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Soda Consumption in the Tropics: The Potential Trade-Off between Obesity and Diarrhea in Developing Countries

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SODA CONSUMPTION IN THE TROPICS: THE POTENTIAL TRADE-OFF BETWEEN OBESITY AND DIARRHEA IN DEVELOPING COUNTRIES

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Abstract

This paper exploits a natural experiment in Peru and finds evidence that a sharp reduction in the price of soda increased its consumption, increased obesity rates and reduced diarrhea prevalence among women without piped water at home. These results suggest that some women are substituting soda for contaminated water, facing a trade-off between diarrhea and obesity. Additionally, it finds that the effect on obesity is significantly greater among women of very low height, suggesting that early life undernutrition plays an important role in the effect on obesity.

Keywords: Obesity; diarrhea; soft drinks; clean water.

JEL Classification: I12, I18, H41, O12

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1 Introduction

Obesity is an escalating worldwide epidemic, with 30% of the world's population now overweight. The rise in this epidemic began in developed countries, but developing countries are beginning to catch up (Swinburn et al., 2011): the number of overweight individuals in developing countries has more than tripled in the last 30 years, and two-thirds of the world's overweight people live in these countries (Keats, Wiggins et al., 2014).

Technological progress has been identified as the main explanation for the current obesity epidemic. Lakdawalla, Philipson and Bhattacharya (2005) develop a model that predicts individuals' weight increases as a consequence of technology that lowers the cost of calories and raises the cost of physical activity. Cutler, Glaeser and Shapiro (2003) provide evidence that the switch from individual to mass preparation of food has reduced the time spent in food consumption. Individuals have increased their number of meals per day more than the amount of calories per meal, and have increased the amount of calories from snacks more than from regular meals. Bertrand and Schanzenbach (2009) argue that technology has also changed the way individuals spend their time and provide evidence that eating and drinking as a secondary activity (while doing something else) has increased the amount of calories consumed.

Carbonated soft drinks, commonly known as "sodas", are a good example of how technology has contributed to changes in consumption patterns and calorie intake. Inventions such as soda fountains, shelf-stable food, artificial flavors and vending machines have enabled the expansion of the soda market to almost every corner of the US and every country in the world. Sodas are consumed both during regular meals and as snacks throughout the day, and many times while engaged in other daily activities or in transit from place to place. In fact, soda consumption and obesity prevalence are correlated across a wide range of countries (Basu et al., 2013), but the expansion of the soda industry also mirrors the increase in obesity rate within countries. In the last few decades, the real price of sodas in the US decreased more than 20% (Powell et al., 2013) while consumption has more than tripled (Allshouse, 2004)and obesity rates have more than doubled. Moreover, the increase in soda consumption alone could explain the increase in obesity rates in the US; an energy imbalance equivalent to 12 oz. of soda per day is enough to explain the increment in average weight in the US in the last few decades (Cutler, Glaeser and Shapiro, 2003) and today an average American consumes approximately 15 oz. of soda per day Silver (2015). While these pieces of evidence are suggestive, they do not prove causality. Technology has simultaneously increased the supply (and decreased the price) of many other processed and high-caloric foods and has contributed to sedentary work regimes and life styles, and heavier people consume more calories (including more calories from soda). More convincing evidence has been provided by Wendt and Todd (2011) by linking a longitudinal study to average retail food prices. They find that a 10% increase in the price of soda is correlated with a reduction in children's Body Mass Index (BMI) of 0.47%. Finally, Fletcher, Frisvold and Tefft (2010*b*) and Fletcher, Frisvold and Tefft (2010*a*) examine a causal effect of soft drink taxes in the US on BMI and obesity rates and find very modest effects in the case of adult women and no effect in the case of children and adolescents. The later result is explained mostly by a modest effect on soft drink consumption that was completely offset by an increase in the consumption of milk. However, the authors acknowledge exploiting taxes of very small magnitude as a possible shortcoming of their study. As a matter of fact, recent studies on higher taxes show larger demand elasticities: the recent soda tax in Philadelphia that increased prices by 17% approximately, decreased soft drinks consumption by 38% (Roberto et al., 2019). A more modest reduction has been found in the case of the soda tax in the city of Berkeley, a decrease of approximately 10% (Falbe et al., 2015; Silver et al., 2017), but the tax and the pass through to prices were significantly smaller (Cawley and Frisvold, 2017). Unfortunately these studies do not estimate the impact on substitutes or on body weight.

In the case of middle- and some low-income countries, soda consumption is increasing at a worrisome pace (Silver, 2015). This is in part driven by the soda companies' strategy of turning their attention to these countries, as their market in richer countries is shrinking (Mitchell, 2016; Taylor and Jacobson, 2016). This rapid expansion of the soda industry is happening, however, in a different context, a context of poor infrastructure, especially poor access to clean water, waterborne diseases and malnutrition. The specific conditions present in these countries might alter the role of soda consumption in the obesity epidemic. For example, if individuals in developing countries are more likely to substitute away from water to soda, as opposed to substituting away from other high-calorie beverages, such as milk, the effect on body weight might be greater than in developed countries. In the case of Mexico, for example, Colchero et al. (2016) finds evidence that the soda tax had a substitution effect mainly on bottled water, which suggest that there could also have been an effect on unbottled water. Moreover, if individuals in poorer countries are more likely to substitute away from *contaminated* water to soda, the decrease in the price of soda might increase obesity but reduce diarrhea prevalence.[1] Finally, Barker (1990) and Gluckman and Hanson (2006) argue that early-life nutritional deprivation strongly affects fetal metabolism, in effect "programming" it such that later in life the individual is at greater risk of obesity in a high-calorie environment. A significantly larger proportion of adults in developing countries suffer from undernutrition early in life, in comparison with richer

[1] In the US, for example there is evidence that some individuals substitute soda for contaminated water (Onufrak et al., 2014)

countries; this is due both to lower food intake and the high prevalence of diarrheal diseases that reduce nutrient absorption (Brown, 2003). What are the effects of changes in the price of soda in terms of consumption and obesity rates in developing countries? Are some individuals at greater risk of obesity? Are some individuals facing a trade-off between diarrhea and obesity?

This paper exploits a natural experiment in Peru as a way of shedding light on these questions. In the first half of 1999, a price war broke out in the soda industry that prompted a sharp drop in prices of different magnitudes in the different regions of Peru. The decision to lower prices was, undoubtedly, prompted in part by changes in the Peruvian soda market in the previous years. However, the Price War was most likely also prompted by the financial struggles of the Coca-Cola Company in the preceding year, which originated mostly outside Peru. In particular, it seems that the timing of the Price War was exogenous to changes in local demand in the short-run. In fact, Coca-Cola decreased their prices in Brazil exactly at the same time (Eizenberg and Salvo, 2015), as we can see in Figure 1.

This paper applies a Difference-in-Difference (DD) approach, where the identification comes from the timing of the Price War and from differences in the magnitude of the shock across regions. I complement this DD strategy with event studies to show that pre-trends do not explain my results. Finally, I exploit variation within region across families with and without access to piped water at home. In Peru, as in many other developing countries, households without piped water at home typically have to resort to drinking contaminated water (Bonifaz and Aragón, 2008). Thus, the heterogeneous effect produced by water access at home allows me to evaluate how the availability of clean water can affect the responses to changes in the price of soda in terms of consumption, but also in terms of diarrhea prevalence; assuming water and soda are substitutes, the decrease in the price of soda could reduce the consumption of water and decrease diarrhea rates, among those with access to contaminated water. Moreover, a reduction in diarrhea prevalence has the potential to increase BMI (Kremer et al., 2011). Thus, the effect through diarrhea could reinforce the direct effect of soda consumption on BMI.

To the best of my knowledge the present study is the first, but not the only, study that examines a causal effect of soda prices on diarrhea prevalence; Gutierrez and Rubli (2019) exploit the soda tax in Mexico and find that the tax increased diarrhea prevalence in areas with low access to piped water and bad surface water quality.

I find that in regions with the highest reductions in the price of soft drinks (carbonated and not carbonated[2]) due to the Price War, there is a significantly greater increase in soft drink consumption and that this increase in consumption is not offset by a reduction in the consumption of milk, alcoholic beverages, coffee or other herbal teas. I also find that the increase in soft drinks is larger for households without piped water at home. Additionally, in these regions, there is a larger reduction in diarrhea prevalence among women without piped water at home. This result suggest that individuals might be substituting unbottled, and sometimes contaminated, water for soda. Finally, I find that in these regions, there is a greater increase in obesity rates among adult women and school-age girls without piped water at home. Moreover, I find an even larger effects on obesity among adult women of very low height, most likely as a result of malnourishment early in life.

Because of the large, sudden change in soda prices it produced, the price war provides a convenient natural experiment, and the DD approach provides us with a robust empirical strategy. However, it is theoretically possible that the effects I find on soda consumption, obesity rates and diarrhea prevalence are generated by omitted variables. While I cannot

[2]Sometimes called here simply as “sodas”.

completely rule out this possibility, the following additional results reinforce the credibility of my results. Events studies show no evidence of pre-existing trends in soda consumption, BMI, or obesity rates. Additionally, I do not find significant effects in the placebo regression on a number of important observable variables. For example, I find no effect on the number of times these households eat outside the house, which is reassuring, given that food prepared outside the home, especially fast food, has frequently been associated with increases in BMI and obesity rates (Currie et al., 2010; Meltzer and Chen, 2011). I also find no concerning effects on height and no evidence that effects on soda consumption and obesity rates are generated by a reduction in the price of sugar or gasoline, important input and distribution costs of soft drinks that can also have a direct effect on body weight. Finally, I find no evidence that reduction in diarrhea was generated by a reduction in open defecation, or by an improvement in malnutrition and I find no placebo effect on pneumonia, which tends to respond to improvements in hygiene habits and water access, but is not directly related to the consumption of contaminated water.

With this study I aim to contribute to the evidence regarding the effect of soda prices and consumption on obesity rates. Second, I aim to shed some light on how the particular context of developing countries might interact with the expansion of the soda industry, taking into account that nutritional status and substitution patterns might not only generate different effects on obesity rates, but also generate unexpected effects on diarrhea prevalence. Finally, this study suggests important policy implications that need to be further investigated; taxes on soda, if not well designed, could yield unintended results for some sectors of the population in developing countries, namely, increase in diarrhea prevalence, while water sanitation programs, by reducing the price of clean water, may not only reduce diarrhea prevalence, but also contribute to prevent obesity.

2 Background of the Price War

1998 was one of the Coca Cola company's worst years, financially speaking. This financial downturn was the results of several problems occurring simultaneously around the world. Among the most notable problems were the following: the company invested heavily in Russia (around US$750 million) and sales fell dramatically in 1998, leaving the company operating at about 50% of its capacity there (Deogun, 1999). In Belgium, in June 1998, several school children became ill after drinking Coke. Coca-Cola had to recall their products in Belgium and other European countries, generating the largest recall in the history of the company (Cowell, 1999). Things were also not going well in Asia or Latin America (Coleman, 1998). In Brazil, Coca-Cola lost 10% points of its market share between 1993 and 1998, despite investing $1.4 billion there between 1995 and 1997 (Deogun, 1999). 1999 did not start well for the company either, with a law suit alleging racial bias that ended in a settlement of over US$150 million in 2000 (Winter, 2000).

In order to recover, Coca-Cola had to try new (and old) strategies; as one commentator put it, "Now, Coke wants to be everywhere again … Coca-Cola Co. is going all out to win back lost customer loyalty. It's also trying new marketing and management strategies to get in closer touch with Coke drinkers worldwide." (Echikson, n.d.). Peru was not overlooked in this global strategy to regain customers. First, in early 1999, Coca-Cola bought Inca-Kola, its main competitor. The same strategy was followed in more than 150 countries, where Coca-Cola bought Schweppes, Canada Dry, Dr Pepper, and Crush brands (Bloomberg, 1999). Second, a price war started, mostly between Coca-Cola and Kola Real (BancoWiese, 2002; ElComercio, 2014). Soda prices dropped dramatically in Lima and other regions of the country, presumably driven by an attempt by Coca-Cola to win clients back from a nationally growing brand, "Kola Real", just as the company did at the exact period of time in Brazil against other B-brands companies (Eizenberg and Salvo, 2015). As can be seen in Figure 1, a sharp decline in prices occurred simultaneously in Lima and in Brazilian main cities. The real price of soda decreased more than 20% in Lima between December 1998 and June 1999.

Kola Real was a soda brand created by a humble and informal family business, which grew into what is now known as the Aje Group, with plants in 20 countries in America, Asia and Africa and exports to United States and Spain (AjeGroup, 2018). The main strategy of the firm was to work at very low costs and charge very low prices (LaRepublica, 2005). The price war between Coca Cola and Kola Real (or Big Cola, the name of the brand in other countries) did not stop in Peru; it was repeated in several other countries from Latin America and Asia (ElDinero, 2011; ElComercio, 2014; Bland and Schipani, 2014).

Given this background, it seems pretty obvious that the price war in Peru was driven in part by local circumstances, but its timing seems to have been driven mostly by external and plausibly exogenous factors.

3 Data and Summary Statistics

For the purposes of this paper, I construct three samples from different datasets. The first sample (hereafter "Demand Sample") is used to estimate the elasticity of demand for soda. For this sample, I use the National Household Survey (or ENAHO, its Spanish acronym) from the years 1997 to 1999. This dataset is representative at the national and regional level, and includes monthly information from the last quarter of each year. In order to exploit the short term in which the timing of the price war was plausibly exogenous, I only evaluate the effect in the first year. Additionally, I use the years 1997 and 1998 to examine previous trends; I do not have data on previous years to explore longer-term trends. This data contains data on household food consumption at home (which is gathered from an expenditure questionnaire), including soft drinks consumption, demographic characteristics for the members of the household and as well as information about water access at home.

The second sample (hereafter "Diarrhea Sample") is used to estimate the effects on diarrhea prevalence. For this sample, I use a special section of ENAHO. It contains data on the incidence of several diseases, including diarrhea. It also contains demographic characteristics for the members of the household and as well as information about water access at home. I use data from 1998 and 1999. Unfortunately, in this case I do not have data from 1997 to explore previous trends.

The third sample (hereafter the "BMI Sample") is used to estimate the effect of soda prices on body weight outcomes. For this sample, I use the first round of the National Nutritional Indicators Survey (or MONIN I, its Spanish acronyms). This dataset is representative at the national and regional level and contains monthly information, so I use the data from July 1997 to June 2000. Again, I do not have data on previous years and in the case of children I only have data since 1998. This dataset contains information about anthropomorphic measures and demographic characteristics of adult women of child-bearing age (age 18 to 49), children at the school level (age 6 to 17) and children age 5 or less. It also contains information about water access at home. I eliminate pregnant women from the sample. I also discard the bottom 1% and top 99% of the BMI distribution to remove extreme and implausible values. Table B.2 shows the main estimations without eliminating extreme values.

Finally, data on soft drink prices are obtained from the Consumer Price Index Data elaborated by the National Institute of Statistics and Informatics' (or INEI for its Spanish acronyms). All price indexes have December 2001 as the base year' meaning price indexes for all products and for all regions equal 100 in December 2001. In order to obtain the real price of soft drinks, I divide the soft drink prices index by the general consumer price index for each month and region. All three samples are matched with these prices at the regional level.

Table 1 reports the summary statistics. The average consumption of soda during these years was 1 liter per week per person, which amounts to 48 liters per year, approximately. This number, however, includes only the consumption of soda at home. As a comparison, in the US, the per-capita consumption of sodas in the same year was estimated at 120 liters per year (Vartanian, Schwartz and Brownell, 2007). It is important to note that the soft drink category includes sweetened and diet carbonated soft drinks as well as non-carbonated soft drinks, such as juices made with artificial flavoring and bottled water. Unfortunately, it is not possible to separate sweetened soft drinks from diet soft drinks and bottled water. However, sweetened sodas represent by far the largest share. For example, in 2000 total consumption of bottled water represented only 6% of soft drinks (LaRepublica, 2011). Moreover, this consumption is probably concentrated among relatively affluent families, since this category does not include consumption of water from the water drums that poor people buy from trucks. Kola Real, for example, did not produce bottled water until 2001 (AjeGroup, 2018), and juices and low-sugar drinks until much later. Coca Cola also had difficulties expanding their diet brands (Arkivperu, 2015).

Drinking water access and quality in Peru is very poor. During the years analyzed here, approximately 48% of households did not have piped water in their homes. Although piped water at home is not necessarily safe everywhere, alternative sources of water, even water sold by privately-owned trucks, do not meet the minimum sanitary criteria demanded by the Ministry of Health, and so water from these sources is often contaminated (Bonifaz and Aragón, 2008). Moreover, even in the case of access to clean water outside the house, transportation and storage can contaminate water (Fewtrell et al., 2005). This context is similar to that prevailing in the rest of developing countries today, where almost one in three urban dwellers have no piped water at home (WorldBank, 2015; UnitedNations, 2015).

The average BMI (defined as weight in kilograms divided by the square of height in meters) of the adult women of my sample is 25, and 11% of the women are obese, where obesity is defined as a BMI of 30 or more. For the classification of obesity among children I follow the World Health Organization cut-offs (WHO, 2006): a standardized BMI for age and gender (BMI Zscore) higher than 2 standard deviations from the mean of the reference population for children age 6 to 17, and a BMI Zscore higher than 3 standard deviations from the mean of the reference population for younger children (age 0 to 5). Table 2 reports that among children age 6 to 17, 3% of the boys and 2% of the girls are considered obese, while among younger children less than 1% of the are considered obese. These figures are very similar to what we currently see in the rest of the world. According to World Health Organization, in 2016, 13% adults aged 18 years and over were obese (WorldHealthOrganization, 2018).

With respect to diarrhea prevalence, Table 3 reports that the average prevalence of diarrhea rate is around 3%, but as expected it is the highest among young children; 6% of boys and girls of age 12 or younger experience diarrhea at least once every 3 months.

Finally. the difference in the statistics between individuals with and without piped water at home are as expected. Individuals without piped water at home have lower incomes, are less educated, weigh less, are shorter, have a higher incidence of diarrhea and pneumonia, consume less quantities of soda and eat outside the home less often.

4 Empirical Strategy

I start by calculating the effect of the price war on prices or the "first stage". The price war was the strongest in Lima, and as we can see in Figure 1, it was concentrated in the first half of the year. By June the accumulated drop reached 22%, and the accumulated drop between December 1998 and December 1999 reached 30%. To estimate the effect of the price war on soda prices, I wanted to use a period of time long enough to cover most of the drop in prices, but no so long that it would incorporate demand responses and becomes endogenous. Keeping this trade-off in mind, I use the percentage decrease in the price of soda between December 1998 and June 1999 as the effect of the price war on soda prices. In my regressions, I include month-year fixed effects to control for any seasonality effect. Figure 1 shows the effect of the price war on prices by region between December 1998 and June 1999. We can see that all but one regions registered a decrease in prices in early 1999s, but there are important differences in magnitude.

I then apply a Difference-in-Difference (DD) approach, exploiting the timing of the price war and the differences in the impact on prices across regions. Specifically, I run a regression of the form:

$$Y_{i,r,t} \quad = \quad \alpha_o + \alpha_1(\triangle P_r^{PW} \times Post_t) + \alpha_2 X_{i,r,t} + \omega_r + \phi_t + \varepsilon_{i,r.t}$$

where $Y_{i,r,t}$ stands for our outcome variable of household, woman or child i, in region r and month-year t; $\triangle P_r^{PW}$ stands for the percentage change in soda prices due to the price war (between December 1998 and June 1999); *Post* is a dummy equal to 1 after June

1999 and 0 otherwise; (ω_r) stands for region fixed effects, (φ_t) stands for month-year fixed effects, and ($X_{i,r,t}$) stands for control variables of household, woman or child i, in region r and month-year t. Standard errors are clustered at the regional level. Since there are only 24 regions in Peru, I present the p-values of Wild Bootstrap inferences, to correct for small number of regions and differential population per region, following Cameron, Gelbach and Miller (2008) and MacKinnon and Webb (2017).

Finally, in order to examine whether those regions where the price war was stronger already had higher levels of soda consumption or obesity rates before the price war, I estimate an event study specification similar to that of Alpert, Powell and Pacula (2018) and Cutler et al. (2010), among others. Specifically, I run a regression of the form:

$$Y_{i,r,t} = \alpha_o + \sum \beta_{trim} \times \triangle P_r^{PW} + \alpha_1 X_{i,r,t} + \omega_r + \varphi_t + \varepsilon_{r,t}$$

where β_{trim} stands for the coefficients of the interactions of the change in soda prices and trimester-year fixed effects, which I will show graphically, normalizing the trimester April-June 1999 to zero (or the trimester October-December 1998, when I only have data of the last trimesters of every year). I multiply the $\triangle P_r^{PW}$ by -1, for the graph to show the effect of the *decrease* in the price of soda due to the price war. β_{98-III} for example, can be interpreted as the effect of a 100 percent decrease in the price of soda 2 trimesters before it actually happened.

5 Results

5.1 Effects on Consumption

Table 4 presents the effect of the change in soda prices produced by the Price War on weekly per-capita consumption of soda and potential substitutes. The first column provides the results among all households, the second and third columns provide the results among households with and without access to water, respectively. All regressions include region and month-year fixed effects and control variables for household income, head of household's age and educational attainment. In Table B.1 we can see results are robust to eliminating control variables. The first row of table 4 shows the estimated coefficient of a change of 100% in soda prices, the second row shows the P-values after the wild-bootstrap correction and the third row shows the 95% confidence interval. A 10 percentage points decrease in the real price of soda generates an increase of soda consumption at home by approximately 0.2 liters. Given the average consumption of soda by households, this effect is equivalent to an elasticity of demand of -2. My estimates, however, are very imprecise; thus, for comparison purposes the effect in terms of standard deviations is more appropriate; a 10 percentage points decrease in the real price of soda generates a 0.10 standard deviation increase in the consumption of soda. The effect is larger among households without piped water at home: a 10 percentage points decrease in the real price of soda generates an increase of 0.4 liters per week per person, which represents an an increase of 60% or 0.22 standard deviations. In the case of households with piped water at home, a 10 percentage points decrease in the real price of soda generates an initial increase of 0.2 liters per week per person, which represents an increase of 13% or 0.06 standard deviations, although the effect is not statistically significant.

The price war, however, could have been stronger in regions where consumption of soda was already increasing. The event studies for soda consumption in Figures 2 to 4 show that this was not the case in any of the household types.

Why are individuals without piped water at home more responsive to changes in the price of soda? I do not have a definite answer to this question, but it might be related to Eizenberg and Salvo (2015)'s hypothesis that there is a new middle class that is more price-sensitive, in general and that it just so happened that most individuals of this new middle class did not have piped water at the time of the Price War in Peru. It is also possible that families without piped water at home spend a larger share of their income on sodas, making them more sensitive to changes, particularly in the case of the price of sodas. Finally, contaminated water, as an inferior good, might have a higher cross elasticity of demand than clean water. It is also important to note that I estimate the effect on the consumption of soda *at home* and it is possible that these households with piped water are less responsive to the consumption of soda at home, but more responsive to the consumption of soda outside the home.

Table 4 also reveals the effects of changes in soda prices on potential substitutes or complements. We can think of milk as a potential substitute. I find no significant effect on milk. Since most sodas have caffeine, it is possible, that individuals substitute soda for other stimulating beverages, such as coffee, tea and other herbal infusions, including "emoliente" and coca leave tea, which are widely consumed in Peru. I find, however, no significant effect in this case either. Alcoholic beverages can be thought of substitutes or complements. For example, soft drinks could substitute for beer or wine, while several types of liquor with higher alcohol content are commonly served in combination with soft drinks in Peru: "Chilcano", "Cuba-Libre", and Vodka and orange juice are some examples. Table 4 shows only a significative increase in the consumption of alcoholic beverages at home for households with piped water at home; a 10 percentage points decrease in the price of soda increases the consumption of alcoholic beverages by 0.025 liters per capita per week, which is equivalent to an increase of 17% or 0.03 standard deviations. These results suggest a complementary effect, which is possible given the number of drinks that combine alcohol and soft drinks. Note in the event study of Figure 3 that the consumption of alcohol was not increasing before the price war. Finally, soft drinks are typically very high in sugar, hence it is possible that the increase in their consumption substitutes away other products high in sugar, such as candies. Tables A.1 and A.5, however, reveal no effect on the consumption of candies or sugar, respectively.

5.2 Effects on Diarrhea Prevalence

In the previous section, we saw that the increase in consumption of soft drinks did not substitute away milk, alcoholic beverages, coffee or other herbal teas. What, then, are individuals substituting soft drinks for? One potential answer is unbottled water. Unfortunately, it is very difficult to obtain data about the consumption of plain water, much less contaminated water. But if this assumption is correct and, given that unbottled water is contaminated in many areas in Peru, is the substitution away from contaminated water generating a decrease on diarrhea prevalence? In this section, I estimate the effects of the price war on diarrhea prevalence by access to piped water. As we saw in the previous section, the effect in terms of consumption was larger for households without piped water at home. Moreover, households that do not have piped water at home are more likely to resort to drinking contaminated water. Hence, the effect on diarrhea is more likely to happen among these households.

Table 5 presents the effects of soda price on diarrhea prevalence by gender. Control variables include household income, household head's educational attainment and average age of the household members. I also control for whether the individual experienced a disease in the last three months; only those who answered this question affirmatively were later asked whether this disease was diarrhea. In Table B.1 we can see results are robust to eliminating control variables. Table 5 shows that the effect among women is, as expected, concentrated among households that do not have piped water at home; a 10% percent decrease in the real price of soda decreases their diarrhea rates by a total of 2 percentage points or 0.23 standard deviations. I do no find, however, significant effects among men. It is not clear why the effect is concentrated on women only, it is possible that among households without piped water at home, the effect on soda consumption was larger for women than for men. I cannot test this hypothesis, but women in developing countries must be increasing their calorie intake (or reducing their calorie expenditure) to a greater degree than men, since obesity rates are increasing much faster for them in the large majority of these countries (Kanter and Caballero, 2012).

Table 6 presents the effects of soda price on diarrhea prevalence by age. It shows the results only for women, since there are no significant results on men. Likewise, it shows the results only for all households and for households without piped water, since there are no significant results on households with water. We can see that there is no significant effect on adult women, which is probably not surprising, given that the prevalence of diarrhea among adults is very small. It is surprising and reassuring, however, to see that the effect is significantly larger among teenage girls than younger girls. This result resembles the consumption pattern of soda found by other studies (Ramírez-Vélez et al., 2015; Rivera et al., 2008; Araneda et al., 2015).

I do not have data on diarrhea before the last trimester of 1998, so I cannot construct an event study for diarrhea prevalence, however, the Robustness Section (which discards several alternative stories) contributes significantly to the credibility of this result.

5.3 Effects on BMI and Obesity Rates

In this section, we estimate the effects on BMI and obesity rates separately by age, because the calculations of BMI and obesity change according to these groups of ages, as we saw in the Data Section. Table 7 presents the effects of soda price on BMI and obesity prevalence of adult women and children; unfortunately we do not have BMI data for adult men. Control variables include age and educational attainment of the adult women or of the mother. This data set has no income variable, so instead a variable for whether or not the woman works outside the home has been included. In Table B.1 we can see results are robust to eliminating control variables. Resembling the results on soda consumption and diarrhea prevalence,Table 7 shows that the effects are larger among women without access to piped water at home; a 10 percentage points decrease in the real price of soda increases BMI by 0.66 units or 0.18 standard deviations and obesity rates by 4.8 percentage points or 0.24 standard deviations. The effects are smaller and not statistically significant for women with access to piped water at home and for the average woman. The event studies for adult women in Figure 5 show that the effects are not driven by previous trends.

Table 7 also presents the effects of soda price on the BMI Z-score and obesity prevalence of children age 6 to 17 by gender. In both cases, we do not see a significant effect on the BMI Z-score, but we do see a significant effect on obesity rates for girls without piped water at home; a 10% decrease in the price of soda increases obesity rate by 1.9 percentage points or 0.14 standard deviations. We also see a significant effect for boys but with access to piped water at home: a 10 percentage points decrease in the real price of soda increases obesity rate by 2.5 percentage points or 0.16 standard deviations. In Table B.1 we can see the results for girls are robust to eliminating control variables, but not so the results for boys. The event studies of Figure 6 show no evidence of pre-trends. Table 7 also presents the effects of soda price on BMI and obesity prevalence of small children. I find no significant effect for boys or girls, with or without piped water at home.

Finally, 8 shows that the effect on the BMI and obesity rates among adult women by normal to low height versus very low height, where very low height is defined as a height equal or below the 10th percentile (4 feet 9 inches). The idea here is to use height as a proxy from early life nutrition to test Barker's hypothesis that individuals who suffer from early-life nutritional deprivation are later in life at greater risk of obesity when exposed to a high-calorie environment. The women in our sample are relatively young; 31 years old on average, still we find a very large difference in the estimates: a 10 percentage points decrease in the real price of soda increases BMI by 1.2 units or 0.3 standard deviations and obesity rates by 1.3 percentage points or 0.4 standard deviations. The effects are smaller and not statistically significant for women with access to piped water at home and for the average woman. The event study for adult women in Figure 7 shows that the effects are not driven by previous trends. The effects on children are not statistically significant.

Magnitudes and Consistency among Estimated Effects

As I mentioned before, the point estimates of this study are very imprecise, which means the point estimates are not as informative as one might hope. Nevertheless, in this section, I will use the estimated effects on soda consumption to perform a back-of-envelope calculation of the expected effect on BMI and compare it with my results.

The most consistent result is among adult women without piped water at home: a 10% decrease in the price of soda generated an increase in BMI of 0.6 units. Given the average height of my sample, this increase corresponds to an average increase of 3 pounds after one year. Applying the rule of thumb of Hall et al. (2011), approximately 60 extra calories per day would generate such an increase in weight in one year.

The effect on soda consumption for families that do not have piped water at home is 0.4 liters per-capita per week. This estimate, however, only takes into account the consumption of soda at home. Assuming the same consumption of soda outside the home, the effect of total consumption should be 4.3 fl oz per day (approximately half a cup). This corresponds to 44 calories per day, which is smaller than the number of calories we estimated necessary to obtain the reported results on adult women's BMI. However, I am using the effect on consumption on the average member of the household and, since I find the highest effect on adult women's BMI, it is likely that their consumption is also higher for them than that of the rest of the household members. Additionally, it is important to mention that a reduction in diarrhea prevalence has the potential to increase BMI (Kremer et al., 2011). Finally, the rule of thumb I am using has been calibrated for an adult population in the US. The effect of calories on weight gain might be larger among individuals in developing countries, given that a significant larger percent of individuals in developing countries, as compared to richer countries, suffer from nutritional deprivation early in life. And as we have seen above, this makes an importante difference. Moreover, within developing countries, individuals without access to piped water at home are also more likely to suffer from deprivation early in life than individuals with access to piped water at home. For example, in the summary statistics, we observe that the percentage of adult women of very low height is almost double among these households.

6 Robustness

The DD analysis of this paper, in combination with the event studies provide credible evidence that the decrease in soda prices generated by the Price War increased consumption and obesity rates, but also decreased diarrhea prevalence, among women who do not have piped water at home. Nevertheless, my empirical strategy does not completely rule out the possibility of contemporaneous changes in omitted variables that bias my results. It is difficult to imagine what alternative story might increase soda consumption and obesity rates and at the same time reduce diarrhea rates, with all these effects being larger or concentrated among women without piped water at home. Nevertheless, in this section, I test some placebos and important alternative stories that I believe will contribute significantly to the credibility of this result.

Alternative Story 1: Effects are driven by an increase in the consumption of fast food and unhealthy snacks ("western diet")

The "Western diet", fast food and snacks, has often been associated with increases in BMI and obesity rates (Harvard..(Harvard, 2020; Currie et al., 2010; Meltzer and Chen, 2011). In particular, the number of meals per day more than the amount of calories per meal, and the amount of calories from snacks more than from regular meals have been associated with the obesity epidemic in developed countries (Cutler, Glaeser and Shapiro, 2003). It might, therefore, be the case that the increase in the consumption of soda and obesity rates in Peru during those years were driven by a general increase in the consumption of highly processed snacks and fast-food. Table A.5 shows no significant effect in the consumption of candies ("golosinas"), the most common type of unhealthy snacks and which are very easy to obtain almost everywhere in Peru. Table A.1 also shows no significant effect on the number of times individuals eat outside the home, this includes just snacks, as well as complete meals.

Alternative Story 2: Effects are driven by a reduction in the production and distribution costs of sodas

Another alternative story would be that the price of soda decreased due to decreases in the production and/or distribution costs and are not due to the price war. Sodas in Peru are mostly carbonated water, sugar and some artificial colors and flavors. Hence, the price of sugar is the main production cost, and, naturally, one of the most important distribution costs is the price of gasoline. If the reduction in the price of soda happened due to a reduction in one of these costs, my results with respect to BMI and obesity rates could be biased, since changes in the price of sugar can affect obesity rates directly through changes the consumption of sugar and sugary food, other than soda. Likewise, changes in the price of gasoline can affect obesity rates through changes in physical activity induced by changes in the cost of driving (Courtemanche, 2011). Tables A.3 to A.3 show the placebo regressions using the price of gasoline and the price of sugar in place of the price of soda and we can see, however there is no significant effect in the relevant outcomes. In Table A.5 we can also see no effect in the consumption of sugar.

Alternative Story 3: Effects are driven by omitted variables that improve hygiene.

We also can imagine some alternative stories with respect to the effects I observe on diarrhea prevalence among women without piped water at home. For example, we know that open defecation is an important driver of diarrheal diseases. Table A.2 shows that the price war had no placebo effect on open defecation (lack of access to a toilet or a cesspit). Another alternative story might be that diarrhea prevalence decreased due to improvements in hygiene habits and better access to water, which could have an effect on the incidence of pneumonia. Drinking less contaminated water and more soda should, however, have no effect on pneumonia. As we can see in Table A.2, the price war had no significant effect on pneumonia among these women.

Alternative Story 4: Effects are driven by changes in height or malnutrition

Given that the construction of BMI depends negatively on height, my results could be driven by a reduction in height. Since nutrition affects height only early in life, we should see no effect on height, in particular among adults. Likewise, several studies have linked diarrhea with malnutrition or stuntedness; stunted children are more vulnerable to diarrhea (Brown, 2003). We have also seen that our effects on obesity rates are larger on short women. Table A.4, however, shows no significant effect on height, stuntedness or "very-low" height.

Placebo regressions with control variables as dependent variables

Finally, tables A.5 to A.6 show the placebo regressions using the control variables as dependent variables. My sample is, in general, very well balanced. Almost all coefficients for the relevant cells are insignificant except for the household head's education of girls in the diarrhea sample: education was higher among the household heads of regions where the soda price decreased the most, which could explain the reduction in diarrhea. However, this correlation is derived from girls with piped water at home and I find no diarrhea effect on these girls. Among girls without piped water at home, the correlation with household head's education is insignificant and of the opposite sign.

7 Conclusions

This study analyzes the effect of a sharp decrease in the price of soda, generated by a price war, on consumption, diarrhea and obesity prevalences in Peru. I find that in regions with the highest reduction in the price of soft drinks, there is a significantly greater increase in soft drink consumption and that this increase in consumption is not offset by a reduction in the consumption of milk, alcoholic beverages, coffee or other herbal teas. I also find that the increase in soft drinks is larger for households without piped water at home. Additionally, in these regions, there is greater reduction in diarrhea prevalence among women without piped water at home. Finally, I find that in these regions, there is a greater increase in obesity rates among adult women and school-age girls without piped water at home.

Moreover, I find even larger effects on obesity among women of very-low height.

This study has important implications. First, this study provides evidence suggesting that for some sectors of the population in developing countries, soda represents a relatively cheap and sweet alternative to contaminated water. Second, the results highlight the disproportionate effect the expansion of soda consumption can have, and probably is having, on obesity in areas with limited access to clean water and on individuals who suffered from nutritional deprivation early in life. Competition in the soda industry has been reducing prices around the world. Additionally a significant proportion of families still live without piped water at home and this population is not confined to rural areas; almost 1 in every 3 urban dwellers in the developing world have no piped water at home (WorldBank, 2015; UnitedNations, 2015). If the soda companies reach populations with sodas before the government can supply clean water, the obesity epidemic will likely continue to spread to these areas. The tradeoff of less diarrhea now for obesity and/or cardiovascular diseases in the future might be more cost-efficient for individuals privately than for a society, in particular for those individuals, who discount future outcomes highly. Finally, this study suggests potential negative unintended effects of soda taxes and positive unintended effects of programs aimed at improving access to clean water, in areas with limited access to clean and piped water at home. The degree of effectiveness of soda taxes and of water sanitation programs as means of combatting obesity and its unintended effects on diarrhea prevalence, or vice-versa, are beyond the scope of this paper, but are important questions for future research.

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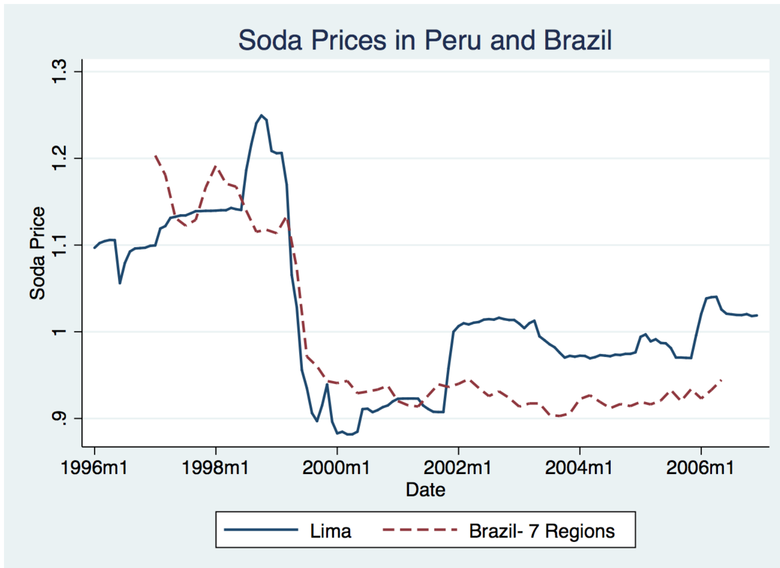
Figure 1: The Effect of the Price War on Prices



Notes: Soda prices from Brazil are from Premium brands in 7 regions, reported at constant Brazil CPI March 2003 terms, divided by 2 for rough US$ values. Source: Figure 2 in Eizenberg and Salvo (2015). Soda prices from Lima are from all brands at constant Peru CPI December 2001 terms and normalized to 1 for that period. Source: INEI, Peru.

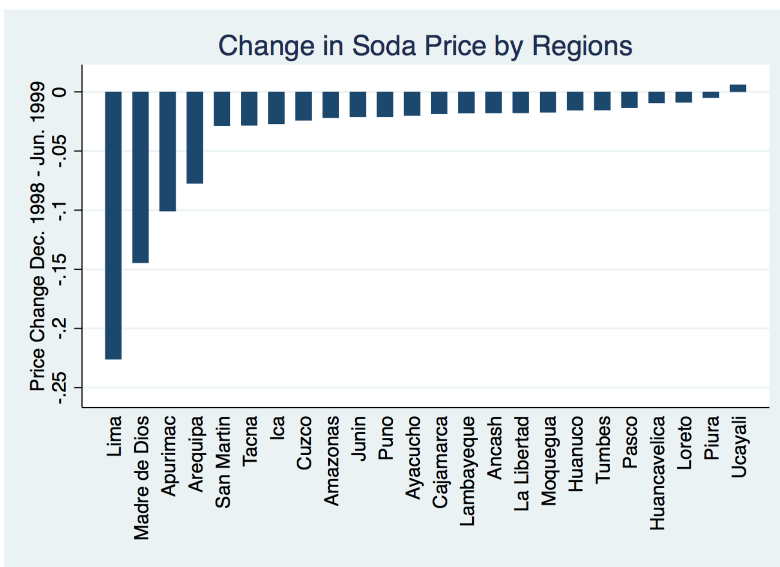
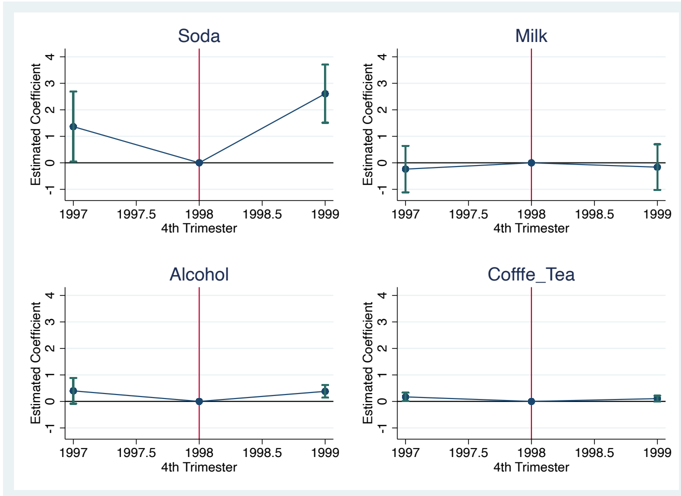
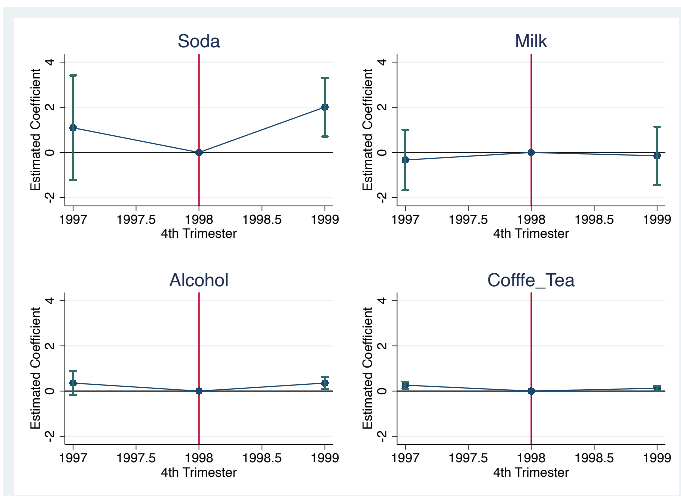


Figure 2: The Effect of the Price War on Consumption



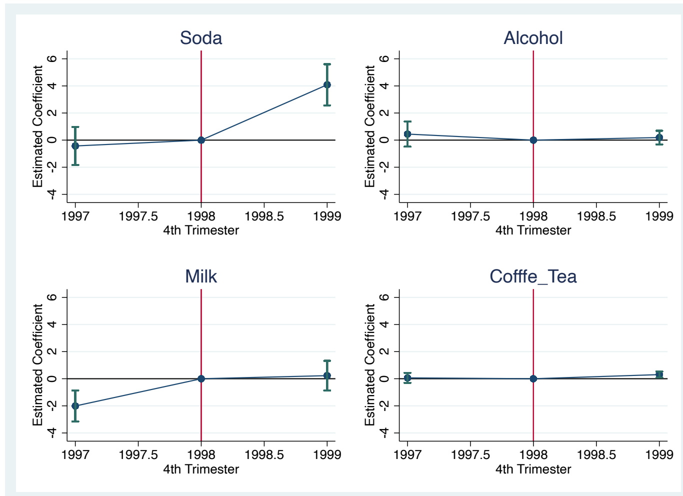
Note: Graphs include point estimates from each event study (normalized to 0 in the 4th trimester of 1998) and 95 percent confidence intervals that are adjusted for within-region clustering.

Figure 3: The Effect of the Price War on Consumption- Households with Piped Water



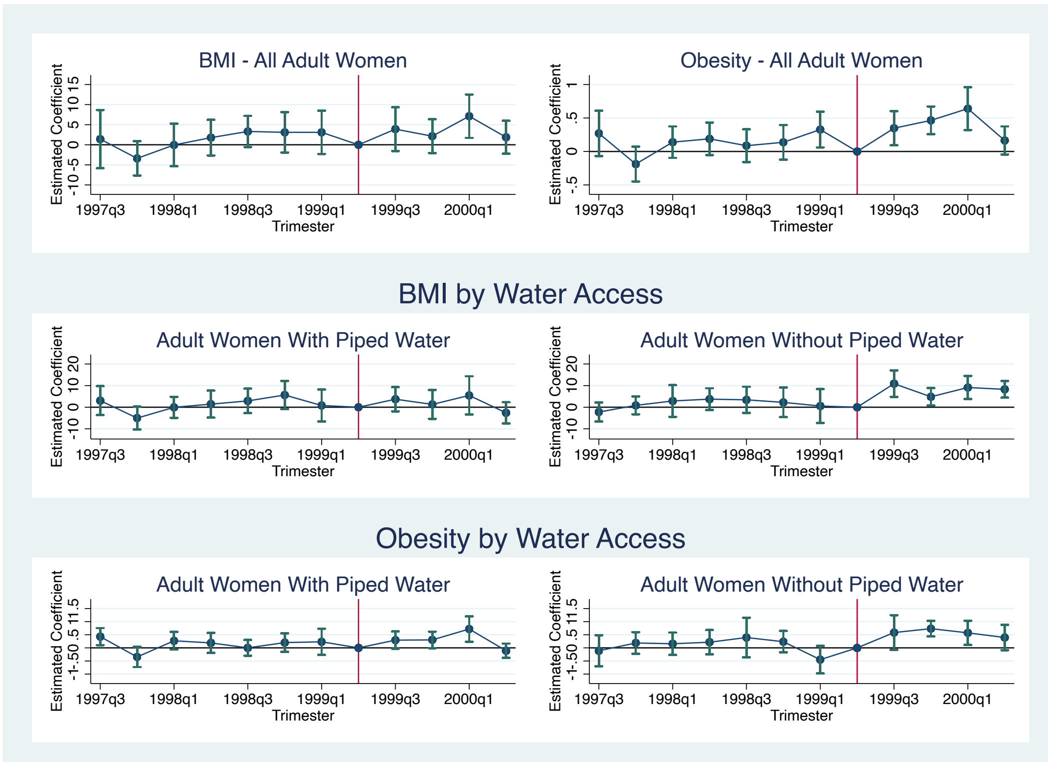
Note: Graphs include point estimates from each event study (normalized to 0 in the 4th trimester of 1998) and 95 percent confidence intervals that are adjusted for within-region clustering.

Figure 4: The Effect of the Price War on Consumption- Households without Piped Water



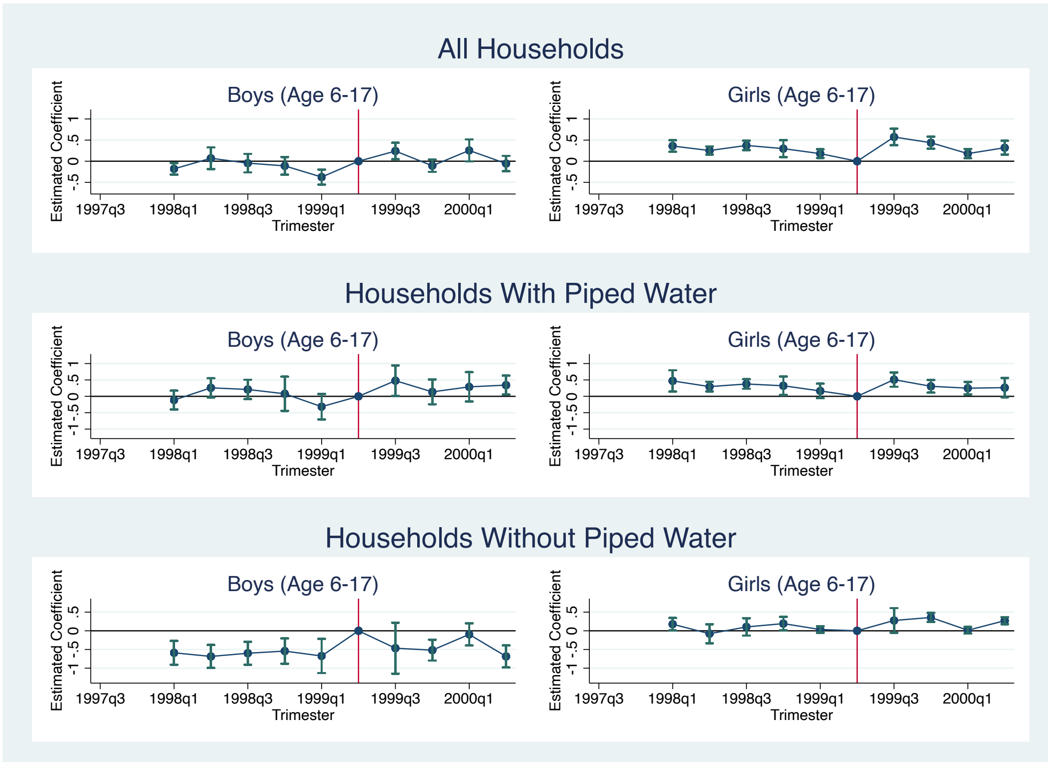
Note: Graphs include point estimates from each event study (normalized to 0 in the 4th trimester of 1998) and 95 percent confidence intervals that are adjusted for within-region clustering.

Figure 5: The Effect of the Price War on Adult Women's BMI and Obesity Rates by Water Access



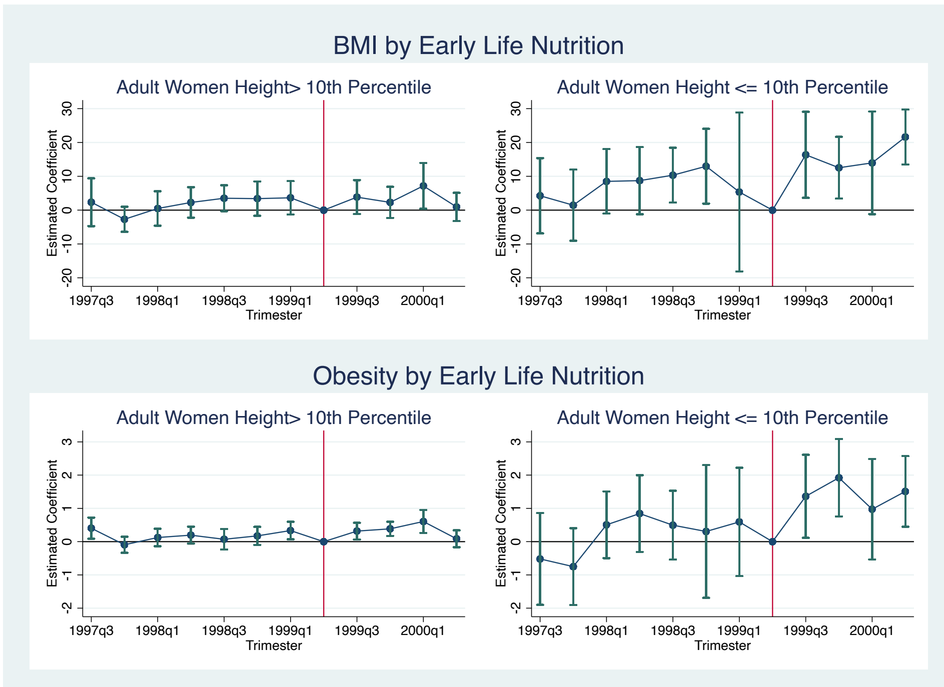
Note: Graphs include point estimates from each event study (normalized to 0 in the 2nd trimester of 1999) and 95 percent confidence intervals that are adjusted for within-region clustering.

Figure 6: The Effect of the Price War on Children's Obesity Rates by Water Access



Note: Graphs include point estimates from each event study (normalized to 0 in the 2nd trimester of 1999) and 95 percent confidence intervals that are adjusted for within-region clustering.

Figure 7: The Effect of the Price War on Adult Women's BMI and Obesity Rates by Height



Note: Graphs include point estimates from each event study (normalized to 0 in the 2nd trimester of 1999) and 95 percent confidence intervals that are adjusted for within-region clustering.

Table 1: Summary Statistics by Water Access at Home (1)

Household

	Without	With	Total
Soft drinks (in liters)	0.657	1.384	1.033
	(2.174)	(3.912)	(3.215)
Milk (in liters)	0.755	1.941	1.370
	(2.107)	(3.455)	(2.946)
Alcohol (in liters)	0.152	0.152	0.152
	(1.029)	(1.009)	(1.019)
Coffe and teas (in liters)	0.0990	0.118	0.109
	(0.546)	(0.361)	(0.460)
Candies (in kilograms)	0.0679	0.0871	0.0779
	(0.457)	(0.489)	(0.474)
N. times eaten outside	8.183	8.829	8.536
	(6.733)	(6.347)	(6.533)
Income (std)	-0.243	0.220	-0.00319
	(0.406)	(1.382)	(1.060)
Piped Water at Home	0	1	0.518
	(0)	(0)	(0.500)
Household head age	45.77	48.43	47.15
	(15.52)	(15.05)	(15.34)
Household head education	1.972	2.531	2.261
	(0.865)	(0.985)	(0.970)
Observations	16952		

mean coefficients; sd in parentheses

Adult Women

	Without	With	Total
Weight (in kg)	55.46	58.76	57.41
	(8.629)	(9.632)	(9.377)
Height (in cm)	149.9	152.2	151.3
	(5.498)	(6.067)	(5.950)
BMI (in kg/cm2)	24.65	25.35	25.06
	(3.463)	(3.824)	(3.697)
Obesity	0.0827	0.123	0.107
	(0.275)	(0.328)	(0.309)
Height <10th Perc.	0.140	0.0846	0.107
	(0.347)	(0.278)	(0.309)
Works	0.311	0.347	0.332
	(0.463)	(0.476)	(0.471)
Age	31.54	31.36	31.43
	(8.519)	(8.587)	(8.559)
Education	2.331	3.054	2.759
	(0.838)	(0.858)	(0.921)
Observations	6778		

mean coefficients; sd in parentheses

Source: ENAHO 1997-1999 and MONIN 1997-1999

Table 2: Summary Statistics by Water Access at Home (2)

Girls (Age 6-17)

	Without mean/sd	With mean/sd	Total mean/sd
Age	10.674	11.163	10.921
	(3.334)	(3.392)	(3.372)
Weight (in kg)	32.612	36.537	34.598
	(12.298)	(13.142)	(12.881)
Height (in cm)	131.097	136.328	133.744
	(15.925)	(15.724)	(16.037)
Height Zscore (std)	-1.905	-1.432	-1.666
	(1.096)	(1.096)	(1.121)
Stunted	0.460	0.290	0.374
	(0.499)	(0.454)	(0.484)
BMI Zscore (std)	0.122	0.250	0.187
	(0.812)	(0.909)	(0.865)
Obesity	0.014	0.034	0.024
	(0.117)	(0.180)	(0.152)
Observations	4241		

Boys (Age 6-17)

	Without mean/sd	With mean/sd	Total mean/sd
Age	9.714	9.907	9.811
	(2.563)	(2.554)	(2.560)
Weight (in kg)	28.567	32.171	30.372
	(8.576)	(10.350)	(9.674)
Height (in cm)	127.415	132.576	130.000
	(14.136)	(15.120)	(14.861)
Height Zscore (std)	-2.001	-1.384	-1.691
	(1.095)	(1.124)	(1.151)
Stunted	0.508	0.287	0.397
	(0.500)	(0.453)	(0.489)
BMI Zscore (std)	0.086	0.305	0.196
	(0.831)	(0.922)	(0.885)
Obesity	0.014	0.042	0.028
	(0.117)	(0.200)	(0.165)
Observations	3338		

Girls (Age 0-5)

	Without mean/sd	With mean/sd	Total mean/sd
Age	2.707	2.686	2.697
	(1.656)	(1.653)	(1.654)
Weight (in kg)	12.835	13.663	13.238
	(3.823)	(4.247)	(4.055)
Height (in cm)	87.276	89.644	88.429
	(14.398)	(14.956)	(14.717)
Height Zscore (std)	-1.851	-1.234	-1.550
	(1.271)	(1.287)	(1.315)
Stunted	0.447	0.271	0.361
	(0.497)	(0.444)	(0.480)
BMI Zscore (std)	0.640	0.704	0.671
	(0.928)	(0.910)	(0.920)
Obesity	0.073	0.084	0.079
	(0.261)	(0.278)	(0.269)
Observations	2503		

Boys (Age 0-5)

	Without mean/sd	With mean/sd	Total mean/sd
Age	2.609	2.607	2.608
	(1.686)	(1.681)	(1.683)
Weight (in kg)	13.218	14.007	13.607
	(4.068)	(4.469)	(4.288)
Height (in cm)	87.727	90.232	88.963
	(14.773)	(15.458)	(15.163)
Height Zscore (std)	-1.887	-1.311	-1.603
	(1.395)	(1.257)	(1.359)
Stunted	0.466	0.281	0.375
	(0.499)	(0.450)	(0.484)
BMI Zscore (std)	0.766	0.767	0.766
	(0.978)	(0.970)	(0.974)
Obesity	0.107	0.110	0.108
	(0.309)	(0.313)	(0.311)
Observations	2463		

Source: MONIN 1997-1999

Table 3: Summary Statistics by Water Access at Home (3)

All Women

	Without mean/sd	With mean/sd	Total mean/sd
Diarrhea (3 months)	0.034	0.020	0.026
	(0.181)	(0.139)	(0.161)
Pneumonia (3 months)	0.010	0.007	0.008
	(0.097)	(0.081)	(0.089)
Ill (3 months)	0.263	0.280	0.272
	(0.440)	(0.449)	(0.445)
Open defecation	0.465	0.115	0.280
	(0.499)	(0.319)	(0.449)
Observations	21526		

All Men

	Without mean/sd	With mean/sd	Total mean/sd
Diarrhea (3 months)	0.033	0.021	0.027
	(0.178)	(0.143)	(0.161)
Pneumonia (3 months)	0.010	0.006	0.008
	(0.101)	(0.078)	(0.090)
Ill (3 months)	0.240	0.244	0.242
	(0.427)	(0.430)	(0.429)
Open defecation	0.460	0.119	0.285
	(0.498)	(0.323)	(0.452)
Observations	21136		

Adult Women (Age 18-49)

	Without mean/sd	With mean/sd	Total mean/sd
Diarrhea (3 months)	0.009	0.007	0.008
	(0.097)	(0.082)	(0.089)
Pneumonia (3 months)	0.007	0.005	0.006
	(0.084)	(0.067)	(0.075)
Ill (3 months)	0.262	0.269	0.266
	(0.440)	(0.444)	(0.442)
Open defecation	0.443	0.092	0.241
	(0.497)	(0.289)	(0.428)
Observations	10726		

Adult Men (Age 18-49)

	Without mean/sd	With mean/sd	Total mean/sd
Diarrhea (3 months)	0.009	0.008	0.008
	(0.095)	(0.089)	(0.092)
Pneumonia (3 months)	0.007	0.003	0.005
	(0.086)	(0.055)	(0.070)
Ill (3 months)	0.200	0.199	0.200
	(0.400)	(0.400)	(0.400)
Open defecation	0.437	0.096	0.246
	(0.496)	(0.295)	(0.431)
Observations	10044		

Girls (Age 13-17)

	Without mean/sd	With mean/sd	Total mean/sd
Diarrhea (3 months)	0.011	0.004	0.007
	(0.103)	(0.061)	(0.084)
Pneumonia (3 months)	0.006	0.003	0.005
	(0.078)	(0.056)	(0.067)
Ill (3 months)	0.180	0.199	0.190
	(0.384)	(0.400)	(0.392)
Open defecation	0.481	0.119	0.293
	(0.500)	(0.323)	(0.455)
Observations	3098		

Boys (Age 13-17)

	Without mean/sd	With mean/sd	Total mean/sd
Diarrhea (3 months)	0.011	0.010	0.010
	(0.102)	(0.098)	(0.100)
Pneumonia (3 months)	0.005	0.002	0.004
	(0.073)	(0.044)	(0.060)
Ill (3 months)	0.178	0.194	0.186
	(0.383)	(0.395)	(0.389)
Open defecation	0.447	0.130	0.286
	(0.497)	(0.337)	(0.452)
Observations	3070		

Girls (Age 0-12)

	Without mean/sd	With mean/sd	Total mean/sd
Diarrhea (3 months)	0.069	0.049	0.060
	(0.254)	(0.217)	(0.238)
Pneumonia (3 months)	0.014	0.012	0.013
	(0.116)	(0.108)	(0.112)
Ill (3 months)	0.295	0.334	0.313
	(0.456)	(0.472)	(0.464)
Open defecation	0.484	0.151	0.330
	(0.500)	(0.359)	(0.470)
Observations	7702		

Boys (Age 0-12)

	Without mean/sd	With mean/sd	Total mean/sd
Diarrhea (3 months)	0.064	0.045	0.056
	(0.245)	(0.208)	(0.229)
Pneumonia (3 months)	0.015	0.013	0.014
	(0.121)	(0.112)	(0.117)
Ill (3 months)	0.302	0.336	0.318
	(0.459)	(0.472)	(0.466)
Open defecation	0.488	0.148	0.334
	(0.500)	(0.355)	(0.472)
Observations	8022		

Data Source: ENAHO 1998-1999

Table 4: The Effect of Soda Prices on Consumption

	(1) Soft Drinks All	(2) Soft Drinks With Water	(3) Soft Drinks Without Water	(4) Milk All	(5) Milk With Water	(6) Milk Without Water
Soda Price Change	-2.30	-2.04	-4.09	-0.15	-0.18	-0.89
	(0.08)	(0.14)	(0.02)	(0.76)	(0.77)	(0.60)
	[-5.84, 0.50]	[-5.86, 1.40]	[-7.44, -1.51]	[-2.22, 2.16]	[-2.36, 2.73]	[-4.19, 4.22]
R^2	0.070	0.061	0.083	0.099	0.077	0.080
Observations	16952	8788	8164	16952	8788	8164

	(1) Alcohol All	(2) Alcohol With Water	(3) Alcohol Without Water	(4) Coffee or Tea All	(5) Coffee or Tea With Water	(6) Coffee or Tea Without Water
Soda Price Change	-0.19	-0.25	0.15	-0.02	0.01	-0.15
	(0.23)	(0.09)	(0.57)	(0.63)	(0.79)	(0.22)
	[-1.20, 0.42]	[-1.12, 0.07]	[-1.39, 1.74]	[-0.34, 0.20]	[-0.24, 0.20]	[-0.65, 0.27]
R^2	0.019	0.019	0.024	0.016	0.023	0.019
Observations	16952	8788	8164	16952	8788	8164

Note: This table shows the effect of a 100% change in the real price of soda. Consumption of beverages is in liters per month and per-capita. Region and year fixed effects are included. Control variables include: age and education attainment of the household head and household income. Standard errors are clustered at the region level. P-values are based on wild bootstrapped standard errors to correct for small number of clusters (24).

Table 5: The Effect of Soda Prices on Diarrhea Rates by Gender

	(1) Men All	(2) Men With Water	(3) Men Without Water	(4) Women All	(5) Women With Water	(6) Women Without Water
Soda Price Change	-0.06	-0.08	-0.04	0.03	-0.02	0.10
	(0.74)	(0.44)	(0.73)	(0.15)	(0.43)	(0.07)
	[-0.21, 0.16]	[-0.16, 0.09]	[-0.26, 0.28]	[-0.07, 0.22]	[-0.09, 0.07]	[-0.11, 0.39]
R^2	0.104	0.080	0.129	0.102	0.079	0.131
Observations	21136	10814	10322	21526	11374	10152

Note: This table shows the effect of a 100% change in the real price of soda. Diarrhea is a dummy equal to one if the individual experienced a diarrhea in the last three months. Region and year fixed effects are included. Control variables include: age and whether the individual experienced a disease in the last three months, the education attainment of the household head and household income. Standard errors are clustered at the region level. P-values are based on wild bootstrapped standard errors to correct for small number of clusters (24).

Table 6: The Effect of Soda Prices on Diarrhea Rates by Age

	(1) Adult Women All	(2) Adult Women Without Water	(3) Girls Age 13-17 All	(4) Girls Age 13-17 Without Water	(5) Girls Age 0-12 All	(6) Girls Age 0-12 Without Water
Soda Price Change	-0.02	0.02	0.05	0.23	0.10	0.07
	(0.41)	(0.42)	(0.07)	(0.06)	(0.11)	(0.41)
	[-0.06, 0.04]	[-0.06, 0.10]	[-0.01, 0.22]	[-0.01, 0.54]	[-0.11, 0.50]	[-0.92, 0.77]
R^2	0.027	0.033	0.043	0.078	0.182	0.222
Observations	10726	4540	3098	1488	7702	4124

Note: This table shows the effect of a 100% change in the real price of soda. Diarrhea is a dummy equal to one if the individual experienced a diarrhea in the last three months. Region and year fixed effects are included. Control variables include: age and whether the individual experienced a disease in the last three months, the education attainment of the household head and household income. Standard errors are clustered at the region level. P-values are based on wild bootstrapped standard errors to correct for small number of clusters (24).

Table 7: The Effect of Soda Prices on BMI and Obesity Rates by Age and Gender

	(1) Adult Woman BMI All	(2) Adult Woman BMI With Water	(3) Adult Woman BMI Without Water	(4) Adult Woman Obesity All	(5) Adult Woman Obesity With Water	(6) Adult Woman Obesity Without Water
Soda Price Change	-2.42	-0.68	-6.56	-0.26	-0.18	-0.48
	(0.33)	(0.62)	(0.08)	(0.45)	(0.33)	(0.03)
	[-6.76, 4.09]	[-4.79, 6.04]	[-18.29, 1.73]	[-0.63, 0.54]	[-0.49, 0.37]	[-1.03, -0.07]
R^2	0.119	0.140	0.127	0.068	0.079	0.082
Observations	6780	4011	2769	6780	4011	2769

	(1) Girls Age 6-17 BMI Zscore All	(2) Girls Age 6-17 BMI Zscore With Water	(3) Girls Age 6-17 BMI Zscore Without Water	(4) Girls Age 6-17 Obesity All	(5) Girls Age 6-17 Obesity With Water	(6) Girls Age 6-17 Obesity Without Water
Soda Price Change	-0.32	-0.62	-0.27	-0.14	-0.11	-0.19
	(0.31)	(0.34)	(0.31)	(0.39)	(0.44)	(0.06)
	[-1.90, 1.03]	[-4.08, 2.50]	[-2.12, 1.06]	[-0.39, 0.19]	[-0.42, 0.43]	[-0.37, 0.01]
R^2	0.056	0.072	0.067	0.033	0.044	0.031
Observations	4241	2146	2095	4241	2146	2095

	(1) Boys Age 6-17 BMI Zscore All	(2) Boys Age 6-17 BMI Zscore With Water	(3) Boys Age 6-17 BMI Zscore Without Water	(4) Boys Age 6-17 Obesity All	(5) Boys Age 6-17 Obesity With Water	(6) Boys Age 6-17 Obesity Without Water
Soda Price Change	-0.57	-1.41	0.51	-0.15	-0.25	0.03
	(0.41)	(0.15)	(0.39)	(0.26)	(0.05)	(0.60)
	[-2.96, 1.89]	[-4.11, 1.16]	[-3.48, 4.20]	[-0.41, 0.17]	[-0.57, 0.00]	[-0.33, 0.43]
R^2	0.134	0.145	0.161	0.033	0.044	0.040
Observations	3338	1672	1666	3338	1672	1666

	(1) Boys Age 0-5 BMI Zscore All	(2) Boys Age 0-5 BMI Zscore With Water	(3) Boys Age 0-5 BMI Zscore Without Water	(4) Boys Age 0-5 Obesity All	(5) Boys Age 0-5 Obesity With Water	(6) Boys Age 0-5 Obesity Without Water
Soda Price Change	0.10	0.42	0.07	0.07	0.04	0.13
	(0.85)	(0.30)	(0.95)	(0.22)	(0.34)	(0.43)
	[-4.01, 2.71]	[-1.71, 2.75]	[-7.15, 7.19]	[-0.05, 0.17]	[-0.12, 0.25]	[-0.05, 0.34]
R^2	0.095	0.118	0.135	0.024	0.042	0.044
Observations	3157	1550	1607	3157	1550	1607

	(1) Girls Age 0-5 BMI Zscore All	(2) Girls Age 0-5 BMI Zscore With Water	(3) Girls Age 0-5 BMI Zscore Without Water	(4) Girls Age 0-5 Obesity All	(5) Girls Age 0-5 Obesity With Water	(6) Girls Age 0-5 Obesity Without Water
Soda Price Change	0.46	0.88	-0.87	-0.01	0.00	-0.01
	(0.24)	(0.22)	(0.27)	(0.48)	(0.50)	(0.63)
	[-1.89, 3.82]	[-2.73, 6.91]	[-5.52, 1.77]	[-0.12, 0.04]	[-0.02, 0.03]	[-0.29, 0.10]
R^2	0.053	0.083	0.091	0.027	0.043	0.042
Observations	3157	1553	1600	3157	1553	1600

Note: This table shows the effect of a 100% change in the real price of soda. Region and year fixed effects are included. Control variables include: age and education attainment and whether the mother works and age of the children. Standard errors are clustered at the region level. P-values are based on wild bootstrapped standard errors to correct for small number of clusters (24).

Table 8: The Effect of Soda Prices on BMI and Obesity by Height

	(1) Adult Woman BMI Not Very Low Height	(2) Adult Woman BMI Very Low Height	(3) Adult Woman Obesity Not Very Low Height	(4) Adult Woman Obesity Low Very Height
Soda Price Change	-1.75	-11.67	-0.18	-1.34
	(0.48)	(0.09)	(0.56)	(0.05)
	[-5.70, 5.42]	[-33.97, 3.74]	[-0.57, 0.65]	[-2.78, 0.02]
R^2	0.119	0.193	0.070	0.131
Observations	6054	726	6054	726

Note: This table shows the effect of a 100% change in the real price of soda. Region and year fixed effects are included. Control variables include: age and education attainment and whether the mother works and age of the children. Standard errors are clustered at the region level. P-values are based on wild bootstrapped standard errors to correct for small number of clusters (24).

A Appendix: Robustness Analysis

Table A.1: Alternative Story: Western Diet

	(1) Candies All	(2) Candies With Water	(3) Candies Without Water	(4) N. Eat Outside All	(5) N. Eat Outside With Water	(6) N. Eat Outside Without Water
Soda Price Change	-0.02	-0.05	0.05	-1.92	-3.51	2.52
	(0.71)	(0.51)	(0.68)	(0.51)	(0.35)	(0.18)
	[-0.26, 0.23]	[-0.41, 0.24]	[-0.20, 1.52]	[-7.12, 5.54]	[-12.60, 8.31]	[-3.77, 12.29]
R^2	0.046	0.061	0.042	0.047	0.046	0.081
Observations	16952	8788	8164	10508	5738	4770

Note: This table shows the effect of a 100% change in the real price of soda. Consumption of beverages is in liters per month and per-capita. Region and year fixed effects are included. Control variables include: age and education attainment of the household head and household income. Standard errors are clustered at the region level. P-values are based on wild bootstrapped standard errors to correct for small number of clusters (24).

Table A.2: Alternative Story: Improvements in Hygiene

	(1) Pneumonia All Women Without Water	(2) Pneumonia Girls Age 13-17 All	(3) Pneumonia Girls Age 13-17 Without Water	(4) Open Def. All Women Without Water	(5) Open Def. Girls Age 13-17 All	(6) Open Def. Girls Age 13-17 Without Water
Soda Price Change	0.07	0.01	-0.00	-0.13	-0.22	-0.39
	(0.53)	(0.61)	(0.88)	(0.49)	(0.69)	(0.82)
	[-0.06, 0.14]	[-0.07, 0.09]	[-0.11, 0.16]	[-0.87, 1.18]	[-1.12, 1.23]	[-3.67, 4.29]
R^2	0.035	0.031	0.049	0.180	0.238	0.177
Observations	10152	3098	1488	10152	3098	1488

Note: This table shows the effect of a 100% change in the real price of soda. Diarrhea is a dummy equal to one if the individual experienced a diarrhea in the last three months. Region and year fixed effects are included. Control variables include: age and whether the individual experienced a disease in the last three months, the education attainment of the household head and household income. Standard errors are clustered at the region level. P-values are based on wild bootstrapped standard errors to correct for small number of clusters (24).

Table A.3: Alternative Story Input Prices

	(1) Soft Drinks All	(2) Soft Drinks With Water	(3) Soft Drinks Without Water	(4) Soft Drinks All	(5) Soft Drinks With Water	(6) Soft Drinks Without Water
Sugar Price Change	-4.04	-4.96	-3.22			
	(0.15)	(0.26)	(0.15)			
	[-12.36, 0.73]	[-15.61, 2.29]	[-8.62, 1.09]			
Gasoline Price Change				1.95	4.15	0.69
				(0.47)	(0.44)	(0.96)
				[-4.53, 3.62]	[-6.93, 6.90]	[-3.90, 2.16]
R^2	0.070	0.061	0.081	0.070	0.062	0.080
Observations	16952	8788	8164	16952	8788	8164

	(1) Diarrhea All Women Without Water	(2) Diarrhea Girls Age 13-17 All	(3) Diarrhea Girls Age 13-17 Without Water	(4) Diarrhea All Women Without Water	(5) Diarrhea Girls Age 13-17 All	(6) Diarrhea Girls Age 13-17 Without Water
Sugar Price Change	0.06	0.01	0.08			
	(0.24)	(0.78)	(0.53)			
	[-0.05, 0.15]	[-0.10, 0.11]	[-0.19, 0.37]			
Gasoline Price Change				0.04	-0.01	-0.02
				(0.18)	(0.65)	(0.77)
				[-0.02, 0.14]	[-0.04, 0.15]	[-0.10, 0.36]
R^2	0.131	0.043	0.074	0.131	0.043	0.074
Observations	10152	3098	1488	10152	3098	1488

	(1) BMI Adult Woman Without Water	(2) Obesity Adult Woman Without Water	(3) Adult Woman BMI Very Low Height	(4) Adult Woman Obesity Very Low Height	(5) Obesity Girls Age 6-17 Without Water	(6) Obesity Boys Age 6-17 With Water
Sugar Price Change	3.94	0.04	-10.37	-0.37	0.10	-0.05
	(0.31)	(0.76)	(0.21)	(0.30)	(0.37)	(0.88)
	[-5.37, 13.61]	[-0.69, 0.32]	[-28.32, 8.91]	[-1.24, 0.57]	[-0.28, 0.39]	[-0.68, 0.89]
R^2	0.124	0.078	0.185	0.115	0.032	0.056
Observations	2769	2769	726	726	2123	1709

	(1) BMI Adult Woman Without Water	(2) Obesity Adult Woman Without Water	(3) Adult Woman BMI Very Low Height	(4) Adult Woman Obesity Very Low Height	(5) Obesity Girls Age 6-17 Without Water	(6) Obesity Boys Age 6-17 With Water
Gasoline Price Change	1.02	-0.02	3.15	0.16	0.00	-0.00
	(0.57)	(0.86)	(0.16)	(0.40)	(0.94)	(0.98)
	[-8.96, 2.64]	[-0.92, 0.44]	[-9.81, 9.38]	[-1.09, 0.81]	[-0.35, 0.34]	[-0.71, 0.66]
R^2	0.124	0.078	0.184	0.115	0.032	0.056
Observations	2769	2769	726	726	2123	1709

Note: This table shows the effect of a 100% change in the real price of soda. Region and year fixed effects are included. Estimations include the same control variables as in the original regressions. Standard errors are clustered at the region level. P-values are based on wild bootstrapped standard errors to correct for small number of clusters (24).

Table A.4: Alternative Story: Height and Malnourishment

	(1) Height Adult Woman All	(2) Height Adult Woman With Water	(3) Height Adult Woman Without Water	(4) Very Low-Height Adult Woman All	(5) Very Low-Height Adult Woman With Water	(6) Very Low-Height Adult Woman Without Water
pricechdecJunpost	1.02	1.08	-1.19	-0.02	-0.12	0.21
	(0.47)	(0.49)	(0.69)	(0.63)	(0.18)	(0.17)
	[-8.80, 10.55]	[-6.62, 14.15]	[-16.97, 20.06]	[-0.32, 0.29]	[-0.48, 0.19]	[-0.21, 0.86]
R^2	0.141	0.146	0.093	0.051	0.064	0.044
N	6780	4011	2769	6780	4011	2769

	(1) Height Zscore Girls Age 6-17 All	(2) Height Zscore Girls Age 6-17 With Water	(3) Height Zscore Girls Age 6-17 Without Water	(4) Stunted Girls Age 6-17 All	(5) Stunted Girls Age 6-17 With Water	(6) Stunted Girls Age 6-17 Without Water
Soda Price Change	-0.42	-0.17	-0.64	0.18	-0.03	0.40
	(0.43)	(0.68)	(0.50)	(0.40)	(0.88)	(0.25)
	[-4.51, 3.51]	[-2.71, 2.22]	[-5.66, 4.42]	[-1.15, 1.61]	[-1.34, 0.97]	[-0.84, 1.44]
R^2	0.177	0.214	0.131	0.133	0.151	0.116
Observations	4465	2289	2176	4465	2289	2176

	(1) Height Zscore Boys Age 6-17 All	(2) Height Zscore Boys Age 6-17 With Water	(3) Height Zscore Boys Age 6-17 Without Water	(4) Stunted Boys Age 6-17 All	(5) Stunted Boys Age 6-17 With Water	(6) Stunted Boys Age 6-17 Without Water
Soda Price Change	-0.12	-1.40	1.05	-0.06	0.42	-0.29
	(0.84)	(0.18)	(0.67)	(0.81)	(0.21)	(0.70)
	[-6.88, 4.23]	[-7.23, 2.16]	[-7.56, 7.66]	[-1.41, 2.22]	[-0.81, 2.28]	[-2.55, 3.05]
R^2	0.229	0.245	0.173	0.152	0.169	0.112
Observations	3402	1710	1692	3402	1710	1692

Note: This table shows the effect of a 100% change in the real price of soda. Region and year fixed effects are included. Control variables include: age and education attainment and whether the mother works and age of the children. Standard errors are clustered at the region level. P-values are based on wild bootstrapped standard errors to correct for small number of clusters (24).

Table A.5: Falsification Tests on Control Variables - Demand Sample

	(1) HH. Age All	(2) HH. Age With Water	(3) HH. Age Without Water	(4) HH. Educ. All	(5) HH. Educ. With Water	(6) HH. Educ. Without Water
Soda Price Change	1.51	1.89	-3.64	-0.39	-0.51	-0.16
	(0.55)	(0.56)	(0.51)	(0.17)	(0.36)	(0.41)
	[-6.84, 7.90]	[-9.17, 8.22]	[-15.43, 17.42]	[-0.84, 0.38]	[-1.43, 0.86]	[-1.82, 1.28]
R^2	0.015	0.015	0.031	0.124	0.091	0.137
Observations	16952	8788	8164	16952	8788	8164

	(1) Income All	(2) Income With Water	(3) Income Without Water	(4) Sugar All	(5) Sugar With Water	(6) Sugar Without Water
Soda Price Change	-0.18	-0.20	-0.25	-0.20	-0.73	0.34
	(0.70)	(0.77)	(0.66)	(0.52)	(0.55)	(0.76)
	[-0.59, 0.91]	[-0.77, 1.34]	[-0.85, 0.71]	[-1.73, 1.28]	[-2.13, 1.86]	[-6.19, 2.18]
R^2	0.068	0.052	0.078	0.055	0.043	0.068
Observations	16952	8788	8164	16952	8788	8164

Table A.6: Falsification Tests on Control Variables Diarrhea Sample - Women

	(1) Age All Women Without Water	(2) Age Girls Age 13-17 All	(3) Age Girls Age 13-17 Without Water	(4) Open Def. All Women Without Water	(5) Open Def. Girls Age 13-17 All	(6) Open Def. Girls Age 13-17 Without Water
Soda Price Change	-1.63	0.28	-0.74	-0.20	-0.03	0.09
	(0.29)	(0.67)	(0.18)	(0.43)	(0.84)	(0.66)
	[-14.11, 6.88]	[-2.51, 2.11]	[-5.11, 1.41]	[-0.93, 0.64]	[-1.10, 1.07]	[-1.73, 1.35]
R^2	0.008	0.010	0.017	0.036	0.028	0.040
Observations	10189	3110	1491	10152	3098	1488

	(1) Income All Women Without Water	(2) Income Girls Age 13-17 All	(3) Income Girls Age 13-17 Without Water	(4) Education All Women Without Water	(5) Education Girls Age 13-17 All	(6) Education Girls Age 13-17 Without Water
Soda Price Change	-275.80	-615.36	493.29	0.03	-0.76	0.03
	(0.44)	(0.77)	(0.31)	(0.93)	(0.12)	(0.92)
	[-1107.69, 1405.24]	[-2892.16, 3008.45]	[-3220.22, 2348.24]	[-2.27, 2.24]	[-1.84, 0.35]	[-1.39, 2.70]
R^2	0.104	0.119	0.138	0.110	0.111	0.138
Observations	10189	3110	1491	10189	3110	1491

Table A.7: Falsification Tests on Control Variables - BMI Sample

	(1) Adult Woman All Age	(2) Adult Woman Without Water Age	(3) Adult Woman All Education	(4) Adult Woman Without Water Education	(5) Adult Woman All Work	(6) Adult Woman Without Water Work
pricechdecJunpost	0.25	-8.16	-0.40	-0.95	-0.21	-0.16
	(0.87)	(0.24)	(0.48)	(0.40)	(0.56)	(0.69)
	[-13.55, 9.34]	[-30.94, 12.34]	[-3.08, 2.84]	[-4.92, 3.56]	[-1.30, 1.29]	[-1.82, 1.96]
R^2	0.095	0.153	0.188	0.241	0.063	0.093
N	6780	2769	6780	2769	6780	2769

	(1) Girls Age 6-17 Without Water Age	(2) Girls Age 6-17 Without Water M.'s Educ.	(3) Girls Age 6-17 Without Water M. Works	(4) Boys Age 6-17 With Water Age	(5) Boys Age 6-17 With Water M.'s Educ.	(6) Boys Age 6-17 With Water M. Works
Soda Price Change	-2.32	-0.15	0.20	-1.72	0.25	-0.53
	(0.27)	(0.69)	(0.51)	(0.33)	(0.56)	(0.34)
	[-17.84, 4.49]	[-4.28, 2.09]	[-1.98, 3.13]	[-8.85, 4.73]	[-2.24, 3.78]	[-2.22, 1.11]
R^2	0.169	0.244	0.104	0.051	0.165	0.108
Observations	2181	2181	2181	1713	1713	1713

B Appendix: Sensitivity Analysis

Table B.1: Estimations Without Control Variables

	(1) Soft Drinks All Households	(2) Soft Drinks Households With Water	(3) Soft Drinks Households Without Water
Soda Price Change	-2.42	-2.04	-4.09
	(0.08)	(0.17)	(0.02)
	[-6.04, 0.61]	[-6.01, 1.47]	[-7.37, -1.56]
R^2	0.035	0.061	0.083
Observations	16952	8788	8164

	(1) Diarrhea All Women Without Water	(2) Diarrhea Girls (13-17) All	(3) Diarrhea Girls (13-17) Without Water
Soda Price Ch.	0.08	0.05	0.22
	(0.07)	(0.09)	(0.07)
	[-0.02, 0.38]	[-0.03, 0.24]	[-0.05, 0.61]
R^2	0.013	0.011	0.024
Observations	10152	3098	1488

	(1) BMI Adult Woman Without Water	(2) Obesity Adult Woman Without Water	(3) Adult Woman BMI Very Low Height	(4) Adult Woman Obesity Very Low Height	(5) Obesity Girls Age 6-17 Without Water	(6) Obesity Boys Age 6-17 With Water
Soda Price Change	-7.15	-0.52	-12.97	-1.46	-0.14	-0.17
	(0.06)	(0.05)	(0.07)	(0.04)	(0.09)	(0.21)
	[-20.08, 0.46]	[-0.98, 0.01]	[-33.14, 1.80]	[-2.79, -0.10]	[-0.31, 0.08]	[-0.41, 0.14]
R^2	0.090	0.058	0.137	0.095	0.031	0.039
Observations	2769	2769	726	726	2123	1709

Table B.2: Estimations without Eliminating Extreme Values

	(1)	(2)	(3)	(4)	(5)	(6)
	BMI Adult Woman Without Water	Obesity Adult Woman Without Water	Adult Woman BMI Very Low Height	Adult Woman Obesity Very Low Height	Obesity Girls Age 6-17 Without Water	Obesity Boys Age 6-17 With Water
Soda Price Change	-5.61	-0.46	-11.84	-1.37	-0.14	-0.18
	(0.10)	(0.05)	(0.11)	(0.04)	(0.10)	(0.10)
	[-19.44, 3.19]	[-0.98, -0.00]	[-38.54, 6.88]	[-2.87, -0.06]	[-0.32, 0.07]	[-0.41, 0.09]
R^2	0.134	0.089	0.210	0.138	0.033	0.057
Observations	2807	2807	733	733	2123	1709