The weight of food inflation in the Brazilian Semiarid[1]

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Abstract: This study investigates the influence of food inflation on birth outcomes within Brazil's semiarid region, leveraging individual-level data from eight million births from 2000 to 2023. Utilizing exogenous fluctuations in local food inflation, we identify a robust relationship between heightened local food inflation and worse newborn health indicators. These effects are primarily attributed to the vulnerability of less educated mothers, contrasting with the absence of any discernible impact on their more educated counterparts. Among the less educated, the effects are further heightened if the mother is unmarried. The timing of exposure to food inflation is crucial; specifically, exposure during the second and last trimesters of pregnancy correlates with reduced newborn health outcomes, while higher food inflation in the first trimester shows no impact. These findings remain consistent across various metrics of birth health outcomes, excluding the COVID outbreak period and different econometric specifications. Despite existing efforts and social safety nets, higher food prices disproportionately impact disadvantaged mothers in climate-vulnerable areas in Brazil.

Keywords: Food inflation, birth outcomes, climate-vulnerable areas.

JEL: Q18, Q54, I15.

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[1] The authors are grateful to Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for funding this work.

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1. Introduction

Food inflation has been linked to various consequences, including increases in the number of strikes (Bellemare, 2015) and political instability (Arezki and Bruckner, 2011), as well as a higher incidence of obesity among women in developing countries (Conklin et al., 2019). However, literature and public policy are primarily concerned with the potential impact of food inflation on making the lives of the poorest populations worse. In this paper, we investigate the impact of food inflation on birth outcomes in Brazil's semiarid region, one of the poorest and most climate-vulnerable areas in the country. To do so, we leverage an individual-level database of newborns spanning from 2000 to 2023, which we link with local food inflation of the three most consumed food groups by the region's poorest individuals (Cereals, legumes, and oilseeds; Flours, starches, and pasta; Baked goods).

The mother's environment influences birth weight and other newborn health outcomes. Fetal exposure to stressors like climate shocks, conflicts, and economic fluctuations can negatively impact neonatal development. Research in this area has highlighted instances where fetal health is compromised due to exposure to extreme heat (Dêschenes et al., 2009; Andalon et al., 2016; Chen et al., 2020), environmental disasters (Oliveira et al., 2020; Carrillo et al., 2020), and prenatal psychological stress from terrorism (Camacho, 2008), among other factors.

When examining maternal nutrition, Almond and Mazumder (2011) identified a correlation between fasting during Ramadan and a decrease in birth weight. Much of the literature exploring the relationship between food inflation (or prices) and newborn health outcomes focuses on low- or middle-income countries. For example, studies by Woldemichael et al. (2022) and Kidane and Woldemichael (2020) were conducted in Ethiopia. The underlying premise is that individuals experiencing poverty are more vulnerable to food price fluctuations, which can lead to food insecurity and hunger. Conversely, in developed countries, higher food prices can also contribute to worsened outcomes by leading to a decline in nutritional status and reduced dietary diversity (Brinkman et al., 2010).

Our study centers on the Brazilian semiarid, a region with comparatively lower development levels than the national average. Therefore, the premise suggests that infants in the Brazilian semiarid are particularly vulnerable to the effects of food inflation. These concerns are magnified by Brazil's recent experience of surging food inflation. Between January 2020 and

January 2023, the food category within the National Consumer Price Index (IPCA), as the Brazilian Institute of Geography and Statistics (IBGE) reported, increased by nearly forty percent.

By leveraging exogenous variation in local food inflation rates, we examine their impact on the birth outcomes of mothers residing in Brazil's semiarid region. Our empirical strategy involves three steps. First, we construct a food inflation index tailored to the poorest inhabitants of the semiarid region[6]. Second, we match this specific local food inflation index with the city of residence of the mothers and the month-year when the child was born. Third, we regress birth outcomes against food inflation while controlling for several mother characteristics (such as marital status and schooling), characteristics of the pregnancy (child gender), year-fixed effects, city-fixed effects, and interaction between city and month.

Our findings indicate that mothers with greater exposure to elevated food inflation during pregnancy experienced poorer birth outcomes. Exposure to the highest decile of food inflation – representing an average increase of eighteen percentage points during the final trimester – resulted in an average reduction of 2.1 grams in birth weight and a 1.8% increase in the likelihood of delivering a low-weight child compared to mothers who encountered no food inflation during this period. For less educated mothers, the probability of delivering a low-weight child increased by 2.7% when exposed to an inflation rate of eighteen percentage points, compared to mothers with no food inflation exposure. The average reduction in birth weight was approximately 5.2 grams among the less educated mothers. Within this group, the two-parent privilege plays a significant role in birth weight outcomes, as being unmarried is associated with an even greater birth weight loss, amounting to 6.2 grams, when exposed to an 18% in-utero inflation rate in the last trimester of pregnancy.

Higher food inflation did not impact birth outcomes among the most educated mothers. Note that specifying the trimester of exposure is crucial for qualifying the computed impact. Across almost all estimates, food inflation exhibits significance during the last trimester of pregnancy, while in some cases, it is significant during the second trimester. However, in almost none of the estimates, food inflation is significant during the first trimester of pregnancy. Altogether,

[6] The methodology for creating our food index is detailed in the third section of this paper.

these results suggest a robust effect of food inflation on newborn outcomes, with the effects being particularly severe for mothers experiencing poverty and those who are unmarried.

Newborn health is highly vulnerable to shocks during pregnancy, with consequences that extend beyond the immediate term, including long-lasting and intergenerational effects such as lower earnings and reduced human capital accumulation (Behrman and Rosenzweig, 2004). Consequently, our results have significant policy implications for mitigating intergenerational poverty. First, we identify which mothers are most vulnerable to food inflation, and second, we specify the timing during which newborns are most affected by it. It provides a roadmap for improving the social safety net, mainly focusing on the second and last trimesters of pregnancy when food inflation increases. Evidence demonstrates that an enhanced social safety net can lead to better newborn outcomes. For instance, Amarante et al. (2016) found that generous cash transfers to impoverished pregnant women accelerated intrauterine growth in Uruguay. Our paper emphasizes the importance of implementing similar initiatives in the semiarid zone of Brazil.

Food inflation exerts an exogenous influence on birth outcomes and the decision to initiate or maintain a pregnancy (Almond et al., 2011; Kidane and Woldemichael, 2020). Given the price level before pregnancy, fluctuations in food prices are typically unpredictable, surprising both economists and expectant mothers. As highlighted by Cruces et al. (2012) in their examination of economic crises in Argentina and their impact on newborn health outcomes, there is limited scope for a third variable to be causing the estimated relationships between macroeconomic variations and newborn health outcomes. In our case, a potential third variable could be government action in providing health services. However, no credible evidence suggests a correlation between food inflation and declining health services. Following the COVID outbreak, food prices skyrocketed, and health services became overwhelmed due to increased demand. Hence, the negative effect of food inflation on birth outcomes could be driven by worsened health services due to the pandemic period rather than solely due to food inflation. We excluded the post-COVID cohort as a robustness check to address this potential confound, yet the results remained consistent. In summary, our conditional correlations are robust even though we cannot claim a causal relationship.

Our paper builds upon prior research that explores the relationship between in-utero factors and children's health outcomes. For instance, Currie et al. (2022) and Koppensteiner and Manacorda

(2016) have explored the impact of exposure to violence on birth outcomes, while Koppensteiner and Menezes (2023) have focused on the effect of dengue infection. We are closely aligned with literature examining the association between economic fluctuations and birth outcomes. Bozzoli and Quintana-Domeque (2014) and Cruces et al. (2012) investigated the impact of the Argentina Economic Crisis on birth outcomes. Additionally, Bhalotra (2010) examined how economic fluctuations affect infant mortality in India. However, our study is mainly connected to research that links price fluctuations with birth outcomes. Notable works in this area include Kidane and Woldemichael (2020), Grace et al. (2014), and Headey and Ruel (2023).

Following this introduction, the subsequent section of this paper provides background information, presenting stylized facts about the Brazilian semiarid region. Following this, we delve into an explanation of our data sources and empirical strategy. The subsequent section presents our results, which are compared with existing literature. Finally, we conclude the paper in the last section, offering insights and policy implications from our findings.

2. The Brazilian Semiarid: Socioeconomic Features and Dietary Patterns

The Brazilian Semiarid region spans approximately 18.2% of the national territory, covering 1.563 million square kilometers and including 1,477 municipalities as of the 2024 delineation (Brasil, 2024). This region is home to around 27 million people, accounting for 13% of Brazil's population (IBGE, 2024). The Semiarid faces significant water shortages due to intense sunlight, high temperatures, and a concentrated rainfall pattern lasting three to four months (Silva et al., 2010). This water scarcity contributes to lower development levels in the region. As of 2010, the latest year for which municipal human development index data is available in 2024, no city in the Brazilian Semiarid region had a higher human development index than the Brazilian national average (IBGE, 2010).

The semiarid zone exhibits higher poverty rates and a greater concentration of population in rural areas than the rest of the country. Figure 1a illustrates the number of individuals receiving Bolsa Família, a primary poverty alleviation initiative in Brazil, relative to the total population in municipalities within the semiarid zone and the rest of the country. To qualify for the program, individuals must fall below the poverty line in Brazil. Thus, Figure 1a highlights that, on average, cities in the semiarid zone have a higher relative number of people experiencing poverty. In Figure 1b, we analyzed the proportion of households in rural areas for each city in Brazil using data from the Brazilian Census of 2010. The analysis shows that the semiarid zone has a higher proportion of people living in rural areas.

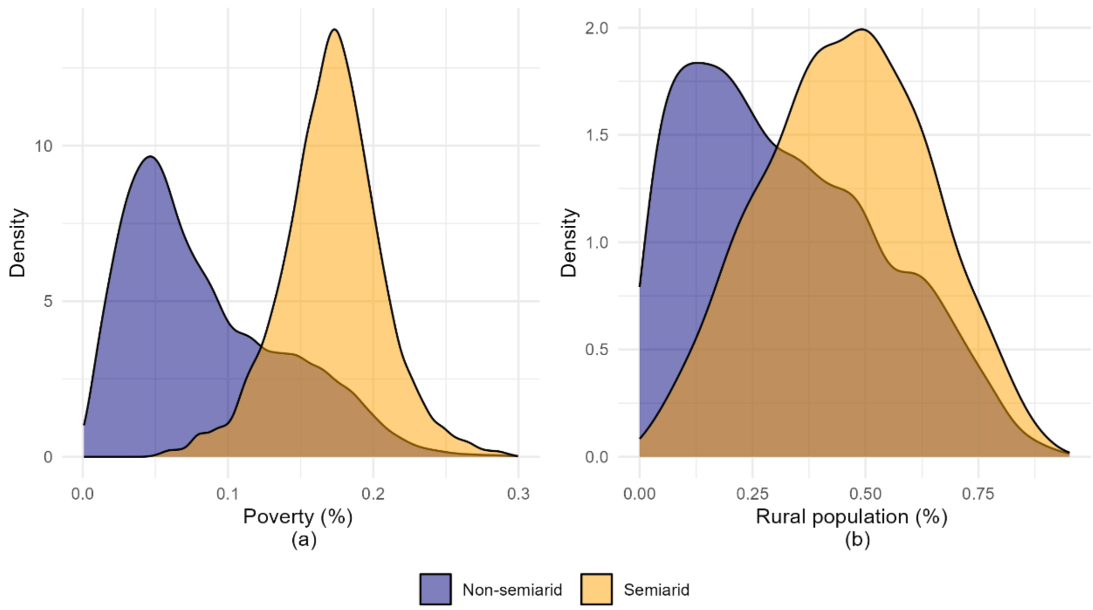

Figure 1- *Proxy for Poverty and Rural Household Distribution. Figure (a) depicts the share of adults receiving Bolsa Família benefits relative to the total population (2013-2021). This data reflects the proportion of adults benefiting from Bolsa Família in each municipality in Brazil, recorded monthly from 2013 to 2021 (Source: Brasil, 2024b). Actual poverty rates may be higher because we calculate poverty rates based on the number of adults receiving Bolsa Família divided by the total population; poverty faced by children is ignored. Figure (b) illustrates the proportion of households in rural areas relative to the total households in 2010 (Source: Brasil, 2010).*

We can continue comparing numerous social indicators of the semiarid region with the rest of Brazil. However, the consistent pattern of worse-off indicators in the semiarid zone persists across various indicators and over time.

Regarding dietary patterns, we lack city-level food consumption surveys in Brazil with sufficient granularity to provide insights specific to the semiarid zone. Our best proxy for this analysis is to examine food consumption patterns in the Northeast Region of Brazil, where most municipalities in the Brazilian Semiarid are located. In this region, individuals in the very low,

low, and lower-middle-income classes typically allocate over 20% of their budget to food expenditures (refer to Figure 2).

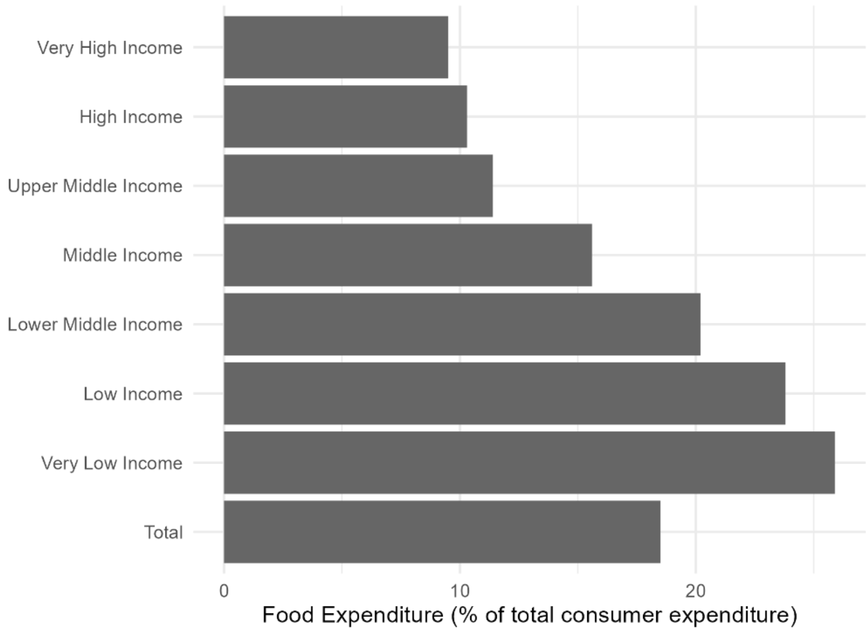

Figure 2 *- Share of Expenditure on Food as a Percentage of Total Consumer Expenditure in the Northeast Region of Brazil, based on data from the Consumer Expenditure Survey (POF 2017/2018). Income classes are defined as follows: Very Low Income (up to 1,908 BRL), Low Income (1,908 to 2,862 BRL), Lower Middle Income (2,862 to 5,724 BRL), Middle Income (5,724 to 9,540 BRL), Upper Middle Income (9,540 to 14,310 BRL), High Income (14,310 to 23,850 BRL), Very High Income (over 23,850 BRL). In 2018, the exchange rate was 1 USD = 4 BRL.*

In the lowest-income quartile in Brazil, rice, beans, and bread are the most consumed foods. In the Northeast Region, maize is also a significant part of this group. Therefore, we constructed our *food inflation (FI) variable* based on the average prices of three food groups: cereals, legumes, and oilseeds; flours, starches, and pasta; and baked goods, which encompass these staple items. The aim is to prioritize food prices most commonly consumed by mothers facing poverty in the semiarid zone[7].

[7] Please refer to the following section for more details on our rationale behind constructing the food inflation variable.

3. Data and Empirical Strategy

We quantify the impact of food inflation on birth outcomes using Equation 1.

$$Y_{i,c,z,t} = \beta_q * FI_{c,z,t} + G_i + MO_i + MS_i + ME_i + C_c + Z_z + T_t + C_c * M_m + \epsilon_{i,c,z,t} \quad (1)$$

Where $Y_{i,c,z,t}$ represents the birth weight in grams (or another newborn outcome) of each child (i) born in a month (z), year (t), and with the mother residing in the city (c). We collected this indicator, along with all mother-related indicators (mother's occupation (MO_i), marital status (MS_i), mother's education (ME_i)), from the Live Birth Information System (*Sistema de Informações sobre Nascidos Vivos*, SINASC, in Portuguese) published by the Brazilian Ministry of Health[8].

We measure food inflation (FI) using the monthly fluctuations of the IPCA, Brazil's official inflation index. Our selection of food groups – cereals, legumes, and oilseeds; flours, starches, and pasta; and baked goods – is informed by insights from the Consumer Expenditure Survey (POF 2017/2018), which identified rice, beans, corn, and bread as staples in the diet of the poorest quarter in the Brazilian Northeast. To calculate our local food inflation variation, we follow three steps. First, we average the food inflation of the three food groups to derive a monthly variation for our basket. Second, we compute the average variation for each trimester of pregnancy as follows:

- Food inflation in the last trimester of pregnancy: The average inflation of our basket for the three months leading up to the child's birth;
- Food inflation in the second trimester: The average inflation of our basket between the sixth and third months before the child's birth;
- Food inflation in the first trimester of pregnancy: The average food inflation of our basket between the ninth and sixth months before the child's birth.

Therefore, we have computed a food inflation variable for the three metropolitan regions surveyed in the IPCA. Figure 3 illustrates that food inflation exceeded thirty percent in

[8] Microdata on child health outcomes is published by the Brazilian Ministry of Health (website). However, for further analysis, accessing the data through the *Base dos Dados* website is recommended.

Salvador, Bahia. Typically, the upper decile of our food inflation shows variations around eighteen percent.

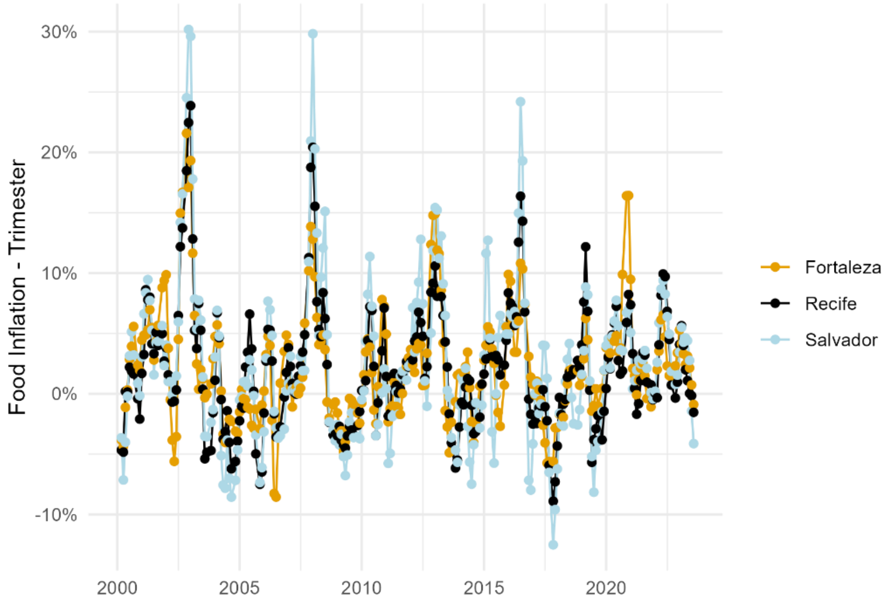

Figure 3 *– Average Trimester Food Price Inflation for Selected Goods in Three Brazilian Metropolitan Regions (Fortaleza, Recife, and Salvador). Data from January 2000 to January 2023, sourced by the National Consumer Price Index (IPCA) from the Brazilian Institute of Geography and Statistics (IBGE).*

Food inflation varies regionally but is not explicitly measured for each municipality in the semiarid zone. Instead, drawing from regional economics concepts, we posit that the food inflation experienced by city (i) can be approximated by the food inflation in the nearest metropolitan region. In short, the proxy for food inflation data encountered by each child (i) during each in-utero trimester corresponds to the food inflation of the nearest metropolitan region to the mother's residence, determined by Euclidean distance. This approach results in three distinct influence zones within the Brazilian Semiarid, where the food inflation of each municipality depends on its proximity to either Salvador, Recife, or Fortaleza. Please refer to Figure 4 for a map illustrating these influence zones.

Equation 1 enables us to estimate a distinct effect for each trimester of pregnancy (q=1, 2, 3). Our parameter of interest, β_q, quantifies the impact of fetal exposure to food inflation during a specific trimester of pregnancy. In addition to the regular fixed effects (month, year, and city), we include an interaction term ($C_c * M_m$) to account for the potential influence a specific month in a particular city may have on birth outcomes. Given the possibility of seasonal variation in birth outcomes, this interaction is particularly important in the Brazilian Semiarid, especially when comparing drought months to non-drought months (Rocha and Soares, 2015).

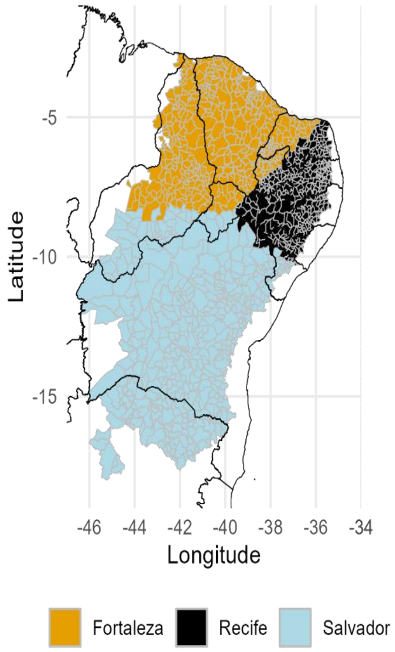

***Figure 4** – Influence zones regarding food prices in each city of the Brazilian Semiarid. The figure displays the spatial nearest neighbor match. Cities shaded in light blue are those closest to the Salvador Metropolitan Region, cities shaded in black are closest to Recife, and cities shaded in dark orange are closest to Fortaleza.*

***Table 1** – Summary Statistics*

Variable	Mean	Std	Max	Min	N
Birth Weight (g)	3219.97	556.58	9999	0	8,815,711
Low Birth	0.08	0.26	1	0	8,815,711
Food Inflation (T1)	2.34	5.68	30.17	-12.51	8,537,314
Food Inflation (T2)	2.35	5.77	30.17	-12.51	8,656,732
Food Inflation (T3)	2.29	5.62	30.17	-12.51	8,781,770
City	2593510.88	285,499	3,171,600	2,100,907	8,858,290
Month	6.05	3.37	12	1	8,858,290
Year	2,010.66	6.77	2023	2000	8,858,290
Mother Schooling	3.50	1.19	9	0	8,635,566
Marital Status	2.11	1.59	9	1	8,741,791
Gender	0.49	0.50	1	0	8,858,290
Mother Occupation	532550.41	375221.62	999994.00	8.00	6,754,127
Week of Gestation	38.57	2.38	46	3	4,151,801

***Notes:** Authors' elaboration using data from the Brazilian Ministry of Health, specifically the Sistema de Informação sobre Nascidos Vivos (SINASC), and the Instituto Brasileiro de Geografia e Estatística (IBGE).*

Thus, we established a link between food inflation and birth outcomes by incorporating the date and the mother's city of residence, thereby constructing the panel dataset (Table 1).

To explore heterogeneities within our sample, we categorized mothers based on their education level: those with more than seven years of schooling were classified as more educated, while those with seven or fewer years were classified as less educated. This categorization serves as a direct measure of human capital and an indirect measure of income level. We anticipated that local food inflation would have a more pronounced impact on less educated mothers due to their lower income levels and reduced access to food in terms of quality and quantity. Additionally, less educated mothers may have limited access to information about how malnutrition can affect the health of a child in utero. Moreover, in line with existing literature that highlights the influence of marital status on birth outcomes (Shan et al., 2011), we also explore the effects of marital status on the impact of food inflation.

4. Effects of Food Inflation on Newborn Health

Baseline Results

Our baseline findings, outlined in Table 2, shed light on the repercussions of food inflation on birth outcomes. Panel A presents a comprehensive analysis of the entire sample, encompassing all mothers. We observe that for each one percent increase in food inflation during the last trimester of pregnancy, there is a marginal reduction of 0.1 gram in birth weight. The ten percent most exposed children, who encountered an average local food inflation rate of eighteen percent during the last trimester of pregnancy, experienced a decrease of 2.1 grams in their average birth weight.

There is no significant impact among mothers with higher education levels (Table 2 – Panel C). However, among less educated mothers (Table 2 – Panel B), the reduction in birth weight was more than double that observed in the overall sample. Specifically, mothers exposed to an 18% increase in local food inflation during the last trimester of pregnancy had children with an average weight reduction of 4.68 grams (-0.260×18). Similarly, exposure during the second trimester resulted in an average birth weight reduction of approximately 3.73 grams (-0.207 × 18), also due to in-utero exposure to an 18% food inflation rate.

Table 2 *– Effects of Food Inflation on Birth Weight (Baseline Results)*

Panel A – All mothers			
	Birth weight (grams)		
Food inflation (first trimester of pregnancy)	0.095 (0.064)		
Food inflation (second trimester of pregnancy)		-0.040 (0.070)	
Food inflation (last trimester of pregnancy)			-0.117* (0.061)
Observations	6,661,844	6,661,846	6,661,847
Panel B – Less educated mothers			
	Birth weight (grams)		
Food inflation (first trimester of pregnancy)	0.087 (0.085)		
Food inflation (second trimester of pregnancy)		-0.207** (0.092)	
Food inflation (last trimester of pregnancy)			-0.260*** (0.073)
Observations	3,120,006	3,120,008	3,120,009
Panel C – More educated mothers			
	Birth weight (grams)		
Food inflation (first trimester of pregnancy)	0.125 (0.081)		
Food inflation (second trimester of pregnancy)		0.101 (0.096)	
Food inflation (last trimester of pregnancy)			0.051 (0.090)
Observations	3,541,838	3,541,838	3,541,838
Panel D – Less educated and unmarried mothers			
	Birth weight (grams)		
Food inflation (first trimester of pregnancy)	0.125 (0.115)		
Food inflation (second trimester of pregnancy)		-0.356*** (0.128)	
Food inflation (last trimester of pregnancy)			-0.333*** (0.106)
Observations	1,363,961	1,363,962	1,363,963

Notes: *Panel A presents results for all mothers, Panel B for less educated mothers, Panel C for more educated mothers, and Panel D for unmarried and less educated mothers. Robust standard errors, adjusted for clustering by city, are reported in parentheses. Symbols *, **, and *** denote rejection of the null hypothesis at significance levels of 10%, 5%, and 1%, respectively. Birth weight is measured in grams, with coefficients representing the marginal effect of a one percent increase in food inflation per trimester on birth weight. All birth weight estimates include fixed effects for year, month, city, mother's schooling, marital status, baby's gender, mother's occupation, and a city-month interaction.*

Table 2 (Panel D) illustrates the impact of food inflation on unmarried and less educated mothers. This demographic group is particularly vulnerable to food inflation, experiencing more pronounced reductions in birth weight when exposed to higher levels of inflation. Here, we did not explore the channels that might contribute to unmarried mothers experiencing worse newborn outcomes. However, two potential explanations are worth considering: Income Channel: Unmarried mothers are more likely to have lower income sources, which can impact their ability to access adequate nutrition and healthcare during pregnancy. Stress Channel: Unmarried mothers are more likely to experience separation or relationship challenges during pregnancy, which can adversely affect maternal health and, consequently, newborn outcomes. The fact is that a 1% increase in food inflation during the last trimester is associated with a birth weight reduction of 0.333 grams for unmarried and less educated mothers. In this case, children exposed to the highest decile of inflation (averaging 18%) exhibit a birth weight reduction of almost 6 grams (-0.333×18).

An additional observation from our baseline results is that all point estimates during the first trimester of pregnancy were positive in all panels of Table 2. While these estimates are not statistically significant from zero, they exhibit positive values that differ from zero in certain robustness checks and alternative specifications. Building on the work of Rocha and Soares (2015), we posit a potential selection bias: could exposure to food inflation during the first trimester positively impact birth weight due to pregnancies that result in miscarriage? Unfortunately, we are unable to directly test this hypothesis due to limitations in mortality databases, which typically do not include fetuses under twelve weeks, and because not all miscarriages necessitate medical intervention. In summary, our findings on the effects of food inflation may be underestimated, as controlling for this possible selection bias could reveal even stronger associations between food inflation and newborn outcomes.

COVID Outbreak

During the COVID outbreak, healthcare services faced overwhelming demands, alongside a notable surge in food prices. As part of our robustness checks, we limited our analysis to newborns born before 2020. The overall trends observed in our study remain consistent (see Table 3 in the Appendix). Specifically, exposure to food inflation during pregnancy's second and last trimesters was associated with reduced birthweight. This effect was more pronounced among mothers with lower levels of education. At the same time, no significant impact was found among more educated mothers facing higher food inflation (comparison between Panel B and C, Table 3 in Appendix). The impact was even more substantial for mothers who were less educated and unmarried.

The estimated effects exhibit a slightly greater magnitude than our baseline results. For example, exposure to an additional one percent of inflation during the second trimester of pregnancy was associated with a birthweight decrease of -0.415 grams for the most vulnerable group – less educated and unmarried mothers – compared to -0.356 grams in our initial findings. Moreover, when mothers in this vulnerable group experienced an eighteen percent increase in food prices, the expected reduction in birthweight would be 7.47 grams.

Incidence of low birth weight

Up to this point, our focus has been on the birthweight variable. However, someone can argue that the decrease in birthweight might be influenced by larger babies skewing the results. To address this concern, we repeated the analysis by examining the probability of having a low birth weight (LBW) child instead. It involved switching from our previous econometric specification to a logistic regression (logit) model.

The results consistently demonstrate a pattern where less educated mothers experience a more significant impact from higher inflation levels than more educated mothers. In the most extreme scenario observed in Table 4, the probability of having a low birth weight (LBW) baby increased by 2.7% ($100 \times (\exp(18 \times 0.0015)-1)$) when less educated mothers were exposed to eighteen percent of food inflation during the last trimester of pregnancy.

Comparing our results with the literature

In Argentina, a reduction of 11% in economic activity is related to a decrease of 35 grams in birth weight for the most affected children who experienced the prolonged effects of the economic crisis (Bozzoli and Quintana-Domeque, 2014). Additionally, Koppensteiner and Menezes (2023) found that exposure to dengue infections during pregnancy results in a reduction of approximately 27 grams in birth weight. Significant impacts on birth weight are also observed with cash transfer programs. In Uruguay, these programs correlate with an increase in birth weight ranging between 23 and 30 grams (Amarante et al., 2016). Furthermore, Da Mata et al. (2023) reported that mothers who received a cistern at the beginning of pregnancy saw an increase in birth weight of 46 grams compared to the control group.

Compared to this cited literature, our results may initially seem modest – a 6-gram reduction in birthweight in the worst-case scenario of our baseline results when mothers are exposed to the last decile of inflation, and 7 grams when excluding observations after the COVID outbreak, also for the last decile of inflation. However, Camacho (2008) reported an 8-gram decrease in birth weight following an earthquake. Similarly, Rocha and Soares (2015) found that a one-standard-deviation change in rainfall patterns corresponds to a 1.6-gram change in birth weight for the Brazilian Semiarid region.

5. Final Remarks

This paper presents evidence that food inflation reduces birth weight in the Brazilian Semiarid. Importantly, these results cannot be explained by reductions in health services during the COVID outbreak. Pregnancy's second and last trimesters appear to be particularly critical periods, exhibiting the most substantial effects. Mothers with lower levels of education consistently experience higher impacts from food inflation compared to the overall sample across various specifications. Additionally, unmarried mothers are identified as a particularly vulnerable subgroup. The average inflation level is eighteen percent in trimesters in the top decile of inflation. When exposed to this level of inflation, less educated mothers experienced an average reduction in birth weight of 6 grams, while mothers who are both less educated and unmarried faced a reduction of 7 grams in birth weight.

Despite the social safety net protections in Brazil, this reduction in birth weight still occurs. Therefore, the natural policy implication from our results is that prenatal nutrition programs, such as the Women, Infants, and Children (WIC) program in the United States and the eggs–milk–oranges (OLO) program in Canada, are highly recommended in the Brazilian Semiarid region.

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Appendix

Table 3 *– Effects of Food Inflation on Birth Weight (Excluding period post-COVID)*

Panel A – All mothers			
	Birth weight (grams)		
Food inflation (first trimester of pregnancy)	-0.015 (0.063)		
Food inflation (second trimester of pregnancy)		-0.144* (0.077)	
Food inflation (last trimester of pregnancy)			-0.175*** (0.065)
Observations	5,565,063	5,565,065	5,565,066
Panel B – Less educated mothers			
	Birth weight (grams)		
Food inflation (first trimester of pregnancy)	0.046 (0.084)		
Food inflation (second trimester of pregnancy)		-0.256*** (0.091)	
Food inflation (last trimester of pregnancy)			-0.291*** (0.075)
Observations	2,919,190	2,919,192	2,919,193
Panel C – More educated mothers			
	Birth weight (grams)		
Food inflation (first trimester of pregnancy)	-0.055 (0.085)		
Food inflation (second trimester of pregnancy)		-0.040 (0.111)	
Food inflation (last trimester of pregnancy)			-0.029 (0.101)
Observations	2,735,873	2,735,873	2,735,873
Panel D – Less educated and unmarried mothers			
	Birth weight (grams)		
Food inflation (first trimester of pregnancy)	0.087 (0.120)		
Food inflation (second trimester of pregnancy)		-0.414*** (0.129)	
Food inflation (last trimester of pregnancy)			-0.346*** (0.107)
Observations	1,278,922	1,278,923	1,278,924

Notes: *Panel A presents results for all mothers, Panel B for less educated mothers, Panel C for more educated mothers, and Panel D for unmarried and less educated mothers. Robust standard errors, adjusted for clustering by city, are reported in parentheses. Symbols *, **, and *** denote rejection of the null hypothesis at significance levels of 10%, 5%, and 1%, respectively. Birth weight is measured in grams, with coefficients representing the marginal effect of a one percent increase in food inflation per trimester on birth weight. All birth weight estimates include fixed effects for year, month, city, mother's schooling, marital status, baby's gender, mother's occupation, and a city-month interaction.*

Table 4 *– Effects of Food Inflation on the Probability of Low Birth Weight*

Panel A – All mothers			
	Low birth weight = 1		
Food inflation (first trimester of pregnancy)	0.00113***		
	(0.00023)		
Food inflation (second trimester of pregnancy)		0.0007***	
		(0.00023)	
Food inflation (last trimester of pregnancy)			0.0010***
			(0.00023)
Observations	8,519,268	8,401,718	8,288,982
Panel B – Less educated mothers			
	Low birth weight = 1		
Food inflation (first trimester of pregnancy)	0.00097***		
	(0.00031)		
Food inflation (second trimester of pregnancy)		0.0012***	
		(0.00031)	
Food inflation (last trimester of pregnancy)			0.0015***
			(0.00032)
Observations	4,012,816	3,922,259	3,835,670
Panel C – More educated mothers			
	Low birth weight = 1		
Food inflation (first trimester of pregnancy)	0.0014***		
	(0.00032)		
Food inflation (second trimester of pregnancy)		0.00022	
		(0.00033)	
Food inflation (last trimester of pregnancy)			0.00051
			(0.00033)
Observations	4,506,452	4,479,459	4,453,312
Panel D – Less educated and unmarried mothers			
	Low birth weight = 1		
Food inflation (first trimester of pregnancy)	0.00095***		
	(0.00033)		
Food inflation (second trimester of pregnancy)		0.00088***	
		(0.00033)	
Food inflation (last trimester of pregnancy)			0.0010***
			(0.00033)
Observations	4,352,715	4,279,653	4,209,400

Notes: *Panel A presents results for all mothers, Panel B for less educated mothers, Panel C for more educated mothers, and Panel D for unmarried and less educated mothers. Standard errors are reported in parentheses. Symbols *, **, and *** denote rejection of the null hypothesis at significance levels of 10%, 5%, and 1%, respectively. This table reports the coefficients from a logit regression of low birth weight (a dummy variable that is equal to 1 if birth weight below 2500 grams). The gender of the baby and the mother's age were included as controls in all panels. Panels A and D also include the mother's schooling as a control variable. The dummy variable indicating whether the mother is unmarried was excluded from Panel D.*