Droughts and Nutritional Status: The effects of Early childhood conditions on future income[*]

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Abstract

This paper studies the effects of exposure to nutritional adversities during early childhood on future labor income. Based on data from the 2010 Demographic Census and information from the Secretariat of Civil Defense of the Ministry of National Integration, individuals exposed to the drought that lasted from 1979 to 1984 during early childhood were selected to verify whether their labor income was affected, when in adulthood. The adoption of exposure to drought was due to the effects generated by it on nutrition and the exogeneity of climatic phenomena. A Propensity Score Matching (PSM) approach was used to estimate the mean effect of drought among individuals exposed to it. Two samples were selected, the first containing individuals born in the same locality, but at different periods, and another with individuals born in different localities, but in the same period. For the first sample, the results indicated that individuals exposed to drought presented lower mean income in the order of 40%, in relation to individual income, and around 60%, for household income, in relation to the control group. For the second sample, however, the results indicated higher mean incomes for treated, around 2%, for individual income, and 4% for household income.

Resumo

Este artigo estuda os efeitos da exposição a adversidades nutricionais durante a primeira infância sobre a renda futura do trabalho. Com base nos dados do Censo Demográfico de 2010 e informações da Secretaria de Defesa Civil do Ministério da Integração Nacional, foram selecionados indivíduos expostos à seca que durou de 1979 a 1984 na primeira infância para verificar se sua renda do trabalho foi afetada, quando em idade adulta. A adoção da exposição à seca deveu-se aos efeitos por ela gerados na nutrição e à exogeneidade dos fenômenos climáticos. Uma abordagem de Propensity Score Matching (PSM) foi usada para estimar o efeito médio da seca entre os indivíduos expostos a ela. Foram selecionadas duas amostras, a primeira contendo indivíduos nascidos na mesma localidade, mas em períodos diferentes, e outra com indivíduos nascidos em localidades diferentes, mas no mesmo período. Para a primeira amostra, os resultados indicaram que os indivíduos expostos à seca apresentaram renda média inferior na ordem de 40%, em relação à renda individual, e em torno de 60%, para renda familiar, em relação ao grupo controle. Para a segunda amostra, entretanto, os resultados indicaram rendimentos médios maiores para os tratados, em torno de 2%, para a renda individual, e 4% para a renda familiar.

Keywords: Early childhood, Future income, Drought, Brazil, Propensity Score

Palavras-Chave: Primeira Infância, Renda Futura, Seca, Brasil, Escore de Propensão

JEL Codes: I150, I260, J24

Area Anpec: *Economia Social e Demografia Econômica*

1. Introduction

Currently, there is a large literature that attributes to the care during early childhood, in particular, the nutritional care, the link between health investment and the development of human capital. Hoddinott et al. (2008) prove that the importance of investing in nutrition in early childhood in developing countries is substantial but indirect, and that this is a long-term economic investment.

According to Bleakley (2010), precarious health in childhood will impair the individual formation of human capital, decreasing income throughout life. Given that childhood is the basis of human capital formation, if the expected development does not occur in this period, the cognitive effect in adulthood will be irreparable.

In this sense, Hoddinott et al. (2008) point to the period between zero and two years of age as the most efficient for investing in nutrition, analyzing specifically the causality among children better nourished with their productivity and health status in adulthood, concluding that this is a positive and significant causality. According to Hoddinott et al. (2013), a diet deficient in specific nutrients throughout early childhood has profound and adverse consequences on the course of one's life. Specifically, growth retardation is a marker of systemic dysfunction during a sensitive phase of childhood development. This is because, at the same time that growth failure is occurring, the development and growth of other organ systems, including the brain and neurological development, are affected.

Thus, the nutritional and health conditions during the early life, which represents a critical period for the formation of abilities that will govern the future results obtained by this (CUNHA and HECKMAN, 2007), comprise one of the most important elements that will enable individuals to realize their potential and develop as social agents. Carneiro and Heckman (2003) and Cunha et al. (2005) indicate that the return on investment in human capital over the life cycle is decreasing, being higher in the first years. Therefore, the earlier you invest in human capital, the greater the potential for the positive impact of that investment and the greater the impact of later investments (of a higher level of sophistication).

Grossman and Kaester (1997) point out that the search for causality between childhood health and educational or labor market outcomes is the key to understanding the relationship between health and future individual outcomes, indicating that this is the greatest weakness of the empirical

work done so far. In addition to this difficulty, Currie and Vogl (2013) and Grantham-McGregor et al. (2007) question the ability of the government and parents of affected children to undo (or at least mitigate) the impacts of adverse shocks in the early stages of life, a situation which is of particular relevance to developing countries, especially where more than 200 million children are at risk of not reaching their full potential as a result of poverty-related adversities and other challenges.

Fay et al., (2015) argue that climate shocks are one of the main adversities faced by families in developing countries. Currie and Vogl (2013) and Rosales-Rueda (2016) further point out that children who experienced climatic shocks during early childhood, between zero and three years of age, had health, education, nutrition and cognitive development losses.

Following this previous literature, this paper aims to identify the effects of nutritional scarcity in early childhood on the future incomes of the individuals. Our analysis focus on Brazilian experience, and, specifically, on the Northeast region, a very dry region. In this region, people are frequently exposed to drought, which has had a direct impact on their nutritional status, especially newborns. Our empirical strategy is based on a Propensity Score Matching (PSM) estimator, considering the exogenous effect of the incidence of severe droughts, during the early 80's, in some of Brazilian municipalities. Using data from the Brazilian Demographic Census 2010, we define a treatment group composed of individuals exposed to a drought in the their early that is compared with a control group which includes individuals born in municipalities affect by the severe drought in early 80's, but in different years. The main findings bring new evidence of the relation between early childhood and long-term development of individual capacities, especially between early child health conditions and productivity in the adulthood.

2. The Brazilian Droughts

According to the American National Center for Drought Mitigation (NDMC), the phenomenon of drought occurs when there is a resident population in a region that presents water deficit. As a result, it can be said that as drought-related issues pervade the vulnerability of the population in question, in the Brazilian case, especially the Northeastern population. This vulnerability became explicit with a drastic drought of 1877, responsible for the death of half the population of the backlands, from when it is possible to observe substantial increase of the network of dams in the region. However, such an investment has not been able to mitigate the destructiveness of the effects of drought to a

population that is heavily affected to the present day.

Azevedo et al. (1998, apud Santana, 2015) characterize a semi-arid climate, under a climatological aspect, as space of high temporal and spatial variation of precipitation, with annual average temperatures high and constant and low levels of humidity. In addition, characteristics such as absence of perennial rivers, long periods of water shortage, shallow soils, rock outcropping and high evapotranspiration rates should be considered.

Molion and Bernardo (2002, apud SANTANA, 2015) emphasize that the Northeast region is subject to greater occurrence of weather and climate phenomena. An example of this is the phenomenon of El Niño, which, due to the abnormal increase in the waters of the Equatorial Pacific Ocean, is also responsible for reducing rainfall in the region, provoking dry/very dry years (Ferreira and Mello (2005, apud SANTANA, 2015).

The drought issue in Brazil is mainly related to the semi-arid climate regions that correspond to 1,133 municipalities, which is equivalent to approximately 20% of the total Brazilian municipalities and to an area of 969,589.4. The semi-arid region in Brazil is located in the Northeast region (just under 90% of its territory) and in the northern region of the state of Minas Gerais, covering 11% of the Brazilian population, that is, there are around 21 million people suffering from low level of socioeconomic development of the region, social indicators below regional and national averages and a precarious economic dynamism (SILVA, 2006).

Deepening the social question, we have the northeastern backlands as an area of epidemic hunger (that which manifests itself during climatic changes, wars, crises, etc.) occurring acutely during periods of drought. De Castro (1952, apud VASCONCELOS, 2008) contextualizes this definition, initially, clarifying that the feeding of the Northeastern population, when supplying the basic nutritional needs of an individual, without providing excesses or deficits, tends to be balanced quantitatively and qualitatively. However, it goes on to elucidate that such a balance has historically been subject to numerous disruptions due to the drought periods in which epidemic hunger was instituted when, in his words, the individual was suddenly subjected to an extremely restricted diet in terms of quantity and diversity of food. This was a situation that reached its climax several times when food was completely depleted, forcing the sertanejo to defend himself against undernourishment through unusual foods such as drought-resistant animals, roots, seeds, among others.

The drought from 1979 to 1984 was selected as the basis of this research because it was considered

the longest and most comprehensive drought in the Northeast region. According to SUDENE data, 3.5 million people died in the region, most of them children, who died as a result of famine in the region and due to maladies derived from malnutrition. A UNESCO survey found that 62% of the northeastern children, from zero to five years old, lived in rural areas, were living in acute malnutrition (CEPED, 2013).

The year 1979, according to SUDENE, was not affected by a widespread drought, but by the low rainfall recorded in the semi-arid region. This was enough to bring the fragile economy into the emergency situation, which, in turn, caused the social collapse described above (CAMPOS, 2004).

Campos (2004) reports the representative case of the state of Ceará in which numerous actions were taken by the government, but there were also many records that aid fronts benefited large landowners, with small and medium-sized landowners deprived of financial aid and without full access to infrastructure investments, such as construction of dams.

In the year 1980, according to Campos (2004), the drought took over the entire state, while the rains, because they concentrated in the month of February, made it impossible to harvest the crops. Already in 1981, the rains were concentrated in the month of March, being the harvest, again, compromised. The following year, 1982, was not marked by rainfall concentration in a single period, but by the low rainfall index, which made it impossible to accumulate water for the fourth consecutive year. This situation has led Sudene to begin the construction of cisterns and wells in order to provide greater democratization of the use of water by the population. The year 1983 was later considered the worst year of the period, since in many municipalities there was no agricultural production or water accumulation in the reservoirs, in addition to many dams having dried and the level of the water table having reduced considerably.

The rains returned late in 1984, after 34 municipalities had run out of water and the situation became even worse. In terms of social structure, the period was marked by countless crimes related to the invasion of private property, looting and abuses by large landowners. This experience has been characterized as traumatic for all spheres of society, with the drought phenomenon being understood as a case of social relevance superior to that lent to it in previous periods. In this context, the fatalistic view of the drought would be permanently replaced by a perspective of greater social relevance. (CAMPOS, 2004).

3. Methodology

3.1. Empirical Strategy

In order to identify the effects of adverse conditions during early childhood on their future incomes, it was decided to use the exposure of individuals to drought situations during the first years of their life. The choice of the use of droughts as a proxy for adversity is explained by a set of characteristic factors, namely:

1. The strategy of using adverse climatic phenomena to identify difficulties in terms of cognitive development of individuals in critical periods of training age is widely known in the literature (MACCINI and YANG, 2008);

2. Climatic phenomena are exogenous effects, that is, they are not correlated with other determinants of individual's skills training, so that problems of consistency of the estimates, when carried out procedures of statistical inference, are avoided;

3. Droughts constitute an adverse climatic phenomenon, being present in a considerable area of the Brazilian territory, named Drought Polygon (*Polígono da Seca)*, reaching 1,108,434.82 square kilometers, corresponding to approximately 13% of the national territory. In addition, nine states are included in the area of susceptibility to prolonged droughts;

4. The adverse effects of exposure to prolonged droughts on the health of individuals, especially through nutrition and exposure to sanitary diseases, are notable (CASTRO, 1980). In this way, once exposed to prolonged droughts, children can develop barriers to the acquisition of sanitary conditions fundamental to the development of skills that allow better future placements in the labor market and, consequently, better associated earnings;

Thus, exposure to prolonged drought seems to be an exogenous phenomenon, comprising a significant part of the universe of individuals in Brazil and therefore it is possible to use it as a differentiating factor between treatment and control groups to perform quasi-experiments that allow capture the effects of adversities along critical periods of skill formation, notably early childhood.

The methodological approach adopted to analyze this issue was the Propensity Score Matching (PSM), under the justification of the following two factors: i) ad hoc exposure of individuals affected by droughts, while the rest of the sample is arbitrarily defined outside the area of exposure to prolonged drought; and (ii) the need to compare the future results of individuals affected by drought

during early childhood with future results of those not affected, in a future period, especially when those individuals were already in the labor market.

To do so, a control group should be identified in the database that is as close as possible to the treatment group, considering as a measure of similarity a vector of observable variables, X, containing all the information about the potential outcome of the individual, if it has not suffered from drought during the period of skill training. The vector X is formed by the set of socioeconomic, demographic and health variables, presented in the previous section, that allow to control observable effects that may interfere with future individual income, such as gender, other sources of income other than the main job, disabilities others. In other words, the (observable) characteristics of the individuals who were and were not exposed to drought should be equivalent, allowing the verification of the effect produced by the drought on the individual capacities to earn income.

3.2. Database

The sample with which this study works contemplates 581,515 individuals distributed in 11 Brazilian states, of which nine represent the Northeast Region, Minas Gerais belongs to the Southeast Region and Paraná is the only state belonging to the Southern Region. The data come from the Demographic Census year of 2010, executed by the Brazilian Institute of Geography and Statistics (IBGE).

From the sample of the 2010 Census, made available by IBGE, the geographic cut of interest was defined. The largest number of Brazilian individuals periodically affected by the effects of drought is concentrated in the state of Bahia, followed by five other northeastern states, Pernambuco, Maranhão, Ceará, Paraíba and Piauí. Then there is the state of Minas Gerais followed by Sergipe, Rio Grande do Norte, Alagoas, and finally Paraná. In this context, it is worth mentioning that 82% of the sample, 474,088 individuals, resides in the Northeast Region as shown in Table 1.

Regarding the sample selection, the total sample was separated by two different samples (Sample 1 and Sample 2). Table 2 brings the detailed information about the treatment group and two different control groups.

In the first sample, named Sample 1, the treatment group is compared with individuals who were born in the same locality, but in different periods. While in the second one, Sample 2, the individuals

Table 1: Sample per states and regions

Region	state	Observations
Northeast	Bahia	172.721
	Sergipe	25.245
	Alagoas	21.482
	Pernambuco	84.394
	Paraíba	48.352
	Rio Grande do Norte	23.229
	Ceará	56.787
	Piauí	36.319
	Maranhão	75.515
Southeast	Minas Gerais	29.205
South	Paraná	8.266
	Total	581.515

Source: Brazilian Census (2010)

in the treatment group is compared with individuals that were born in different locations, but in the same period. It was decided to evaluate a second sample in order to eliminate a possible source of bias due to the learning of the population and local governments on how best to deal with the drought phenomenon. This is because, despite the idiosyncrasy of such phenomenon, it cannot be said that it does not keep a certain periodicity. Therefore, social improvements were expected to be implemented over the years. These improvements will hardly be captured by an econometric model, and, as robustness, we built an alternative control group in the Sample 2.

We estimate two models (Model I and Model II) for each of the samples (Sample 1 and Sample 2). The first model includes the dependent variables related to individual income (gross income from the main job and income in all jobs), whereas the second model includes the dependent variables related to household income (household income and household income per capita). Thus, using three distinct pairing techniques (Neighbor, Kernel and Radius), it was possible to compare the effect that the drought exerts on the incomes of the treatment and control groups.

Since the aim of this study was to verify the effects of nutritional adversities arising from exposure to drought conditions during early childhood, we considered variables that measured the individual and household labor income of the sampled workers when in adulthood. To do so, the 2010 Census provides a set of four variables that capture income from work, namely, Total household income in July 2010, Household income per capita in July 2010, Income in the main job and Income in other

Table 2: Samples Description

Sample 1		
Excluded Individuals	**Control Group**	**Treatment Group**
Individuals who in July / 2010 were between 30 and 35 years of age and were not born in municipalities affected by the drought from 1979 to 1984 during the period analyzed: between 1980 and 1984.	Individuals born in municipalities affected by the drought from 1979 to 1984, but because they were born in a period before or after the period analyzed (from 1980 to 1984), were not affected by it. Thus, these individuals are between 25 and 29 years of age or between 36 and 45 years old, including the date of the survey, July 2010	Individuals who were born between 1975 and 1980, therefore presenting between 30 and 35 years in July of 2010 (date of the research). In addition, such individuals were born in municipalities affected by the drought from 1979 to 1984 during the period analyzed, from 1980 to 1984.
268.933 observations	217.705 observations	94.877 observations
Sample 2		
Excluded Individuals	**Control Group**	**Treatment Group**
Individuals between the ages of 25 and 29 inclusive and between 36 and 45 years inclusive	Individuals aged between 30 and 35 years old who were not born in municipalities affected by the drought from 1979 to 1984 during the period analyzed, from 1980 to 1984	Individuals who were born between 1975 and 1980, therefore presenting between 30 and 35 years in July of 2010 (date of the research). In addition, such individuals were born in municipalities affected by the drought from 1979 to 1984 during the period analyzed, from 1980 to 1984.
217.705 observations	268.933 observations	94.877 observations

Source: Brazilian Census (2010).

Nota: Municípios do grupo Tratamento são aqueles com IPA de baixo risco para a malária (menor que 10) no ano de 1997 e que passaram a ser classificados como médio ou alto risco (IPA maior ou igual a 10) no ano de 2001.

jobs, all measures in monetary units.

The set of specified dependent variables operate as proxies for labor returns of the individuals in the sample, either in individual terms (Income in the main job and Income in other jobs), or in family terms (Total household income in July 2010, Household income per capita in July 2010). Thus, assuming that such measures can operate as metrics to capture the return from work activity of the individual, it is possible to verify possible effects produced by exposure to nutritional adversities occurred between the first and fifth years of life of the individuals in the sample

The set of explanatory variables included information contained in the 2010 Census question-naires, defined in order to control for determinants that may affect labor income, for example age, race, gender, schooling, and others.

4. Resultados

Tables 3 to 6 bring the results of propensity score estimation, considering sample 1 and sample 2 and two different models.

Table 3: Propensity Score test – Sample 1 – Model 1

Sample 1	Coef.	S.E.	z	P>z	[95% Int.	Conf.]
Sex	-0.002	0.007	-0.250	0.802	-0.015	0.011
Age	-0.047	0.001	-81.060	0.000	-0.048	-0.046
Mental dysfunction	0.002	0.045	0.050	0.964	-0.087	0.091
Permanent difficulty in seeing	0.050	0.093	0.530	0.594	-0.133	0.232
Monthly Earnings from others sources	0.046	0.023	1.990	0.046	0.001	0.091
White	0.012	0.029	0.390	0.695	-0.046	0.069
Black	0.031	0.030	1.020	0.307	-0.029	0.091
Brown	0.022	0.029	0.740	0.457	-0.035	0.079
Wealth	0.107	0.050	2.150	0.031	0.010	0.204
Incomplete Elementary Education	0.044	0.063	0.710	0.480	-0.079	0.168
lementary Education and Incomplete High -School	-0.055	0.063	-0.880	0.381	-0.179	0.068
High School and Incomplete Under graduation	-0.062	0.063	-0.990	0.321	-0.186	0.061
Under graduation	0.012	0.064	0.190	0.846	-0.112	0.137
Formal Employee	0.028	0.013	2.070	0.039	0.001	0.054
Military and Civil Servants	0.077	0.018	4.360	0.000	0.042	0.111
Informal employee	0.013	0.013	0.990	0.320	-0.012	0.037
Self-employee	0.017	0.013	1.310	0.189	-0.009	0.043
Employers	0.057	0.033	1.720	0.085	-0.008	0.121
Unpaid employee	-0.051	0.029	-1.760	0.079	-0.108	0.006
Maranhão	-0.001	0.010	-0.100	0.923	-0.020	0.018
Minas Gerais	0.003	0.011	0.250	0.800	-0.019	0.024
Paraíba	-0.001	0.013	-0.100	0.922	-0.026	0.024
Rio Grande do Norte	-0.073	0.050	-1.470	0.142	-0.170	0.024
Ceará	-0.004	0.017	-0.210	0.834	-0.036	0.029
Alagoas	0.010	0.030	0.320	0.748	-0.048	0.067
Piauí	-0.038	0.021	-1.820	0.069	-0.079	0.003
Sergipe	0.032	0.014	2.310	0.021	0.005	0.059
Pernambuco	0.006	0.010	0.630	0.527	-0.013	0.025
Paraná	-0.042	0.018	-2.340	0.020	-0.077	-0.007
Constant	0.964	0.079	12.270	0.000	0.810	11.182
Observations						184,531

Source: Author's elaboration

Table 7 brings the preliminary ATT (average treatment effects on the treated) estimates, for Sample 1, considering three different kinds of matching.

The results show that the mean income of individuals affected by the drought during early childhood is inferior to the mean income of non-exposed individuals. Considering the Neighbor method, the estimate of the average difference on the treated, when considered the main job, was minus R$

Table 4: Propensity Score test – Sample 1 – Model 2

Sample 1	Coef.	S.E.	z	P>z	[95% Int.	
Sex	0.007	0.005	1.450	0.146	-0.003	0.017
Age	-0.043	0.000	-91.470	0.000	-0.043	-0.042
Mental dysfunction	-0.011	0.019	-0.570	0.568	-0.048	0.026
Permanent difficulty in seeing	-0.009	0.065	-0.130	0.893	-0.136	0.119
Monthly Earnings from others sources	0.039	0.019	2.020	0.044	0.001	0.077
White	0.011	0.024	0.460	0.646	-0.036	0.058
Black	0.02 6	0.025	1.060	0.287	-0.022	0.075
Brown	0.013	0.024	0.550	0.580	-0.033	0.059
Wealth	0.134	0.038	3.510	0.000	0.059	0.208
Incomplete Elementary Education	0.085	0.050	1.710	0.087	-0.012	0.183
Elementary Education and Incomplete High -School	-0.016	0.050	-0.320	0.749	-0.114	0.082
High School and Incomplete Under graduation	-0.014	0.050	-0.280	0.777	-0.112	0.083
Under graduation	0.078	0.051	1.550	0.122	-0.021	0.178
Maranhão	0.008	0.008	1.020	0.309	-0.007	0.024
Minas Gerais	0.018	0.009	1.970	0.049	0.000	0.036
Paraíba	-0.004	0.010	-0.410	0.682	-0.024	0.016
Rio Grande do Norte	-0.040	0.037	-1.080	0.280	-0.114	0.033
Ceará	0.011	0.013	0.840	0.403	-0.015	0.038
Alagoas	0.018	0.023	0.780	0.437	-0.027	0.062
Piauí	-0.027	0.016	-1.660	0.096	-0.059	0.005
Sergipe	0.029	0.011	2.700	0.007	0.008	0.051
Pernambuco	0.017	0.008	2.190	0.028	0.002	0.032
Paraná	-0.031	0.016	-1.980	0.048	-0.062	0.000
Constant	0.746	0.062	12.000	0.000	0.624	0.868
Observations						279,317

Source: Author's elaboration

395.56. Thus, on average, there is evidence that workers exposed to drought conditions in the sample during early childhood show lower labor incomes than those not exposed, in the order of R$ 400. Such a result is in line with that expected and in accordance with the literature (e.g. MACCINI and YANG, 2008). In relation to the dependent variable that considers the income of all the individual's jobs, in 99% confidence, the estimate obtained was R$-430,58, so that individuals exposed to drought in early childhood present average incomes lower than those not exposed. These findings suggest that there are negative effects of exposure to nutritional adversities in early childhood, as the water scarcity in the first childhood tend to affect future incomes of the individuals.

The estimates from Kernel and Radius pairing techniques, in relation to Model I, did not present statistical significance at traditional levels.

In the Model II estimates, the income sensitivity of the individuals, now in household terms,

Table 5: Propensity Score test – Sample 2 – Model 1

Sample 1	Coef.	S.E.	z	P>z	[95% Int.	Conf.]
Sex	-0.004	0.007	-0.600	0.548	-0.018	0.009
Age	0.003	0.002	1.520	0.128	-0.001	0.007
Mental dysfunction	-0.041	0.047	-0.870	0.384	-0.134	0.051
Permanent difficulty in seeing	0.103	0.098	1.050	0.292	-0.089	0.294
Monthly Earnings from others sources	0.030	0.025	1.220	0.224	-0.018	0.078
White	0.292	0.028	10.370	0.000	0.237	0.347
Black	0.058	0.029	1.970	0.048	0.000	0.115
Brown	0.209	0.028	7.530	0.000	0.155	0.264
Wealth	0.180	0.051	3.530	0.000	0.080	0.281
Incomplete Elementary Education	0.002	0.064	0.040	0.971	-0.123	0.128
Elementary Education and Incomplete High -School	-0.016	0.064	-0.250	0.799	-0.143	0.110
High School and Incomplete Under graduation	-0.032	0.064	-0.500	0.619	-0.158	0.094
Under graduation	-0.009	0.065	-0.140	0.891	-0.136	0.118
Formal Employee	-0.103	0.014	-7.480	0.000	-0.130	-0.076
Military and Civil Servants	-0.092	0.018	-5.000	0.000	-0.128	-0.056
Informal employee	-0.042	0.013	-3.220	0.001	-0.067	-0.016
Self-employee	-0.078	0.014	-5.720	0.000	-0.104	-0.051
Employers	-0.003	0.037	-0.080	0.939	-0.075	0.069
Unpaid employee	-0.041	0.031	-1.330	0.183	-0.101	0.019
Maranhão	0.049	0.011	4.630	0.000	0.028	0.070
Minas Gerais	0.000	(Omitted)				
Paraíba	-0.492	0.012	-42.280	0.000	-0.515	-0.469
Rio Grande do Norte	-1.846	0.028	-66.770	0.000	-1.900	-1.792
Ceará	-1.116	0.012	-90.220	0.000	-1.140	-1.092
Alagoas	-1.221	0.020	-60.870	0.000	-1.260	-1.181
Piauí	-0.967	0.016	-60.810	0.000	-0.998	-0.936
Sergipe	0.162	0.015	10.740	0.000	0.133	0.192
Pernambuco	-0.255	0.009	-26.940	0.000	-0.273	-0.236
Paraná	0.000	(Omitted)				
Constant	-0.675	0.098	-6.870	0.000	-0.868	-0.483
Observations						200,557

Source: Author's elaboration

presented results convergent to those verified in the theoretical and empirical literature (e.g. HOD-DINOTT et al., 2008; GROSSMAN, 1972), considering the pairing by the nearest neighbor. The estimate of the average effect that the drought exerted between the control and treatment groups for the total household income, when the matching was done by the Neighbor method, was of R$ -1,769.55, at a significance level of 1%. When considering the per capita household income, the estimate of the difference between the means of the groups in comparison showed a negative value of R $ 756.41, at a confidence level of 99%. In this way, it can be said that there is evidence that the household income of individuals exposed to nutritional adversities caused by periods of drought during early childhood is lower in average terms than the household income of individuals not affected by such situation.

The results of the estimations that had by pairing method the Kernel approach, similarly to

Table 6: Propensity Score test – Sample 2 – Model 2

Sample 1	Coef.	S.E.	z	P>z	[95% Int.	
Sex	0.000	0.005	0.000	1	-0.010	0.010
Age	0.002	0.002	1.550	0.122	-0.001	0.005
Mental dysfunction	-0.009	0.019	-0.480	0.631	-0.047	0.029
Permanent difficulty in seeing	-0.007	0.068	-0.110	0.916	-0.139	0.125
Monthly Earnings from others sources	0.027	0.021	1.290	0.197	-0.014	0.067
White	0.267	0.023	11.720	0.000	0.222	0.312
Black	0.030	0.024	1.250	0.210	-0.017	0.076
Brown	0.169	0.022	7.530	0.000	0.125	0.213
Wealth	0.080	0.039	2.050	0.041	0.003	0.157
Incomplete Elementary Education	0.042	0.051	0.830	0.405	-0.057	0.141
ementary Education and Incomplete High -School	0.009	0.051	0.170	0.861	-0.091	0.109
High School and Incomplete Under graduation	0.003	0.051	0.050	0.959	-0.097	0.102
Under graduation	0.037	0.052	0.720	0.470	-0.064	0.138
Maranhão	0.006	0.008	0.650	0.517	-0.011	0.022
Minas Gerais	0.000	(Omitted)				
Paraíba	-0.519	0.009	-55.050	0.000	-0.538	-0.501
Rio Grande do Norte	-1.801	0.021	-85.060	0.000	-1.842	-1.759
Ceará	-1.115	0.010	-111.480	0.000	-1.135	-1.096
Alagoas	-1.191	0.016	-76.570	0.000	-1.222	-1.161
Piauí	-0.957	0.013	-75.680	0.000	-0.982	-0.932
Sergipe	0.203	0.012	16.540	0.000	0.179	0.227
Pernambuco	-0.301	0.008	-39.350	0.000	-0.316	-0.286
Paraná	0.000	(Omitted)				
Constant	-0.665	0.078	-8.520	0.000	-0.817	-0.512
Observations						310,693

Source: Author's elaboration

the results seen in the Model I estimation, did not present statistical significance at traditional levels. Positive estimates, in this case, do not indicate positive effects of exposure to drought in early childhood on labor income. Thus, through this pairing technique, it is not possible to establish a relationship between future household income of workers and the conditions of nutritional adversity experienced during early childhood.

When considering the estimates using the Radius method, the mean treatment effect calculated was -51.23, in monetary units, for the total household income. The level of significance was 5%. However, when the per capita household income was considered, the parameter estimated for the average effect of the drought, although bearer of negative signal, as expected, did not present any significance at traditional levels. Thus, although there is evidence of a negative relationship between household income and exposure to nutritional adversities in early childhood, it cannot be said that

Table 7: Average Treatment Effects on the Treated (ATT) – Sample 1

Sample 1 Model I - 184.531 observations			
	Neighbor	Kernel	Radius
Main Job income (Reais)	**-395.56*****	14.00	0.40
t statistic	-5.34	1.52	0.08
All Job income (Reais)	**-430.58*****	11.72	0.54
t statistic	-5.35	1.20	0.10

Sample 1 Model II - 279.317 observations			
	Neighbor	Kernel	Radius
Household income (Brazilian Reais)	**-1769.55*****	3.74	**-51.23****
t statistic	-4.72	0.19	-4.34
Household per capita income (Brazilian Reais)	**-756.41*****	6.43	-6.74
t statistic	-7.47	1.07	-1.77

Source: Author's elaboration
Note: ***significant at 1%, **significant at 5%, *significant at 10%

this is valid in terms of household income per individual, when considered the pairing Radius method. The results of the estimates of the mean treatment effect when considering the sample composed of individuals residing in different municipalities, but born in the same period, control 2, are presented in Table 8. For Model I, which considers income variables at the individual level, the calculated mean difference in earnings between the control and treatment groups, for the cases in which the pairing was performed by the Kernel and Neighbor methods, showed a positive estimated signal, indicating a counter intuitive relation. However, at traditional levels of significance, all estimates presented coefficients estimated as zero, so that there was no evidence of a significant relationship between individual income and exposure to drought during early childhood.

But, the results of the Radius technique estimates were significant at 5%. However, the positive sign of both estimates suggests that individuals exposed to drought in early childhood had higher future results in the labor market. The magnitude of the difference calculated for income in the main job was R$ 12.99, while the estimated difference for income in all jobs was R $ 13.08.

A similar result can be verified when considering household income. However, for this case, the estimates were significant, in 1%, in all types of pairings. For the Neighbor type pairing, and estimation of the mean treatment effect, it was indicated that, on average, there is evidence that

Table 8: Average Treatment Effects on the Treated (ATT) – Sample 2

Sample 2 Model I - 200.557 observations			
	Neighbor	Kernel	Radius
Main Job income (Reais)	10.74	4.68	**12.99****
t statistic	1.56	0.73	2.36
All Job income (Reais)	10.03	4.96	**13.08****
t statistic	1.35	0.72	2.24

Sample 2 Model II - 310.693 observations			
	Neighbor	Kernel	Radius
Household income (Brazilian Reais)	**67.30*****	**40.33*****	**62.56*****
t statistic	4.64	3.08	5.84
Household per capita income (Brazilian Reais)	**15.68*****	**10.38*****	**18.27*****
t statistic	3.31	2.5	5.31

Source: Author's elaboration
Note: ***significant at 1%, **significant at 5%, *significant at 10%

individuals exposed to drought in early childhood presented higher incomes, in R$ 67.3 compared to non-exposed individuals, considering household income total. For the case where per capita household income is considered, exposure to drought positively affects average incomes, there an effect of R$ 15.68.

On the other hand, in the kernel pairing method, the positive effect of exposure to drought is appreciably attenuated. Considering the total household income, the average difference calculated is R$ 40.33, while a value of R$ 10.38 was verified for household income per capita.

Radius pairing, when achieving the estimation of the mean treatment effect, produced higher estimates than those obtained when the pairing was obtained through the other two approaches. The total household income of individuals exposed to nutritional adversities was higher than those verified for untreated individuals at R$ 62.56. In turn, in per capita terms, the difference reached R$ 18.27.

All the estimates obtained for the mean effect of exposure to drought in early childhood for the sample composed of individuals born in the same period and in different locations were positive, with mean differences statistically significant for all pairing approaches for household income and, in turn, for individual income under the radius technique. Thus, it can be affirmed that there is evidence that exposure to drought in early childhood produces positive results on the future job income for

individuals exposed to droughts when compared with the control group 2.

In summary, the results obtained by the estimates of the mean treatment effects, presented in Table 7 and Table 8, indicate a divergent result when considering the two different control groups. Regarding the control group 1, which refers to individuals born in the same location, but in different periods, it presented expected results. All significant coefficients for the mean difference between groups of individuals exposed or not exposed to drought during early childhood indicated that those exposed to nutritional adversities had an average individual income about 40% lower than their counterparts. Likewise, the average family income showed a reduction between 55% and 66%, for the total and per capita family income, respectively, for the individuals served. The results are convergent with those found in the literature (for example, CURRIE, 2009).

The results regarding sample 2, which control group considers individuals born in different municipalities, but in the same year, however, presented non-intuitive results. Estimates of the mean effect of exposure to drought in early childhood, both in the specification that considers individual income and in that which specifies household income, presented a positive signal, although of a magnitude considerably lower than those observed for control group in sample 1. The coefficients of statistically significant differences showed a positive difference between 2% and 5%, in all approaches.

The divergence between the results of the mean effects of treatment on the treated between the two samples may be related to the characteristics of the samples in question. Bozzoli, Deaton and Quintana-Domeque (2007) attribute to the existence of a self-selection effect the possibility of finding different results among groups of individuals arranged in different locations.

In this sense, since control group 2 refers to individuals born in equal periods, but in different locations, a selection effect can be attributed among individuals exposed to drought. The sample considers individuals born in different localities, but in the same year, so that the incidence of drought occurred in only some of the localities defined in the sample, reaching only the treatment group in early childhood. In these localities, since the incidence of drought has produced adversities, even with high infant mortality (with about 3.5 million deaths, mostly children), it is possible to attribute a selection effect to these individuals, so that, similarly to what occurred in terms of adult height, for the individuals in the Bozzoli, Deaton and Quintana-Domeque (2007) sample, they had the selection effect, such that their future labor income respond positively effects of drought.

5. Conclusions

This study aims to analyze the impact of drought on the future incomes of those affected by it during early childhood. It is understood that nutritional adversities experienced at periods sensitive to the skills training of individuals, especially early childhood, tend to negatively affect the development of the skills necessary for the professional development of the individual in adulthood. Therefore, labor returns, measured through labor income, would suffer negative impacts compared to those not exposed to such adversities. The occurrence of periods of drought appears to be a climatic adversity that directly affects the nutritional supply of individuals, leading to an adverse shock capable of compromising future results in terms of income from work.

The results show that, for the sample that includes individuals born in the same locality, but in different periods, individuals exposed to drought in early childhood presented, when the pairing method followed the neighbor approach, individual average incomes in the main job and in all the jobss below those not exposed on the order of, respectively, 38.25% and 39.17%. When considering household incomes, the mean difference presented lower values at 54.98% for total household income and 66.28% for household income per capita. For the estimation that had by pairing method the radius approach, only negative difference of 3.42% was verified for the difference between the total household incomes.

The mean differences estimated for the sample that considered individuals born in different locations, but in equal periods, presented statistically significant results for all three pairing methods. The signs were positive, indicating that individuals exposed to drought in early childhood had higher mean returns than those observed in their counterparts, between 2% and 5%. This result, although counter intuitive, can be explained by the existence of a selection effect, which causes individuals exposed to adversities to present higher than expected results because they have a set of unobserved characteristics that dominate the negative effects of drought exposure.

This work contributed to the empirical literature on the effects of nutritional adversities during early childhood on future incomes of the individuals, a phenomenon still little studied for Brazilian data, with results partially convergent with those verified in the international literature. In addition, the counterintuitive results verified in the estimation of the mean treatment effect of the second sample open the way for studies that consider the effect of the selection of individuals exposed to nutritional adversities on future earnings.

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