensitivity analysis
Our results showed that the distributional effects of BFP are seen only for BMI-per age. Therefore, we further examined the results by applying Wilcoxon-Mann-Whitney test and Quantile Treatment Effects (Table 4 and 5).

Following the recent work done on the inequality of self-reported health status in Chile (GALLARDO; VARAS; GALLARDO, 2017), we used Wilcoxon-Mann-Whitney test in order to test the existence of strong equality of opportunity. As shown in Table 4, Wilcoxon-Mann-Whitney tests rejected the strong equality of opportunity for the children of parents with black origin and without secondary education in the case of BMI and for the children of black parents in the case of HFA. These observations partly reproduce our previous results on the equality of distributions (Test A) when testing for stochastic dominance.

The Quantile Treatment Effects (QTE) has been used to analyse the program with the purpose of studying heterogeneous outcomes (DJEBBARI; SMITH, 2009). The main advantage of QTE is the possibility of finding program effects on a given quartile (or percentile) instead of the conventional mean impact (FIGUEROA, 2014).
Table 1.4 - Wilcoxon-Mann-Whitney test of BMI z scores, HFA z scores and BW between treatment and control groups for each type.

<table>
<thead>
<tr>
<th>Type</th>
<th>Null: Equality of Distributions</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>zBMI</td>
</tr>
<tr>
<td>Black parents</td>
<td>Equality of Distributions</td>
<td>0.064</td>
</tr>
<tr>
<td>White parents</td>
<td>Equality of Distributions</td>
<td>0.995</td>
</tr>
<tr>
<td>Parents without secondary education</td>
<td>Equality of Distributions</td>
<td>0.068</td>
</tr>
<tr>
<td>Parents with secondary education</td>
<td>Equality of Distributions</td>
<td>0.901</td>
</tr>
</tbody>
</table>

Source: Authors.

In this study, we estimated unconditional QTE as proposed by Firpo, Fortin, and Lemieux (2009) using the same covariates applied for the average effects (DE BRAUW et al., 2012) (Appendix III). As shown in Table 1.5, QTE results partly reproduce our previous findings for stochastic dominance, especially for the CDF of BMI z-scores for children of black origin and for children of parents without secondary education. In this case, positive program impacts can be seen in mostly of deciles, but they are not all statistically significant. Similarly, the HFA z-scores for children of parents with secondary education largely followed our earlier KS results showing control dominance; however, the results were not significant.

Differently, QTE estimations for the HFA z-scores and BW did not reflect our primary findings of stochastic dominance. HFA distribution for the children of black parents mostly did not showed any program results, with the exception that it was statistically significant at the eightieth decile. On the other hand, BW showed both positive and negative program effects for children of black parents and for children with parents of no secondary education.

According to Figueroa (2014), a drawback in QTE that can explain the difference between its results and the ones associated with stochastic dominance is that QTE is based on previously selected percentiles for average effects estimation. Hence, any other effects on the non-selected percentiles can be ignored, which is not the case when testing the whole distribution as in KS tests.
Table 1.5 - Quantile Treatment Effects of BMI z scores, HFA z scores and BW between treatment and control groups for each type.

<table>
<thead>
<tr>
<th></th>
<th>Q(0.1)</th>
<th>Q(0.2)</th>
<th>Q(0.3)</th>
<th>Q(0.4)</th>
<th>Q(0.5)</th>
<th>Q(0.6)</th>
<th>Q(0.7)</th>
<th>Q(0.8)</th>
<th>Q(0.9)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black parents</td>
<td>0.56&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.41&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.30&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.19</td>
<td>0.12</td>
<td>0.04</td>
<td>-0.03</td>
<td>0.14</td>
</tr>
<tr>
<td>White parents</td>
<td>-1.22</td>
<td>-0.11</td>
<td>0.07</td>
<td>0.15</td>
<td>0.15</td>
<td>0.35</td>
<td>0.3</td>
<td>0.32</td>
<td>-0.18</td>
</tr>
<tr>
<td>Parents without secondary education</td>
<td>0.3</td>
<td>0.33&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.38&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.34&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.28&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.15</td>
<td>0.16</td>
<td>0.05</td>
<td>0.17</td>
</tr>
<tr>
<td>Parents with secondary education</td>
<td>0.08</td>
<td>-0.26</td>
<td>-0.5</td>
<td>-0.79</td>
<td>-0.18</td>
<td>0.03</td>
<td>-0.09</td>
<td>0.62</td>
<td>1.21</td>
</tr>
<tr>
<td><strong>HFA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black parents</td>
<td>0.2</td>
<td>0.21</td>
<td>0.12</td>
<td>0.11</td>
<td>0.08</td>
<td>-0.08</td>
<td>-0.34</td>
<td>-0.39&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.22</td>
</tr>
<tr>
<td>White parents</td>
<td>0.37</td>
<td>0.38</td>
<td>0.16</td>
<td>-0.09</td>
<td>0.08</td>
<td>0.14</td>
<td>0.18</td>
<td>0.33</td>
<td>-0.26</td>
</tr>
<tr>
<td>Parents without secondary education</td>
<td>0.16</td>
<td>0.23</td>
<td>0.14</td>
<td>0.2</td>
<td>0.11</td>
<td>0.08</td>
<td>-0.04</td>
<td>-0.22</td>
<td>-0.19</td>
</tr>
<tr>
<td>Parents with secondary education&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.67</td>
<td>-0.3</td>
<td>0.1</td>
<td>-0.28</td>
<td>-0.54</td>
<td>-0.47</td>
<td>-0.47</td>
<td>-0.59</td>
<td>-0.54</td>
</tr>
<tr>
<td><strong>BW</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black parents</td>
<td>0.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.18&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.05</td>
<td>-0.04</td>
<td>-0.03</td>
<td>-0.08</td>
<td>-0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.05</td>
<td>0.01</td>
</tr>
<tr>
<td>White parents</td>
<td>-0.05</td>
<td>0.0</td>
<td>0.1</td>
<td>0.0</td>
<td>-0.06</td>
<td>-0.04</td>
<td>-0.07</td>
<td>-0.12</td>
<td>-0.15</td>
</tr>
<tr>
<td>Parents without secondary education</td>
<td>0.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.20&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.0</td>
<td>-0.02</td>
<td>-0.05</td>
<td>-0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.05</td>
<td>-0.08</td>
</tr>
<tr>
<td>Parents with secondary education</td>
<td>0.02</td>
<td>0.09</td>
<td>0.100</td>
<td>-0.07</td>
<td>-0.15</td>
<td>-0.16</td>
<td>-0.22</td>
<td>-0.24</td>
<td>-0.3</td>
</tr>
</tbody>
</table>

Source: Authors.  <sup>a</sup>10% significance level  <sup>b</sup>5% significance level  <sup>c</sup>1% significance level

<sup>1</sup>The QTE for HFA for children of parents with secondary education had one less covariate than the others due to missing values.
1.4. Discussion

Studies concerning Bolsa Familia have mostly showed positive effects on child health (PAES-SOUZA; SANTOS; MIAZAKI, 2011; DE BRAUW et al., 2012; RASELLA et al., 2013; SHEI, 2013; SHEI et al., 2014). Our findings partly agree with prior results, as observed by the fact that the program creates health opportunities for children under five years old in cases of BMI.

Furthermore, the lack of BFP effects on HFA is our major concern, since this indicator is related to the long-term undernutrition and reveals poor health and nutrition “since and even before birth” (WHO, 2010, p.1). However, some considerations are necessary to better clarify the context of these findings. First, previous research has pointed out that Brazil has halved child stunting between 1996 and 2007, as a result of improvement in the maternal education, families’ purchase power, healthcare coverage, and sanitation conditions (MONTEIRO et al., 2009).

The covariates used for the formation of treatment and control groups were similar with the predictors of stunt reduction in Brazil with the exception of the variable related to the expansion of healthcare. Therefore, one could argue that this phenomenon was not controlled in our study design; so, this could have impacted the results for HFA.

Secondly, another plausible argument is that the treatment and control groups used in the present study did not account for potential heterogeneity originated from children’s time exposition to BFP combined with the geographical regions they are from. As detailed in our methodology, the treatment group consisted of households who received BFP in 2009 but was not enrolled in this program or any of its predecessors in 2005. For this reason, it is crucial to understand when the children of black parents and parents with secondary education initiated their participation in the program, especially if they are from the regions with higher incidence of stunting.

Finally, it should be noticed that the Brazilian nutritional transition and its influence on food consumption, physical activity, and malnutrition were already a public health concern during the time of data collection for this study (BATISTA FILHO et al., 2008). Actually, obesity rates are rapidly growing among the low-income population, the targeted group of BFP (PINHEIRO; FREITAS; CORSO, 2004). For this reason, positive results regarding weight gain rather than height are supposed to be more expected.
1.4.1. Comparison with previous studies

Our study indicates positive treatment effect for BMI z-scores distributions for the children of black parents. Therefore, we argue that BFP creates health opportunities for this indicator as well as for RO in cases this vulnerable type of children.

Although we did not find other studies using distributional effect techniques, our results are in line with other impact evaluation studies. For example, using the same delimitation of treatment and control groups as the present study, Brauw et al (2012) have shown that BFP increases BMI of the children under five years old by 0.39 standard deviations. Nevertheless, it does not mention that weight changes due to program participation leads to higher prevalence of child overweight and obesity (BRAUW et al., 2012). Camelo, Tavares and Saiani (2009) have used the 2006 National Demographic and Health Survey in order to study BFP average impact on food security, nutritional outcomes, and child mortality. Their conclusion has revealed that BFP participation increases the probability of a child to have normal weight for his age. Furthermore, Baptistella (2012) has used the Brazilian Household Budget Survey with the purpose of assessing the impact of BFP on food consumption and nutritional outcomes. Her research has indicated that the program has positive impacts on BMI related to normal weight and negative effects on BMI for the obese children and adolescents.

Distributional effects worked in a different manner for HFA z-scores because graphical analysis did not show stochastic dominance and KS test indicated that control group stochastically dominated the treatment group for two types of children. In this case, the absence of health opportunities by BFP could infer a lack of program effect for all types of children.

These findings are different from previous results, although they have not used the distributional effects or disclosed average effects results for subgroups similar to this paper. Although Brauw et al (2012) have report that no average effects for HFA z-scores or for stunting prevalence are encountered for Bolsa Familia; others have found those effects to be positive and significant. For instance, using a logistic model, Paes-Sousa, Santos and Miazaki (2011) have found that BFP children are more likely to present normal height-for-age than their non-participant counterparts. Additional studies on HFA, stunting, and CCTs in Brazil for children under five years
have focused on the descriptive analysis of nutritional outcomes in a local level (PERES; FREITAS, 2008; SALDIVIA; SILVA; SALDIVIA, 2010; SANTOS et al., 2015) or have studied a prior Brazilian CCT called *Bolsa Alimentação* (MORIS et al., 2004; ASSIS et al., 2015).

In our study, BFP did not demonstrate effects on the children in regard to their weight at birth, so lacking evidence that some types have lower probability of LBW and HBW due to BFP participation. Previous work assessing the average effects on all participants has also not shown any significant results for this indicator (BRAUW et al., 2012).

### 1.1. Health opportunities channels

The BFP mechanisms that could create health opportunities were not investigated by our work; however, some possible channels were provided. As for the case of children overweight and obesity, one possible explanation is that BFP can mitigate some of the socioeconomic risks associated with child obesity by providing more variety and diverse diet or increasing the parental health literacy (YANCEY, 2007).

This argument is based on the evidence that BFP households had higher food expenditure within Brazilian low-income population, especially for the purchase of fresh and minimally processed foods (MARTINS; MONTEIRO, 2016). Furthermore, BFP involves conditions directly related to child health, including antenatal visits for pregnant beneficiaries as well as growth and child development monitoring and immunization for children less than seven years (BRASIL, 2018). There is also evidence that the program has increased the health services utilization (SHEI et al., 2014). This promotes more interaction between the child caregivers and health workers that could strengthen the parental health literacy, a predictor of child health (DEWALT; HINK, 2009).

### 1.4.2. Limitations

Some limitations are present in this study. First, the main drawback of using KS for testing the first-order stochastic dominance is that it does not determine the range of this dominance on the cumulative distribution. Davidson and Duclos (2013) have proposed more robust test that gives the interval where the difference between CDFs are statistically significant (FIGUEROA, 2014).
As pointed out earlier, the approximation used in KS tests is based on the asymptotic distributions, which are not recommended for small sample size \((n < 50)\), as it may yield higher \(p\)-values than needed (STATA, 2018). Although Stata has presented more efficient estimations of the \(p\)-values in the non-directional test, the same is not done for the unilateral ones (STATA, 2018). This fact can affect the results of stochastic dominance for the distributions of HFA in children of black origin and for the distribution of BW in all types.

### 1.5. Conclusions

In this paper, we showed that Bolsa Familia creates health opportunities by using stochastic dominance in order to assess the distributional effects of the program on child health indicators. The results of this study contribute to the discussion about the relationship between BFP and inequality of opportunity by evaluating if the program fulfills its mandate of creating life chances for more vulnerable children.

As previously mentioned, our results were not homogenous among the types and health indicators. Positive program effects were only noticed for black children in the case of BMI.

The lack of significant evidence of the distributional effects for some of the types encountered in our investigation raise some issues for further considerations in future research. First, more robust tests should be used in order to determinate the range where the difference between CDFs are significant. Second, the effects of the duration of BFP participation should be considered in assessing the distributional effects. Lastly, the information gathered by AIBF could be used for assessing possible channels for the creation of health opportunities by BFP to show how the program can be improved.
1.6. References


CHOR; D., LIMA; C. R. A. Aspectos epidemiológicos das desigualdades raciais em saúde no Brasil. *Cad. Saúde Pública* [Internet], v. 21, n. 5, p. 1586-1594, 2005.


GALLARDO, K.; VARAS, L.; GALLARDO, M. Inequality of opportunity in health:


http://apps.who.int/iris/bitstream/10665/204176/1/9789241510066_eng.pdf?ua=1&ua =1


Appendix I

Figure 1 - Cumulative Distribution Function of BMI z-scores by treatment and control groups among types

Source: Authors.

Figure 2 - Cumulative Distribution Function of HFA z-scores by treatment and control groups among types.

Source: Authors.
Figure 3 - Cumulative Distribution Function of BW in grams by treatment and control groups among types.

Source: Authors.
Appendix II

Table 7.6 - Tests for stochastic dominance (KS) of BMI z scores, HFA z scores and BW between treatment and control groups for each type

<table>
<thead>
<tr>
<th>Type</th>
<th>Null: Equality of Distributions</th>
<th>Null: Control FSD Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>zBMI P-value</td>
<td>zHFA P-value</td>
</tr>
<tr>
<td>Black parents</td>
<td>0.013</td>
<td>0.026</td>
</tr>
<tr>
<td>White parents</td>
<td>0.934</td>
<td>0.643</td>
</tr>
<tr>
<td>Parents without secondary education</td>
<td>0.051</td>
<td>0.245</td>
</tr>
<tr>
<td>Parents with secondary education</td>
<td>0.939</td>
<td>0.036</td>
</tr>
</tbody>
</table>

Source: Authors.

Appendix III

Table 7.7 - Covariates for QTE estimation per level and year

<table>
<thead>
<tr>
<th>Level</th>
<th>Variable</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household (from AIBF)</td>
<td>Number of children aged 0-15 at baseline</td>
<td>2005</td>
</tr>
<tr>
<td>Household (from AIBF)</td>
<td>Household size</td>
<td>2005</td>
</tr>
<tr>
<td>Household (from AIBF)</td>
<td>Housing quality index, from 0-11</td>
<td>2005</td>
</tr>
<tr>
<td>Household (from AIBF)</td>
<td>Log of per-capita monthly expenditure (food + nonfood)</td>
<td>2005</td>
</tr>
<tr>
<td>Household (from AIBF)</td>
<td>Whether head is illiterate</td>
<td>2005</td>
</tr>
<tr>
<td>Municipality</td>
<td>Average family size</td>
<td>2000</td>
</tr>
<tr>
<td>Municipality</td>
<td>Percent of population working without card</td>
<td>2000</td>
</tr>
<tr>
<td>Municipality</td>
<td>Percent of population working in agricultural sector</td>
<td>2000</td>
</tr>
<tr>
<td>Municipality</td>
<td>Percent of households with access to piped water</td>
<td>2000</td>
</tr>
<tr>
<td>Municipality</td>
<td>Percent of households with access to solid waste collection</td>
<td>2000</td>
</tr>
<tr>
<td>Municipality</td>
<td>Households with cell phones (per 1,000)</td>
<td>2000</td>
</tr>
<tr>
<td>Municipality</td>
<td>School attendance rate: 7-14 y.o.</td>
<td>2000</td>
</tr>
<tr>
<td>Municipality</td>
<td>Number of public schools per capita</td>
<td>2003</td>
</tr>
</tbody>
</table>