The Effectiveness of Sin Food Taxes: Evidence from Mexico

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Draft: February 13, 2019

We measure the effect of the taxes on sugar-added drinks and caloric-dense food products introduced in Mexico in 2014. Using a scanner dataset containing information on the weekly purchases of 47,973 barcodes by 8,130 households, we find that at the time of the taxes' introduction, calories purchased from taxed drinks and taxed food decreased respectively by 8.5 and 5.4 percent. Nonetheless, total calories as well as other components like saturated fat, cholesterol, and sodium increased slightly. We show that substitution towards untaxed products and within product categories is a crucial determinant of the overall impact of the taxes.

JEL: H20, I18, H31

Keywords: Obesity, Sin Taxes, High Caloric Foods and Drinks.

* Marc Brooks, Kin Gutierrez, Isaac Meza, and Ricardo Miranda provided outstanding research assistance. We thank Anna Aizer, Jay Bhattacharya, John Cawley, Arantxa Colchero, Janet Currie, Sebastian Galiani, Paul Gertler, Tadeja Gracner, Jonathan Gruber, Fernanda Marquez, Emily Oster, and seminar participants at the Banco de Mexico, ITAM, LACEA, NEUDC, and RIDGE for their very helpful comments. We are grateful to Kantar Worldpanel for providing the data used in this paper and to ConMexico for their support in obtaining the latter. ConMexico hired the authors of this paper to write a report on the impact of the taxes. The authors' right to also exploit the dataset for academic purposes was stipulated in the contract for the report. ConMexico had no voice or veto regarding the content of this paper. All errors are ours. Corresponding author: enrique.seira@gmail.com

I. Introduction

Obesity and its associated chronic illnesses are a growing and costly health problem affecting both developed and developing countries. Since 1980, worldwide obesity rates have almost tripled, while the prevalence of diabetes and hypertension has doubled (Gracner (2015), WHO (2002)). At the top of the ranking of obesity among adults in OECD countries where on average 18% of the adult population is obese are Mexico and the US, with values of 35% and 32%, respectively. While the high costs of obesity are undeniable, debate continues over the extent to which government intervention is needed and what policies might best combat the problem. Proposals span a wide spectrum (Cawley, 2015), including increasing the availability of drinking water, mandating nutritional labeling, launching media campaigns promoting healthier lifestyles[1], and limiting the serving sizes of certain high-caloric foods OECD (2014). Several international institutions and various policy-makers strongly advocate for taxes on high caloric foods and sugary drinks. In fact, some countries have already implemented or are discussing such measures.[2]

In this paper, we explore whether two such taxes —a one peso per liter tax on drinks with added sugars, and an 8% VAT on solid food products with high caloric density (more than 275 calories per 100 grams)— introduced in Mexico on January 1, 2014, had an impact on the nutritional composition of household consumption bundles.[3] We exploit an extraordinarily detailed proprietary home scanner panel dataset from Kantar Worldpanel (KWP), which contains information on the weekly purchase of 47,973 product-barcodes for 8,130 households in 93 cities across Mexico, combined with information on the nutritional content of all the food and drink products in the dataset.

[1]Recent literature has, however, shown that simply informing individuals about their health status, or even giving disease diagnoses, has little effect on their diets (Hut and Oster (2018),Oster (2017),Ogden et al. (2010))

[2]Most saliently, the UK recently announced a tax on sugary drinks. Some US states have imposed taxes on sodas. In 2011, Denmark implemented a tax on all foods with saturated fat content above 2.3%, only to revoke it a year later. Finland has imposed extra taxes on candies, ice cream, and soft drinks since 2011. That same year, Hungary levied a tax on a range of products including soft drinks, energy drinks, pre-packed sweetened products, salty snacks, and condiments. In France, a tax on all beverages with added sugar was introduced in 2012. Ireland, Japan, and the US have implemented or are considering implementing such taxes. The city of Berkeley, in the US, also recently introduced similar taxes

[3]The implied tax rates introduced in Mexico for sugary drinks are 2 to 3 times higher than those of US. This tax has attracted an enormous amount of international attention. For instance, a Google query of "obesity tax Mexico" in February 2016 resulted in 490,000 hits. The tax has been reported on, among other places, in The Economist, the New York Times, and the Financial Times.

Using an event study design (exploiting the exact date on which both taxes came into effect), we document a 9.7% increase in prices and a 8.5% decrease in the purchase of calories from taxed drinks (TDs) associated with the introduction of the tax. Similarly, we document a 6% increase in prices and a 5.4% decrease in the purchase of calories from taxed foods (TFs). Importantly, when we sum calories from all product categories in our dataset (taxed and untaxed), we find a small but positive 3.7% *increase* in the purchase of *total* calories. We also find an increase in the consumption of other nutrients, such as cholesterol (12.6%), sodium (5.8%), saturated fat (3.1%), carbohydrates (2%), and proteins (3.8%). To the extent that total caloric intake is the main cause of weight gain, the lack of a decrease in total calories documented in this paper is concerning. We also estimate price incidence and quantity changes by BMI of the household head. While we find that price incidence is very similar across the BMI distribution, the effect on total calories is instead somewhat heterogeneous, with increases for normal and overweight households, but not for obese ones. Price incidence and quantity changes do not differ by our measure of socioeconomic status, except for low increases in caloric consumption among the poorest group.

We explore the mechanisms behind these results. The lack of a decrease in total caloric intake is mainly driven by substitution towards untaxed goods, which include both food products containing less than the threshold level of calories per 100 grams, and items that were exempt from the tax for other reasons. We estimate a 6.8% increase in calories consumed from non-taxed drinks and a 5.4% increase in calories from non-taxed foods. The government decided to exclude a number of goods (e.g. milk, oil, bread - grouped into the so-called Basic Consumption Basket (*Canasta Basica*)[4] from the taxes, even if some are of high caloric content, due to concerns of the regressive nature of the levies introduced. The tax caused, in fact, substitution towards these untaxed goods. This outcomes highlights the tension between the objective of reducing consumption of certain goods while at the same time trying to limit the negative welfare effects of such taxes on the poor.

These taxes also implied changes in relative prices in both the TD and TF categories and con-

[4] The basic consumption basket is a collection of about 80 goods deemed indispensable for a family to satisfy their basic consumption needs. It is determined by the central bank based on the income and expenditure survey (ENIGH).

sequently different substitution patterns *within* these groups. In particular, within TD, barcodes with higher caloric content saw larger price increases. However, the opposite was true for TF: the ad-valorem tax on high caloric foods generated greater price increases for barcodes with fewer calories within this category shifting relative prices in favor of goods with more calories within the TF group. These results suggest that the design of the taxes may be an important determinant of its ultimate impact.

Our paper contributes to different strands of literature. It adds to the growing body of work that endeavors to identify whether food and soda prices are responsible for the rise in obesity rates.[5] Most studies, however, correlate prices and quantities, conflating supply and demand, and find a wide range of estimates (Andreyeva et al. (2010)).[6] A different strand of the literature deals with the endogeneity of prices by conducting randomized experiments that vary prices. Their main limitation is that they observe consumption only at the specific experimental site and therefore cannot fully account for substitution patterns that may arise beyond that location.[7] In Cawley (2015)'s words, this literature "is limited by a scarcity of powerful and valid instruments for prices, time costs, and generally missing data on the intermediate step of food consumption." This study provides both a valid instrument for prices and very detailed data on food consumption.

Most of the existing work estimates the demand elasticity for sodas and simulates what the effect of the taxes would be, without modeling the supply side of the market. That is, they use variation in prices, not in taxes, and therefore cannot measure the pass-through of taxes to prices or, for that matter, the effect of tax reforms. We measure the effect of an actual tax on a national scale and directly observe the resulting price changes. Studying *actual* taxes instead of simulated ones is crucial since, as we will document, there is considerable heterogeneity in

[5]See Cawley (2015) for a recent review of this literature.

[6]Other non-experimental studies estimate the direct relationship between consumer's weight and soda and food prices, finding small correlations (Powell et al. (2009) and Lakdawalla and Zheng (2011)). For expositional purposes, and to show that our data is consistent with this literature, Figure A.XIII in appendix section V confirms two of the stylized (correlational) facts in the existing literature: the cross-sectional relationship between TD prices and liters consumed and the cross-sectional relationship between TD prices and BMI is negative, although this is not necessarily a causal relationship.

[7]In a meta-study of 23 papers on experimental results, Epstein et al. (2012) show that the price elasticity of foods oscillates between -0.5 and -3.8 depending on the product and setting. Giesen et al. (2011) find that although price changes cause variation in consumption, this is not reflected in calorie changes. In contrast, Yang and Chiou (2010) study price changes in sugary drinks and find a price-calorie elasticities of -0.6.

price changes across taxed products, and this had an effect on total calorie consumption. Taxes to fight obesity are controversial and difficult to design[8], not only because the large variety of substitution possibilities makes modelling difficult, but also because food is a physiological need and a central planner may only wish to discourage *over*-consumption.[9]

Our paper is, of course, also closely related to other recent studies on the impact of the Mexican tax on drinks with added sugars. Grogger (2015), for example, investigates the effect of the tax on the prices of sugary drinks and those of their substitutes. He finds a significant increase (more than 100% pass-through) in the price of taxed drinks and a smaller increase in that of non-taxed drinks, which he interprets as evidence of substitution towards non-sugary drinks as a result of the tax. Our analysis of the impact of the tax on prices corroborates these findings, but differs from Grogger (2015) in two main respects. First, we exploit a household-level panel dataset, which allows us to construct a household-specific price index. This in turn allows us to explore whether the taxes' impact varied with respect to household-level observable characteristics (such as BMI and socio-economic status). Second, because we directly observe the quantities of all taxed and untaxed products, we can further explore to what extent the substitution patterns induced by the introduction of the taxes affected caloric intake from both categories of products.

Another related study is that of Colchero et al. (2016), who investigate the impact of the Mexican tax on drinks with added sugar on the quantity consumed, also using a (different) proprietary household scanner panel dataset. Our paper confirms their main finding: at the exact timing of the introduction of the tax, we observe a significant decrease, of 8.5%, in the purchase of calories from TDs. Given that both we and Colchero et al. (2016) exploit proprietary data in

[8]Policy-makers promoting food-specific taxes often cite correlations between food prices, soda consumption, and weight (e.g., Duffy et al. (2010), Malik et al. (2006)) as supporting evidence for such taxes. On the one hand, Philipson and Posner (2008) argue that "Probably any feasible tax response would cost more to enforce than it would be worth in reducing the social costs of obesity" and Gruber (2010) argues that "a simple tax on calories could do more harm than good by deterring low-income people from getting enough nutrition." On the other hand, Brownell and Frieden (2009) argue for an excise tax and claim that not only would it be effective, but that "it is difficult to imagine producing behavior change of [the magnitude of a tax] through education alone". Finally, Griffith and O'Connell (2010) discuss the complexity of such taxes but do not take a strong position for or against them due to a lack of empirical evidence. Other academics such as Bhattacharya and Sood (2011) question the very existence of negative externalities caused by obesity, and suggest there may not be a need for corrective taxation at all.

[9]To make progress, Gruber (2010) recommends starting cautiously, trying and evaluating a tax on sodas like the one we study for Mexico here.

our respective analyses, it is of value to corroborate this finding.

We build on the literature in three additional respects. First, we focus not only on the tax on drinks, but also measure the effect on consumption induced by the tax on high caloric foods. Second, we explore in detail whether these taxes induced substitution from taxed to untaxed categories, and within taxed categories, allowing us to calculate the taxes' impact on the nutritional content of a larger consumption bundle. Third, we study total calories, and find that despite the decrease in the consumption of taxed drinks, the total consumption of calories did not decrease in the short term.[10] Fourth, using a synthetic control method we are able to estimate effects on soda consumption up to 12 months after the implementation of the tax. We close the paper by showing long run (3-4 years after the taxes) trends of soda production, and taxed drinks and taxed food consumption.

The study most similar to ours is that of Fletcher et al. (2010), who exploit cross-state variation in soda taxes in the US to estimate a difference-in-differences model of state-level taxes on liters of soda consumed, calories consumed, and weight. They find that a 1 percentage point increase in the tax implies a reduction of only 6 soda-calories per day, and no change in total calories. The taxes we study are 3 to 4 times larger than those studied by Fletcher et al. (2010) and were implemented on a national scale (thus limiting out of State substitution possibilities). Our data also allows us to look in more detail at the substitution patterns induced by the Mexican taxes, and the impact that their introduction had on the consumption of other nutrients.

The paper proceeds as follows. Section II reviews the obesity outlook in Mexico and provides details on the taxes we evaluate. Section III describes our data sources. Section IV outlines our empirical strategy. Section V presents the main results, while sections VI and VII discuss robustness checks and longer run effects. The last section concludes.

[10] Given that we employ an event-study design, our analysis focuses mostly on short-run effects. Colchero et al. (2016) extrapolate trends linearly to identify effects after several months. Batis et al. (2016) study the kilos of food, again extrapolating trends, and conclude that we need studies that study calories and nutritional intake, which we do.

II. Context

Over the past decades, worldwide obesity rates have risen at an alarming pace. In Mexico, the proportion of the overweight population has increased from 30 to 70% over the past 25 years Gracner (2015). This has large health implications: obesity is a major cause of chronic diseases like diabetes and hypertension (Kahn et al. (2006), Eckel et al. (2011)), which account for more than one third of the costs of health care in Mexico (Barquera et al. (2010)). The direct and indirect costs of obesity in Mexico increased from 35 billion pesos in 2000 to 67 billion in 2008. According to the Mexican Ministry of Health, 3 out of 4 hospital beds are devoted to patients with obesity-related diseases.[11] The cost is also high in terms of lives: the mortality rate due to type 2 diabetes increased from 77.9 to 89.2 per 100,000 inhabitants between 2000 and 2007, making it the number one cause of death in the country (Sánchez-Barriga, 2010) (see Olshansky et al. (2005); for the US case, see and Bhattacharya and Sood (2011)).

In an effort to fight widespread obesity, on January 1, 2014, the Mexican government introduced two levies as part of Mexico's Special Tax on Production and Services (*Impuesto Especial de Productos y Servicios –IEPS* for its acronym in Spanish): a tax on drinks with added sugar, and another tax on high caloric dense foods.[12] The nominal incidence of the tax falls on producers and importers, who pay the taxes on a monthly basis to Mexico's tax authority. The 2014 IEPS reform established that drinks with added sugars were to be taxed at one peso (6 US cents) per liter, which amounts to approximately 12% of their average price. Taxed drinks include sodas, some nectars, concentrates with added sugar, and powdered drink mixes, among others described in detail in the appendix.[13] Dairy products are exempt, as are alcoholic beverages, although the latter are subject to another tax rate defined in the IEPS law.[14]. Drinks sweetened

[11] Similarly, Finkelstein et al. (2009) note that "The estimated annual medical cost of obesity in the US was $147 billion in 2008; the medical costs for people who are obese were $1,429 higher than those of normal weight.". The UN (2011) predicts that the cost of diabetes, hypertension, and related chronic diseases in low-and middle-income countries will surpass $7 trillion by 2030.

[12] IEPS was originally established in 1980, and it imposed specific tax rates on the acquisition or import of products such as alcoholic drinks, tobacco, and fuel and on activities such as lotteries and gambling. The 1980 tax did include some drinks with added sugar but was later modified in 1987 to exclude them. Before 2014, the government only taxed drinks with added sugars as part of a 16% VAT, while high caloric foods were VAT exempt. The tax instituted in 2014 is applied in addition to the VAT for drinks with added sugar.

[13] See Section I.C in the appendix. The law establishes that sugars include monosaccharides, disaccharides, and polysaccharides employed as sugar substitutes with caloric content. Partial liters are proportionately taxed. For example, a 355ml soda is charged a tax of 35.5 Mexican cents.

[14] If a soda is mixed with an alcoholic beverage to form a cocktail and sold, it is considered an alcoholic

with non-caloric sugar substitutes are also excluded. The reform also stipulates a separate tax on foods, which consists of an 8% tax on products with a caloric content greater than or equal to 275 kilocalories per 100 grams, with some exceptions considered as part of the basic Mexican diet (e.g., tortillas and cooking oil). Products subject to this tax include snacks, candies, chocolate, pudding, marmalade, peanut butter, and cereals (among others). Caloric density (calories per 100 grams) is determined using the information on the product's nutritional content information label. If a product lacks this information it is automatically taxed.

The taxes are relatively high (about three times that of the average state-level soda tax in the US) and have a fairly broad base: they apply to 39.4% of food products and 46.3% of beverage products in our data. Taxed products account for about 23% of expenditures captured in our data, 33% of total calories from packaged goods, and 39% of total food expenditures. The introduction of these taxes resulted in 31,945 million pesos of tax revenues in 2014, 18,280 from TDs and 13,666 from TFs. This represents a significant fraction of the total revenue from IEPS.[15]

III. Data Sources

We exploit two main data sources: a detailed proprietary dataset on household consumption collected by Kantar Worldpanel (KWP), and data gathered by our own research team on the caloric and nutritional content of products in the KWP dataset.

A. Household Barcode-Level Consumption

Measuring consumption can be challenging for a variety of reasons. Comprehensive measures require long questionnaires, which lead to respondent fatigue and non-compliance (Beegle et al., 2012). Such an approach also typically measures unit values instead of prices, and rarely consumption at a fine level of disaggregation, either in terms of products or frequency of purchase. The ideal dataset to determine the effect of taxes on consumption would be a household-level

beverage, and taxed as such.

[15]In 2014, IEPS revenue totaled 124,061 million pesos, an increase of 51.7 percent with respect to 2013. Source: http://finanzaspublicas.hacienda.gob.mx/es/Finanzas_Publicas/Estadisticas_Oportunas_de_Finanzas_Publicas, consulted on March 25, 2016.

panel with high frequency consumption data, together with scanned product barcode-level information on quantities and prices, where prices are gathered from ticket receipts to eliminate reporting errors. The data would ideally include measures of BMI and other socioeconomic characteristics to study heterogeneous effects. The KWP dataset provides just such information.

KWP is an international company that operates in over 50 countries and has over 60 years of experience.[16] They specialize in the collection of high quality household consumption data, aimed at satisfying company information needs for marketing and sales strategy purposes. In order to ensure a high quality panel, KWP recruits and provides incentives to households for participation, selecting a representative sample of households across 93 cities in Mexico. Households participate in the panel for up to four years, during which they are required to keep ticket receipts for all purchases made in formal and informal establishments. They are visited by surveyors weekly and all collected receipts are scanned and saved. The scanned information allows KWP to record each product's barcode, price, number of units purchased, week of transaction, and type and name of the store. KWP also assigns precise information to each barcode: the product's brand name, its content in liters (for drinks) or grams (for solid foods), whether it was bought as a bundle of units, and in this case, the number of units per pack. In addition, the dataset contains a detailed catalog of barcodes, indicating the broad category of each product (e.g., carbonated flavored beverages, coffee, snacks, soup, yogurt, cereal, etc.), its flavor, whether it is branded as low in calories or sugar, and some of its ingredients (importantly for the categorization of barcodes into taxed and untaxed, this includes information on whether it is a dairy product).[17] In our main results, we exploit the information in this dataset for all weeks in 2013 and 2014, restricting to households that were interviewed at least once in both 2013 and 2014. This amounts to 8,130 households in 93 cities and 727,397 household-week observations.[18] Our data includes 2,560 barcodes for sugary drinks and 3,663 barcodes of high caloric food products.

[16]KWP is the main competitor of Nielsen, and its household level data is similar to that of Nielsen, but it covers more households and more cities in Mexico.

[17]Figures A.I and A.II in section I.A in the online appendix provide examples of the dataset's level of detail.

[18]Of all the households in our sample, 20.8% reported their purchases every week in the 2013-2014 period, 25.9% reported for all except three weeks at most, and 53.3% reported purchases for more than half of all the weeks in 2013 and 2014.

KWP also carries out a yearly questionnaire that captures a useful set of socioeconomic and demographic characteristics, including household assets and both the male and female household head's age, weight, and height, from which we compute their body mass index (BMI).[19] We classify households as having a normal weight if the reported BMI of the female head is lower than 25, over-weight if it lies between 25 and 30, and obese if above 30.[20] We use KWP's classification for our socioeconomic status (SES) categories, which gathers households into three groups (ABC+, CD+, and DE) as a function of household assets, where ABC+ refers to the highest SES level.

Table I shows that the KWP information matches important data from Mexico's 2014 Income and Expenditure Survey (ENIGH) and the 2012 Health and Nutrition Survey (ENSANUT), the country's main consumption and health surveys. The average age of household heads is 46, and 79% are male. We also observe also a close match with asset holdings, from which KWP constructs its SES categories. Finally, BMIs are similar, even though the ENSANUT BMIs are measured by trained nurses rather than self-reported. This suggests that the KWP data is relatively representative of the country.

While extraordinarily detailed and well-suited for study of the impact of the taxes in Mexico, the data does have some limitations. First, it measures purchases, which do not necessarily correspond perfectly to consumption. However, as we show below, there is no indication of change in households' inventories around the taxes' introduction date. Since our identification strategy measures change in quantities, and as long as waste is unaffected by the tax, our estimates should approximate changes in consumption well. With this caveat, we will use the word purchases and consumption interchangeably. Second, our dataset contains information only on processed packaged foods, and does not include the purchase of fresh foods like fruits and meat. Table I shows that, according to the ENIGH, the average Mexican household's monthly food expenditure amounts to 2,415 pesos, while, on average, the KWP captures a monthly expenditure on food products of only 1,085 pesos. Yet the ENIGH captures about the same level of

[19]See online appendix for more details. BMI measures are self-reported, which may impose limitations on our analysis. Nonetheless, data checks (see working paper version) suggest they are good indications of individuals' body weight.

[20]We find a large within household correlation, above 0.5, for the BMIs of the male and female heads of the same household. Because strong positive correlations of BMI across members of a household are typical, we take the liberty of referring to household BMI, even if we are using the female household head BMI only.

expenditures on the goods included in the KWP as KWP data does. Importantly, taxes are levied on packaged products, not on fresh food. As long as the degree of substitutability and complementarity between packaged and fresh foods is low, our estimates of the *change* in consumption of nutrients from the set of products included in the KWP will not be biased. Moreover, given that the existing literature argues that the availability of *packaged* foods and drinks is likely one of the most important forces behind increasing obesity rates (Cutler et al. (2003), Brownell and Frieden (2009)), our focus on these goods is appropriate.[21] Finally, the KWP records only in-home consumption. According to the 2014 ENIGH, 19.5% of all food expenditure corresponds to out-of-home consumption in Mexico. In order to explore whether our results are biased due to the exclusion of out-of-home consumption, we compare our estimates of the impact of the tax on drinks with those obtained using total soda production from national statistics and obtain similar results.[22]

B. Barcodes' Nutritional Content

In order for taxes to be an effective tool in combating obesity, they must affect caloric intake.[23] Our main analysis explores whether this occurred, and observes change in the purchase of various nutrients: sugar, carbohydrates, fat, saturated fat, cholesterol, sodium, and protein. To this end, we systematically collect nutrient information for a large share of the barcodes contained in the KWP data, made possible because the great majority of the products are packaged and display nutritional content labels, as mandated by law. Our enumerator team gathered information for 6,071 barcodes representing 81.6% of all purchase events, which correspond to 83.1% of expenditures in our data. As coding the nutritional content required direct observation of product labels in supermarkets and convenience stores, the information for items available only in specific regions was imputed following a careful procedure described in detail in subsection I.C in the online appendix. It is possible that our imputation procedure could introduce mea-

[21] 59% of total expenditures in the KWP data are devoted to food and drinks, while 22% of total expenditures correspond to taxed products.

[22] Dubois et al. (2014) is the closest paper to ours in terms of data, and thus faces similar limitations. Our working paper version explores in detail potential bias in our estimates driven by partial observation of consumption and concludes that we are not underestimating the taxes' impact.

[23] There is a ongoing argument in the medical literature stating that the source of calories matters as a well, with sugars being potentially more damaging. We don't take a position and report changes in several nutrients.

surement error in one of our main outcomes of interest. We consequently perform several tests on the quality of the imputation and conclude that this risk is small. Moreover, the fact that we find precisely estimated effects for some nutrients suggests that noise is not too large.[24]

IV. Empirical Strategy

Identifying the effects of the introduction of this Mexican tax reform is challenging for several reasons. First, it did not consist of a universal tax on food and sugar, but was rather aimed at thousands of specific products. Thus in order to analyze the taxes' impact, it is necessary to first identify which of the barcodes in the KWP dataset were subject to the taxes and which were excluded. To this end, we rely on the content of the above-mentioned IEPS law and detailed statements provided by Mexico's tax authority, as well as consultation with the industry. Second, the impact of the tax reform could differ across products (and households), and complex substitution patterns might occur both within taxed foods/drinks and towards untaxed products. We consequently focus first on a summary measure of the aggregate effect of the taxes that takes into account all substitutions: total calories purchased. Indeed, reducing total calories –and consequently obesity– was the primary objective of the reform. We study substitution patterns across products only after establishing the total effect on price, calories, and nutrients. A third challenge concerns isolating exogenous variation in taxes. Most studies conduct comparisons across markets or across persons, conflating supply and demand. Furthermore, the literature tends to use variation in prices, not in taxes, and therefore cannot measure the pass-through of taxes to prices or, for that matter, the effect of tax reforms. In order to identify causal effects, our main empirical strategy exploits the sharp price variation which occurred at the moment the taxes were enacted together with the high-frequency data in the event study design described below.

Given that there are thousands of products subject, and not subject, to the tax, we needed a

[24]One such check randomly deletes the nutritional information for 10% of the products captured and uses the remaining 90% to perform our imputation procedure. We compare the real values to the imputed values and show that the imputation error is very small. The interquartile range *of the imputation error* of calories for TDs (TFs) is 9.5 cal/100ml (35 cal/100gr), with a mean error of 11.14 cal/100ml (49.5 cal/100gr) (see Appendix). This compares favorably with the interquartile range of calories 39.51 cal/100ml (317.11 cal/100gr) and a mean of 127.5 cal/100ml (267.4 cal/100gr). We also hired an internationally renowned auditing firm, who used their own procedure to compare calories. They independently concluded that our data on calories is of high quality.

strategy to study substitution. The simplest approach is to classify products into four different categories: taxed drinks, non-taxed drinks (NTDs), taxed foods, and non-taxed foods (NTFs). This allows us to focus on obvious substitutions - namely between taxed and untaxed goods - in a parsimonious way. We could look for substitutions across all products in our sample but this quickly turns into a dimensionality problem as there are thousands of items, as well as raises a statistical issue of multiple testing. Another avenue would be to choose a particular subset of products like milk and water, but this would be ad-hoc.

We also explore the effect of the taxes on price incidence and how the latter varied both across socio-demographic groups and normal versus overweight individuals.[25] The government wished to avoid, to the extent possible, price increases for the poor, hoping that the highest price increases would primarily affect the overweight population. One challenge in studying the effect of price is again that there are thousands of products. Our solution was to construct a Laspeyres-type price index for each household in our dataset for each of the four product categories, and for the whole set of products consumed during 2013 according to the KWP. Conducting the analysis at this level of aggregation makes the size of the dataset more manageable, as well as automatically weights the results by the appropriate consumption quantities for each household or groups of households.[26]

A. Construction of the Main Variables

A1. Tax variable

We begin by distinguishing between taxed and untaxed barcodes in the KWP dataset. To this end, we use the two main official regulations and resolutions issued by the Mexican tax authority (SAT) –the IEPS law, and the Miscellaneous Fiscal Resolution[27]– to identify which goods are taxed. Using this information, we classified products in the KWP data as taxed or

[25]Whenever we use the word "prices", we are referring to purchase prices, which is what we observe in our data.

[26]An alternative would be to run regressions at the barcode level with barcode fixed effects, and weight the barcode by the amount of it consumed in the economy. Our index is not only simple to construct and implement, it explicitly incorporates the weighting.

[27]These regulations can be accessed at (IEPS law): https://goo.gl/K44kp5 and here (Miscelanea Fiscal): https://goo.gl/uJBCya

untaxed,[28] implementing this procedure separately for drinks and food (as done by the law).

More specifically, we first identify all food and drink barcodes in the data. Then, because the main potential errors in the classification between taxed and untaxed products come from exemptions described in the law, we simply identify, based on their caloric content (for TFs) or the sugar added (for TDs), which barcodes qualify for a tax exemption. For barcodes in the drinks category, we consider all dairy products and all items with no added-sugar as tax-exempt. For foods, we classify all product categories included in the Basic Consumption Basket and all barcodes with less than 275 calories per 100 grams as exempt from the tax.

Section II in the online appendix describes in detail the procedure adopted to classify products into the taxed and untaxed categories. Roughly, all barcodes that meet the caloric density criterion within the following broad categories of the KWP are subject to the tax: snacks, confections, chocolate and other cocoa products, flans and puddings, marmalades, jams and other spreads made from fruits and vegetables, peanut and hazelnut-based creams and butters, dulce de leche, cereal-based processed foods, ice creams, sorbets and popsicles. Drink products that were classified as subject to the tax include: all flavored drinks (carbonated and non-carbonated), concentrates, extracts, essences and powders that when diluted result in flavored drinks as long as they contain added sugar. Given that the average price per liter of SDs in December 2013 was close to 8 pesos, the one peso per liter tax represents, on average, 12% of the pre-tax price. We carefully exempted products included in the Basic Consumption Basket.

Given that our findings on substitution rely on the correct classification of products as taxed or untaxed, we asked an independent and renowned international auditor (Deloitte) to verify our classification. We provided them with the full sample of food and drink barcodes and requested that they use their own methodology to choose 200 products and assess the accuracy of our classification. Deloitte chose the 200 products for which they anticipated the greatest likelihood of misclassification on our part. Based on the results of this exercise, the auditor concluded that our procedure adequately interpreted the tax regulation. Of the 200 products chosen as *difficult to classify*, there was disagreement on just 6.5% of the cases from our classification. In 4.5% of the cases, it was judged that the law is not specific enough to be able to clearly classify the

[28]The Stata do-files are available at `http://www.aguilaresteva.com/do-files/`.

product.[29]

Further evidence that our classification is correct can be obtained directly from the data and our results. First, we find that prices jump sharply for taxed goods right around the tax implementation date, whereas they change only slightly for untaxed products.[30] Second, we obtain almost identical quantitative results as other papers that have estimated the decrease in quantities of liters of taxed drinks using alternative data sources, suggesting that their classification is similar to ours. Moreover, our main result focuses on the purchase of total calories and other nutrients, which is unaffected by any dispute of the accuracy of our classification of products into taxed and untaxed.

A2. Quantity Variables

This paper examines the consumption of different nutrients. Our main outcome variables therefore are the total consumption of each respective nutrient. We aggregate detailed weekly household $\times$ barcode level information in the KWP data as follows. For each household i in week t of year y, we calculate a measure of calories from taxed drinks consumed (C^{TD}_{ity}) by first multiplying the units of barcode b consumed, u^{TD}_{bity}, by their calories, c_b, and then summing across b for all barcodes in the TD category. Formally, $C^{TD}_{ity} = \sum_{b \in TD} u^{TD}_{bity} c_b$. We do this separately for untaxed drinks, taxed foods, untaxed foods, and for all food and drink products together.

A3. Price Variables

Creating a household level price index requires a bit more care. We generate a Laspeyres-type index keeping each household's weekly 2013 consumption basket (q^{2013}_i) fixed throughout all

[29]These cases correspond to situations in which the tax definition is not clear and mostly apply to types of ice-creams that, despite being foods potentially subject to the tax (as explicitly indicated by the law), had less than 275 calories per 100 grams according to our conversion (ice cream has to be melted to be weighed). The other product which gave rise to discrepancies were creamer substitutes for milk (e.g., coffee creamers). While we understood that creamer substitutes are derived from milk and thus excluded them, Deloitte thought they should be included. In any case, they constitute just a small percentage (less than 0.5%) of food expenditures. When we re-estimate our main table classifying all ice-creams as taxed, and then as no ice-creams taxed, the results are almost identical (see Table A.IX).

[30]Some of the prices of untaxed goods changed as well, but to a much lesser extent. We know, for example, that in the case of Diet Coke, for which we had the opportunity to speak directly with producers, this is an explicit strategy of keeping relative prices constant. In other cases, this may be due to increased demand for untaxed goods.

of 2013 and 2014. We avoid using 2014 observed purchases for the construction of this consumption bundle, since the 2014 quantities purchased may have been affected by the tax. For each household we calculate what it would have spent had it kept the average 2013 basket of products J constant across time, but using actual prices. This means that for both 2013 and 2014 the index is an imputed expenditure. Since we want to calculate percentage changes, we normalize the index to 100 in December 2013. The household-level price index then assigns to each barcode a weight that is equal to the fraction of total expenditures that each household devoted to that barcode during 2013. Formally, our household-level price index can be expressed as:

$$P^J_{ity} = \sum_{b \in J} (u^J_{bi,2013}\ p^J_{bity}) * \frac{100}{A_i} \tag{1}$$

where $A_i = \sum_{b \in J}(u^J_{bi,2013}\ p^J_{bi,52,2013})$ is household's i 2013 consumption basket value in December of that year, where $u^J_{bi,2013}$ measures the total units of barcode b (restricted to group J) purchased by household i in 2013, and p^J_{bity} is the price of barcode b that household i incurs in week t of year $y = \{2013, 2014\}$. We calculate price indices for the four subsets of barcodes: $J \in \{TD, NTD, TF, NTF\}$. Once we have price indices defined at the level of the household, we can easily conduct analyses for groups of households, such as the overweight or the low income, by aggregating them accordingly.

Note that p^J_{bity} is not always observed, as household i may not have purchased item b in week t. In such cases, prices are imputed following a sequential procedure. First, we impute the average price for each item in the respective week, city, and store. When barcode-level prices are still not observed for a given item in a given week, city, and store, we proceed to a higher level of aggregation. Further details on the price imputation procedure are provided in section III of the online appendix.[31]

[31] These imputations seem to be a good approximation of true prices given that imputation-cell dummies explain on average 93% of the price variation for TD and 72% for TF. This means that price variation within cells used for the imputation procedure is small.

B. Identification Strategy and the Target Parameter

Our empirical strategy exploits the sharp change in prices observed on the date when the taxes came into effect. It can thus be considered as an event study or as a regression discontinuity design that uses time as a running variable, with the date after which the taxes were introduced (January 1st, 2014) as the treatment of interest. A number of recent papers have profitably used an analogous empirical design (e.g. Byker (2016), Chetty et al. (2014a), Chetty et al. (2014b)), but it has a tradition in economics and finance (MacKinlay (1997)). The main identification assumption is that absent the tax change, prices and quantities of food consumed would have followed a smooth trend after controlling for seasonality, and so any sharp change in prices in January 2014 can be attributed to the taxes.

In a potential outcomes framework let $Y_i(1)$ and $Y_i(0)$ denote potential outcomes with and without the tax. Let $\bar{t}$ denote January 1st 2014. A consumer i is then treated at week t when $t \geq \bar{t}$.

$$Y_i = \begin{cases} Y_{it}(0) & \text{if} \quad t < \bar{t} \\ Y_{it}(1) & \text{if} \quad t \geq \bar{t} \end{cases}$$

We are interested in estimating the average treatment effect of the tax close to the enactment date $\tau := \mathbb{E}\{Y_{it}(1) - Y_{it}(0) | t = \bar{t}\}$. Following the literature we construct the estimator of τ by using kernel-based local polynomials on either side of the threshold.

$$\hat{\tau}_p(h_n) = \hat{\mu}_{+,p}(h_n) - \hat{\mu}_{-,p}(h_n) \tag{2}$$

where where $\hat{\mu}_{+,p}(h_n)$ and $\hat{\mu}_{-,p}(h_n)$ represent the intercept (at $\bar{t}$) of a weighted pth-order polynomial regression for only treated and only control units, respectively, and h_n is a positive bandwidth sequence. Following Calonico et al. (2014) we use local polynomial and robust bias-corrected confidence intervals in our RD estimation to estimate the effect of the tax. Concretely, we use local regression with a second order local polynomial and triangular kernel with a 52 week bandwidth using the Calonico et al. (2017) rdrobust stata command. We perform this estimation after partialling out week-of-the-year and household fixed effects from our main outcomes to remove seasonality and household-specific components (Calonico et al. (2018)). Section 4 of the online appendix presents a series of robustness checks. The results are robust to different bandwidths, including 6,9,12,15, and 18 months (Table A.VII). We provide graphical evidence for all our main estimations, which visually corroborate the discontinuous jump. Finally we also compare our results with parametric specifications and find similar results (Table A.VIII). Note that given the nature of the RD design, we can only identify the effect locally, which means that we estimate short run responses to the tax.

V. The Impact of the Taxes

This section presents the main effects of the taxes on drinks and foods on prices and nutrients. We will then discuss mechanisms and robustness in the sections that follow. We first review the graphical evidence and then show the RD statistical estimates from equation 2. We present results for all 4 categories of goods —(a) Taxed Drinks, (b) Untaxed Drinks, (c) Taxed Foods, (d) Untaxed Foods— and the overall effects on the aggregate consumption basket.

A. Prices

One important aspect of taxes is their price incidence. An increase in price from the tax is a necessary condition for its effectiveness in reducing consumption. Price incidence depends on the supply and demand (own and cross price) elasticities for the thousands of products that were taxed and their substitutes[32], which is why it is difficult to predict exante the effects of such levies.

We begin with graphical evidence. Figure I presents the weekly evolution of the price indices constructed using equation 1 for different baskets of goods. We show the demeaned and seasonally adjusted index. These residuals were obtained from an OLS regression of the price index in equation 1 –for instance P_{ity}^{TD} for taxed drinks– on household fixed effects and 51 calendar

[32]Throughout the text we avoid talking about *a* demand elasticity, since many products were taxed. Our aim is not to estimate demand elasticities but rather only the reduced form effect of the tax on the nutrients of the consumption basket. Estimating demand elasticities would require many assumptions in our set up; we have only one instrument for prices and hundreds of pricing equations.

week dummies. We then use these residuals at the household-week level to plot a binscatter plot and a quadratic polynomial prediction, separately to the left and right of the threshold, along with a 95% confidence interval for the mean prediction. Since quantities are kept constant at their 2013 level, the jump observed in January 2014 is only attributable to changes in prices, not to changes in consumer behavior.[33] The large jump in TDs and TFs contrasts with their non taxed equivalents, which display much smoother trends. Looking at these graphs, it may appear tempting to use untaxed drinks and foods as a control group or placebo check. However, as we will later show, households responded to the taxes by substituting away from taxed products and increasing their consumption of untaxed items. The slight increases in prices for untaxed drinks could potentially be explained by this shift in consumption.[34]

We now discuss the quantitative effect separately for the four categories of products in light of the results in Panel A of Table II. We observe that prices of taxed drinks increased by 9.7%, which is roughly an average pass through of 4/5.[35] Similarly, the prices of taxed foods increased by 6%. Given that these foods were subject to an ad-valorem tax of 8%, average pass through was about 3/4, lower than that for taxed drinks. For NTF, we detect a slight 0.78% increase in the price, and for NTD a 2.7% increase. As mentioned above, these later results could be interpreted as evidence of substitution towards these categories. In the following sections we directly document that such substitution did indeed occur by looking at quantities. Our results resemble those of (Grogger, 2015), who finds that soda prices increase by about 1.2 pesos per liter and taxed non-carbonated drinks by about 0.7 pesos. The results do not, however, need to exactly given that we have a larger set of goods and a greater number of cities,[36] and we weight by the actual consumption of the households in our dataset.

[33] The raw data presented in the working paper version of the paper indicates that prices have an upward trend consistent with inflation, and that prices for taxed drinks and foods jump immediately when the tax comes into effect. This increase does not show signs of abating later in the year.

[34] We know that Coca Cola increased the price of Diet Coke and Coke Zero –which are not taxed– simultaneously with the price of taxed Coke as a part of their strategy of keeping relative prices relatively constant.

[35] Because this averages across hundreds of types of drinks we do not map this number into demand and supply elasticities. Furthermore, Bulow and Pfleiderer (1983) showed that even in a simple monopoly case, we can not infer demand elasticity from the effect of cost changes on prices.

[36] Our dataset contains information on households' purchases in 93 cities, while Grogger (2015) observes the prices that the Mexican statistics office collects, in 46 cities, and uses menu prices instead of purchased prices.

B. Nutrients

Ultimately, we are interested in the impact of the taxes on the nutritional content of households' consumption baskets. We follow the same methods to analyze the effect of the taxes on calories and other nutrients for the four categories of foods/drinks under consideration.

Figure II shows RD graphs of calories purchased, using the same methodology as described for prices, but with the log of calories as a dependent variable. We observe that calories from taxed drinks experience a sharply declined in the weeks following the implementation of the tax. On the contrary, calories from untaxed drinks increased. The same is true of food: while we document a significant decrease in the purchase of calories from taxed foods, there is an increase in calories from untaxed foods. For both beverages and solid foods, the evidence thus points toward a substitution of calories from taxed to untaxed products. In fact aggregating across all categories, subfigure (e) shows that there is *a slight increase* in total calories purchased. Quantitatively the results in Table II show that calories from taxed drinks decreased by 8.5%.[37] Those from taxed foods decreased by 5.4%, while those of untaxed drinks and untaxed foods increased by 6.8% and 5.4%, respectively. Aggregating these effects, total calories purchased *increased* by 3.6%.

Figure III presents RD graphs for nutrients other than calories, while the accompanying Table III shows the estimates of the total change in consumption of nutrients attributable to the introduction of the taxes. All estimations are run with the full sample, while each column uses the log of a different nutrient as the dependent variable: sugar, saturated fat, carbohydrates, cholesterol, sodium and proteins. We find no effect on sugar, a 3.1% increase in saturated fat, a 2% increase in carbohydrates, a 12.6% increase in cholesterol, a 5.8% increase in sodium, and a 3.8% increase in proteins.

Section VI and Section 4 in the online appendix show that the results presented here are robust to different bandwidths, anticipatory effects, different classifications of taxed products (based on the Deloitte's assessment), using soda production instead of consumption, and several

[37] In our working paper version we estimate an analogous decrease for taxed drinks when measured in liters. In a paper written contemporaneously with ours Colchero et al. (2016) use home scanner data from a different source (Nielsen) and another methodology and find very similar results for the impact of the SD tax on liters of SD purchased (they don't observe calories). In light of the replication crisis in economics, we consider this similarity in results a positive outcome.

placebo checks.

C. Heterogeneity

Studying heterogeneity in our context is important. The government's aim is to target as much as possible the overweight and obese population and reduce their caloric consumption, while at the same time limit the tax's incidence among low income groups and thus curb regressiveness. Table IV shows the effect of the tax on calories estimated separately for different subsamples based on the pretreatment body mass index category and pretreatment socio-economic category.

Panel A replicates the results of Table II for comparative purposes only. Panel B shows the estimated effects for households who had an obese, an overweight, or a normal weight household head. We observe very similar average increase in prices for taxed drinks and taxed food for these groups. There is no particularly higher price incidence for the obese group. In addition, while there is an increase in total calories for the overweight and the normal-weight households, there is no such increase for the obese households. Panel C shows also that while every socio-economic level household experienced similar increases in prices, increases in total calories were concentrated in the high and medium socioeconomic strata, with the low strata experiencing a non-significant change in the latter.

D. Discussion of Main Results

The small but positive effect in total calories is not encouraging news. The goal of these sin taxes is to decrease caloric intake (and by this route obesity), which did not happen here. Although the existing studies and the media have praised the Mexican tax reform for the decrease in liters of soda consumed –which we replicate– none have studied total caloric intake. Our results on total calories provide a less optimistic prediction of the taxes' potential effect on obesity. The following back-of-the-envelope calculation is illustrative. Using Mexico's National Health Survey (ENSANUT) which covers in-home and out-of-home consumption Stern et al. (2014) find that children 1 to 4 years old consume only 20 calories from soda per day, while they consume close to 100 from milk, another 75 from flavored milk, and 25 from juice drinks. Adults consume less than 100 daily calories from sodas. If we take the 7%-8% reduction in soda consumption observed by both Colchero et al. (2016) and us, we would conclude that the tax on drinks achieved an average reduction of 7 calories per day for adults, and less than that for children, even before taking substitution into account.[38] Yet these are averages, and concentration among the overweight could imply larger effects. However, even if they were concentrated among the overweight population (1/3 of the total) this would amount to only about an 18 calorie ($= 6 \times 3$) per day reduction from TD.

One may be concerned with measurement error in the construction of the calories and nutrients data. Yet the fact that we *do* find calorie reductions for taxed drinks and foods, and an increase in calories from untaxed categories makes it unlikely that our results are spurious. Furthermore, we find very diverse effects on different nutrients, suggesting systematic substitution patterns towards foods with more fats but not more sugar. Section V.E below shows that substitution patterns map closely onto specific relative price changes within TD and TF categories.

Another concern may be that calories do decrease but only for products outside the KWP dataset. While we cannot fully address this concern, we believe it is unlikely that substitution towards products not included in the KWP dataset can invalidate our main findings. First, our data contains most of the goods to which the new taxes applied. For substitution patterns to overturn the positive effect, households would have had to *decrease* their consumption of *untaxed* goods not included in our dataset in a significant way. We explored this possibility in the working paper version and we conclude that, if anything, we may be biased against finding a zero or negative effect on calories, since we find that the more expenditure we capture (compared to matched households in the Mexican expenditure survey) the larger is the positive effect we estimate. Secondly, as we will show below, we find similar results when using production instead of consumption as the dependent variable.[39]

The most important caveat to our results (and those of other papers studying this tax) is that we focus on estimating effects on calorie consumption in the short run. To our knowledge only Fletcher et al. (2010) have attempted to measure effects on soda consumption and total

[38] One way to benchmark this is again to cite Stern et al. (2014), who observe that "From 1999 to 2012, total daily energy from beverages increased among children aged 5-11 (+45.3 kcal), females aged 12-19 (+57.3 kcal), and adult females aged 20-49 (+96.4 kcal)." So we are finding average effects that are an order magnitude smaller than the recent 13 year increase, and this is before we take substitution into account.

[39] Since international trade in sodas is negligible, national production should approximate total national consumption well, even if it is outside the household.

calories in the medium run as responses to soda taxes using a differences in differences strategy comparing across several US states. They find that soda taxes in the U.S. led to a decrease in daily soda consumption of 6 fewer calories per day, but they also find no decrease in total calories once other substitute foods are taken into account.[40] In Section VII we plot longer run trends of soda production and TF and TD consumption and show that these are still on the rise. We also use a synthetic control methodology comparing households in Mexico to those in Central America and show that the tax seemed to have only a temporary effect in soda consumption, with no effect 1 year after the tax.

We conclude this section by reviewing our methodology. Our main identification assumption (for the short run estimates) is that once we control for week dummies and smooth time trends, the sharp increase in prices in January are due to the new taxes. We argue that the following aspects provide strong evidence for the validity of this assumption: (a) the sharp price increases and their unusualness compared to price changes on other dates (see the Fisher tests in subsection IV.F in the online appendix), (b) their overwhelming presence in taxed foods and drinks compared to untaxed items, (c) RD evidence presented in the appendix (Figure A.VI), which employs the caloric density threshold (275cal/100gr) of the tax rule to show a discontinuous jump right at the threshold, (d) the fact that they only jump in such a way for Mexico compared to other countries and for 2014 compared to other years within Mexico.[41]

E. Substitution within Taxed Drinks and Taxed Foods

Thus far, we have shown that the introduction of the taxes did not have the desired impact on total calories purchased. While the taxes did decrease caloric consumption from taxed products, substitution towards untaxed barcodes counteracted this reduction. This was in part due to the fact that the 2014 left many drinks and foods untaxed. In 2013, 65% of calories came from foods and drinks in our dataset that were not in these taxes' tax base. This includes milk, juice, beer and alcoholic drinks, bread tortillas, etc.

[40] This paper complements that of Fletcher et al. (2010). There are several differences between the two. First, in our case the taxes we study are about 3 times large. Second, our tax is national and and applies to a much broader set of goods. One therefore may expect less substitution. Third, they use cross sectional comparisons in a DID framework whereas we use an RD design. Finally, and perhaps more importantly, we study specific substitution patterns within taxed goods and across taxed and untaxed goods.

[41] See working paper version for point (d).

The richness of the data allows us not only to study responses across taxed and untaxed categories, but also to observe shifts within both the taxed drinks and foods categories, and to understand which particular products experienced the largest changes. A useful way to organize this analysis is by comparing price changes for barcodes with more calories versus those with less calories. We model the relationship between prices of barcodes p_b and calories per barcode c_b using a polynomial of degree q and parameters β: $h_q(c_b, \beta)$. We then allow this relationship to change after the tax is implemented. For practicality, we estimate the following regression by OLS:

$$y_{bity} = \alpha_i + \gamma_{w(t)} + f(t, g(b)) + \eta I(t \geq 2014) + f(t, b) \times I(t \geq 2014) + h_q(c_b, \beta) + \mathbf{I(t \geq 2014)} \times \mathbf{h_q(c_b}, \theta) + \nu_{bity} \quad (3)$$

The regression is estimated at the barcode b, household i, week t level of year y. We weight each barcode by the number of units of that barcode sold in the 2013-2014 period. Note that by controlling for smooth time trends in prices of groups of barcodes $f(t, g(b))$[42], we use variation given by the discontinuity at the moment of the taxes' implementation for identification. We are interested in the term $I(t \geq 2014) \times h_q(c_b, \theta)$ which measures discontinuous changes in prices and consumption before versus after the tax across barcode's caloric content (c_b). We also control for household fixed effects α_i, seasonality with 51 week dummies ($\gamma_{w(t)}$), and dummies for product groups ($f(t, g(b))$)[43]. We set q=2, which means that a second order polynomial is employed to analyze the heterogeneity of the taxes' impact by caloric content. This regression is estimated for the log prices and for the log number of units purchased of barcode b for household i in period t of year y. Having estimated the coefficients of regression 3, one can calculate the heterogeneous effect of the tax for barcodes with different calories as $\Delta(c_b) = [\hat{y}_+(c_b)] - [\hat{y}_-(c_b)]$. This will be a polynomial of order two that is a function of barcode caloric content (c_b) evaluated at the estimated parameters $\hat{\theta}$ at week 1 of 2014. Here $\hat{y}_+(c_b)$ and $\hat{y}_-(c_b)$ stand for the limits of

[42] We allow for flexible time trends $f(t, g(b))$, where $g(b)$ indicates deciles of calories – each decile has its own quadratic time trend before and after the tax.

[43] e.g. cookies, chips, cereals, etc. Although these dummies do not, however, have much of an effect on the estimation much as we are identifying $h_q(c_b, \theta)$ out of discontinuous changes in prices.

the outcome variable when approaching the discontinuity (January 1, 2014) from the right and left, respectively. Given the interaction with $h_q(c_b, \theta)$, this is a function of c_b.

Figure IV plots $\Delta(c_b)$ as a red line separately for taxed foods and for taxed drinks, where the dependent variable is either prices or quantities. The figures also display in the background a histogram of calories per barcode to show that barcodes cover the whole support. Panel (a) shows that prices increased proportionately more for units with higher calories within the taxed drinks category: from a negligible price change for units with less than 200 calories, up to an increase of almost 14% for units with 1000 calories. Such price increases should discourage consumption of the more caloric units, and indeed this seems to be the case: note the corresponding change in relative demand shown in Panel (c), where higher calorie barcodes experience a decrease in purchases. Interestingly, the opposite occurs for taxed foods: barcodes with *less* calories experienced *higher* price increases. The difference is almost 15 percentage points between units with 2500 calories versus those with close to 100 calories. This means that the price-substitution effect is pushing consumers towards buying barcodes with *more* calories (see Panel (d)).[44]

These results underscore the difficulty of predicting the effects of taxes on total nutrient consumption. In the case of Mexico, TFs suppliers changed prices in such a way that the resulting relative prices created substitution effects towards more caloric foods. Understanding why is, unfortunately, beyond the scope of this paper. Each barcode has its own demand curve and may have a different supply side structure, making this a complex problem. Moreover, while taxes on foods were ad-valorem, those for drinks were unit prices, and we know from the literature that unit prices have larger pass through under fairly general assumptions (Delipalla and Keen (1992), Suits and Musgrave (1953)).

[44] In the working paper version we also find substitution toward smaller TD package sizes, and towards products with cheaper calories.

VI. Robustness

A. Anticipatory effects

A crucial assumption of our methodology is that consumers and producers reacted to the taxes on the date when they came into effect. In our estimation, we assumed that inventories stayed constant before/after the tax and interpret the changes in purchases as shifts in consumption. If in 2013 consumers anticipated higher prices and consequently increased their inventories before the tax was imposed, we would be *over*estimating the effect of the tax, as we would observe higher than normal purchases before its introduction and fewer purchases right after its implementation.

If this is indeed the case, it would go against our argument that changes in calories were minuscule. We perform a simple exercise in order to explore whether this channel is operational. We recalculate our estimates by excluding one, two, and three weeks before and after the introduction of the tax, finding almost identical effects (see Table A.X). We also implemented a placebo test. Following the logic of a Fisher exact test we estimated our main specification - imputing different placebo tax dummies for each of the 53 weeks between July 2013 and June 2014. Figures A.VII and A.VIII in the appendix show these estimations for our main results on prices and caloric consumption, respectively. Here we rank the estimated placebo treatment effects, and show clearly that January 2014 is clearly an atypical month for price and calorie changes for the product categories we analyze. Finally, the appendix Table A.XI shows that there is not any atypical hoarding (higher purchases of TD) just before the tax came into effect.

B. Industry Level Production

A final potential caveat to consider is that of in-home versus out-of-home consumption. As described in Section III, KWP measures only the former, such that our results apply only to in-home consumption.[45] We address this question by analyzing changes in total *production* of sodas in Mexico as a function of the tax. Given that (a) less than 2% of sodas sold in Mexico are

[45] According to the the National Survey of Household Income and Expenditure (ENIGH), about 20% of food expenditure corresponds to out-of-home consumption.

imported/exported, (b) neither exports nor imports of sodas changed with the introduction of the taxes,[46] and (c) that inventories likely do not vary considerably over a period of several months, *total* domestic production should be a good proxy of *total* domestic consumption. Estimating a drop in production of a similar magnitude as that reported above would provide strong evidence that changes in total out-of-home consumption are at most small.

To estimate the effect of the tax on the production of soda, we use public data from Mexico's National Institute of Statistics and Geography (INEGI). Concretely, for prices we use Mexico's Consumer Price Index (INPC), and for quantities we use the Monthly Survey of Manufacturing Industry (EMIM). The INPC data is gathered from more than 16,000 stores in 46 cities countrywide, while EMIM includes more than 1,200 food and beverage manufacturing plants. The EMIM survey is designed to cover, on average, more than 80% of production in every product category, although in the specific case of sodas all producing plants are surveyed. Soda production is measured in thousands of liters and is classified into five packaging and flavor categories. For the analysis, we sum these to get total production. An added advantage of this analysis is that since the information is public, it is easy to replicate. A disadvantage is that it that they are aggregate national time series data.

To conduct this test, we follow an empirical strategy that is as close as possible to that used before, except that here we are forced to use aggregate time series information on national prices and production and, given the paucity of data, estimate a parametric RD. We run the following specification:

$$log(Y_{ty}) = \alpha_t + \theta I(y \geq 2014) + f(ty) + \epsilon_{ty} \tag{4}$$

where Y_{ty} refers to prices and volume produced, $f(.)$ is a second order polynomial in time, α_t are monthly dummies, and $I(y \geq 2014)$ is our variable of interest. We have monthly data from 2007 to 2015 on soda prices and quantities.[47]

[46] See figure A.IX in the online appendix.

[47] Figure A.X in the online appendix plots the log of seasonally adjusted liters produced, revealing both a sharp jump in the price of sodas and a slowdown in the growth of soda production, thus qualitatively replicating our main finding using the KWP data.

Columns 1 and 2 of Table V present the estimated θ coefficient when the dependent variable is the soda price index and thousands of liters respectively. The main takeaway is that the results are quantitatively close to our previous results: we find an increase of 12% in price of sodas and a decrease of 6.9% in liters of sodas produced. To assess whether these results are spurious, we also estimate *placebo* regressions, where instead of using January 2014 as the start of the tax regime we use January 2012 and 2013. Columns 3 and 4 present placebo results for 2013 for price and quantity, while columns 5 and 6 do the same for 2012. Placebos show no changes in quantities and small decreases in prices. This suggests that we are not reaching erroneous aggregate conclusions by not observing out-of-home consumption in the KWP data.

VII. Longer Run Effects

Thus far we have focused on short-term results given that the RD methodology we rely on is local in nature. Longer run effects are, however, certainly of interest. Unfortunately, these are harder to estimate, both because the time span in our data is not long and because the policy we study was national, making it difficult to identify a control group that was unaffected by the tax.

We can, nonetheless, see from Figure Figure II that although there was an immediate decrease in calories from TDs consumed, afterwards there is an upward trend, reaching a level that is close to the pre-tax one. That said, many things may have changed after the tax, and the event study methodology is less credible if we extrapolate for months after the event. In an attempt to shed some light on long-term outcomes, in this section we plot time trends for the production of drinks and for tax revenues from TD and TF, as well as employ a synthetic control method (SCM) to compare the consumption of sodas for households in Mexico with that of households in six Central American (CAM) countries (Costa Rica, Guatemala, Honduras, Nicaragua, Panama and Salvador) for which we also have scanner data for the same period of time.

Panels (a) and (b) of Figure V use two independent data sources to assess the evolution of the consumption of TDs. They have the advantage of plotting longer-term results –4 years after the tax– and of using easily accessible public data, but the disadvantage of not presenting rigorous causal effects. Panel (a) uses INEGI data[48] on liters of drinks produced in Mexico by year. To ease comparison of growth across drinks, we normalized production to 1 in 2014. We observe a flat production profile for sodas from 2011 onwards, and no visible change after the tax.[49] In addition, we also observe an increasing trend in water production since 2007 that accelerated somewhat after the tax, with an even larger increase for juice of almost 40% in the 3 years following the tax.

Panel (b) uses data from Mexico's tax authority (SAT)[50] to plot tax revenue from drink and food categories reported by SAT, including exactly what we have called here TD and TF, as well as drinks that are taxed from before and did not experience tax changes in 2014. Recall that for taxed drinks one peso is collected for each liter, so tax revenue tracks taxed liters exactly. While the tax on sugary drinks and high caloric foods began on January 1, 2014, beer and liquor had already been taxed for many years before that. Since there were no tax rate changes for these drinks in the plotted period, changes in revenue are good proxies for changes in consumption. The figure also plots total VAT collected for comparison. Again we normalize to 1 in 2014. Two results stand out in this graph. First, there does not seem to be a trend break in 2014 on the consumption of TD and TF when looking at yearly averages. Second, the consumption of TD and TF continues to increase at high rates, even 4 years after the tax: consumption of TD and TF is about 30% higher in 2017 than in 2014. In fact, consumption grew *faster* in TD and TF than in VAT and beer, although slower than liquor. This of course does not mean that the tax did not work, since the counterfactual consumption might have been even higher, but it does mean that consumption growth has not stopped, suggesting that obesity is not likely to be hindered by the tax as currently designed today.

Panel (c) uses a synthetic control method to try to get at causality. We focused on CAM countries because their obesity patterns and diet are similar to those in Mexico (see our working paper version of this paper), and because we were able to obtain consumption data for them, covering the same dates (2013-2014) also collected also by KWP using the same methodology as for Mexico. For the estimation, we use all of our Mexican households and 1,954 households

[48] See https://www.inegi.org.mx/

[49] Unfortunately INEGI reports volumes for sodas without separating (light) sodas with no sugar vs those with calories. Note also that sodas are only part of TDs, making panels (a) and (b) not directly comparable.

[50] http://presto.hacienda.gob.mx/EstoporLayout/estadisticas.jsp

for the CAM. An observation in the data is a month of consumption of liters of sodas for a given household. We also observe their monthly expenditure (converted to Mexican pesos) on drinks and food, as well as total liters and kilos of drinks and food purchased (i.e., we observe 5 variables). Unfortunately, neither data on calories purchased or information on food by category is available to us.

We are interested in estimating the effect of the tax on the purchase of sodas for Mexican households. Our dependent variable is the liters of soda purchased in a month by a household. We standardize each observation by subtracting its household specific 2013 mean and dividing it by its household specific 2013 standard deviation. In contrast to Abadie and Gardeazabal (2003) and Abadie et al. (2010) we have multiple treated units. We define a household as treated if it resides in Mexico and the year is 2014. All households in the CAM are potential controls.[51] Several recent papers have shown how to apply SCM methods for multiple treatment units (e.g Acemoglu et al. (2016), Cavallo et al. (2013), Firpo and Possebom (2018), Xu (2016)). Roughly speaking, for each Mexican household, the SCM selects a set of control households in CAM and applies weights to each of them in order to minimize the pre-treatment period distance between that Mexican household and its synthetic control on the five variables we mentioned above. It then calculates the treatment effect in 2014 for *each* Mexican household by comparing soda consumption to that of *its* synthetic control. We then average the treatment effects across the multiple treated units. We obtain confidence intervals by bootstrapping. For brevity we refer the reader to the methodological details described in the above-cited papers.

Panel (c) of Figure V presents the estimated treatment effect by month. The y-axis is measured in standard deviations of liters. The solid line reports mean treatment effects and the dashed line median treatment effects, while the gray area corresponds to 99% confidence intervals for the mean effect obtained by bootstrapping. The x-axis is event time, where January 2014 is time zero and December 2014 is time 11. The pretreatment period shows a reasonably good synthetic control fit in 2013. Immediately after the tax came into effect, we estimate a decline of about 0.2 standard deviations in the consumption of liters of sodas by Mexican households compared to

[51] Once we have multiple treatment units and resampling confidence intervals, the SCM is computationally demanding. As a dimension reduction strategy, we formed 400 clusters of households in Mexico and 100 for CAM using k-means clustering, and keep in the dataset only the median household in each cluster.

their synthetic controls. This is equivalent to 0.8 liters per household-week (close in magnitude to the RD estimate), but it is short lived, reverting to a an effect of zero 3 months after. The effect becomes less precise with time, but there is no noticeable downward trend. This suggest that there is no long run decline in soda consumption, and given our previous substitution results, it is even less likely that there is a decrease in total caloric consumption. A word of caution is in order, as the SCM imposes more identifying assumptions than the RD method, it is best to take care in interpreting these effects, especially for longer periods of time.

VIII. Conclusions

Several governments and different organizations have recently advocated for the introduction of special taxes on food in order to combat obesity. There is, however, little evidence to date of the effectiveness of such taxes. This paper contributes to the current debate by exploiting a uniquely detailed and high quality home-scanner dataset to estimate consumers' response to a very ambitious, large, and national fiscal policy aimed at tackling obesity through taxation.

The richness of the data allows us to estimate the pass-through of the taxes to consumer prices and their effect on the consumption of total calories and other nutrients, as well as to explore consumers' substitutions across and within product categories. We find that both the food and drink taxes implemented in Mexico were moderately effective in decreasing consumption of some taxed drinks and foods. However, we also document substantial substitution towards untaxed foods and drinks, resulting in no decrease in total caloric intake, and an increase in the purchase of other nutrients, such as sodium and saturated fat. Consumption of these taxed goods 4 years after the introduction of the taxes is still on the rise, and although this paper does not examine obesity (see our working paper), international organizations like the OECD as of 2017 still predict a strong increase of obesity in Mexico.[52] This is not much of a surprise. Hill et al. (2003) estimate that to *prevent weight gains* calorie intake has to decrease by 100 calories per day, while Butte and Ellis (2003) say it should be at least 200 calories per day. Even larger reductions would be needed to decrease weight.

Our results provide important insights for those who wish to achieve a reduction in obesity

[52] https://www.oecd.org/els/health-systems/Obesity-Update-2017.pdf

through such taxes, particularly the need to take substitution into account in the design of the tax base.[53] Excluding certain high calorie drinks and foods from the tax base high calorie drinks and foods allows for substitution towards these products. A tax that applies more broadly to sugar or calories could be more effective than that currently implemented in Mexico. But we conjecture that to achieve reductions of close to 200 calories the tax would have to be almost prohibitive, an order of magnitude larger.

Our study has several limitations and directions for further research. First, we have refrained from discussing whether there is an economic rationale for government intervention, or to what extent the regressive nature of the taxes should be traded off against any benefits. It is likely, however, that the dual desire to both reduce consumption but also avoid harming to the poor is what has made this tax less effective. Further research might examine the social costs and externalities of obesity. Second, even if calorie consumption remains unchanged, taxes such as these might have an impact on health through a shift from soda consumption to other foods with different nutritional content. Medical research would have to determine whether the shift we document and its magnitudes are important, while economic research would have to weight health gains against the consumer welfare lost from higher prices. Third, longer run effects on obesity directly should be studied.

Our biggest concern with a unique focus on taxes is that other aspects of public policy like information, easy availability of water and healthy food, and subsidizing exercise are relegated. Obesity is a complex problem and many measures will be needed to limit is advance.

[53]For instance, Stern et al. (2014) show that in the Mexican context, “aguas frescas” which usually sold informally and not not subject directly to drinks tax, supply as many calories to children as do sodas.

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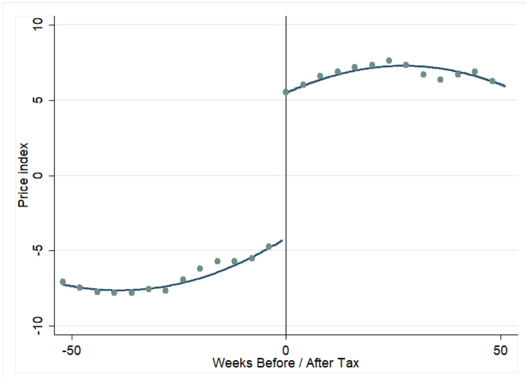
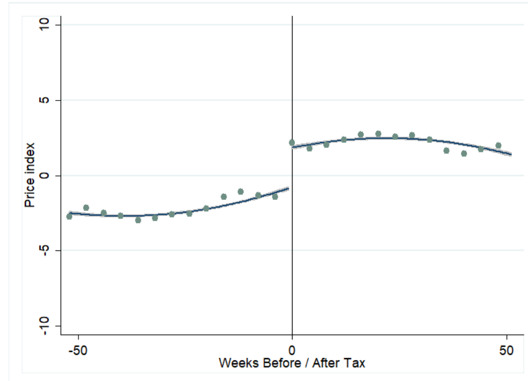
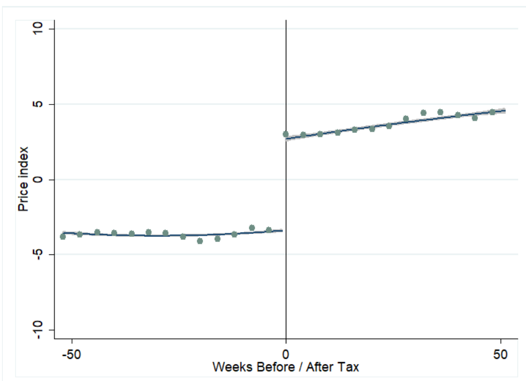
FIGURE I. TAX EFFECT ON PRICES, BY TYPE OF PRODUCT



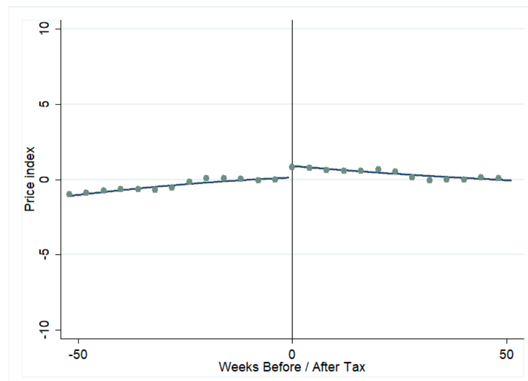
(a) Taxed Drinks



(b) Non-Taxed Drinks



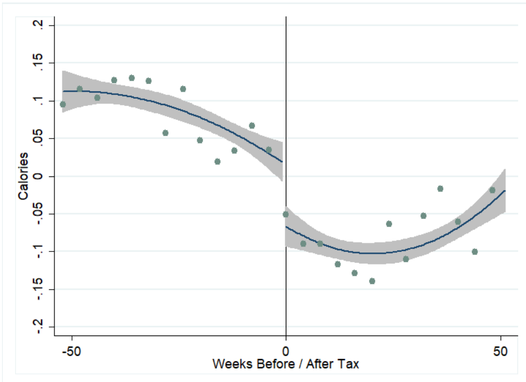
(c) Taxed Food



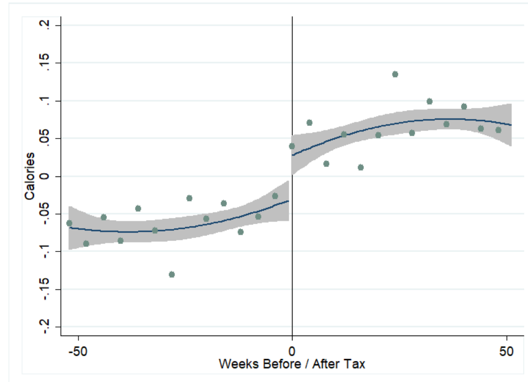
(d) Non-Taxed Food

Note: This Figure show the weekly evolution of the prices indices P^k_{ity} defined in equation 1 for our four baskets of goods: $k \in \{TD, NTD, TF, NTF\}$ and its aggregate. Each graph's horizontal axis covers all 2013 and all 2014. Week 1 corresponds to the first week of January 2014, when the tax started being collected. The price index is representative of our sample households consumption basket in 2013 and normalized to 100 at December 2013. Since quantities are kept constant at their 2013 level, the jump observed in January 2014 is only attributable to changes in prices, not changes in consumer behavior. Graphs show RD plots on de-meaned and seasonally adjusted residuals. These residuals were obtained from an OLS regression of the respective price index P^k_{ity} on household fixed effects and 51 week of the year dummies. We then use these residuals at the household week level to plot a month bin scatterplot, and fit a separate quadratic polynomial prediction to weeks corresponding to 2013 and those corresponding to 2014, along with a 95% confidence interval for the mean. The level change at the discontinuity corresponds to the inferred effect of the tax. Graphs were produced using the qfitci Stata command.

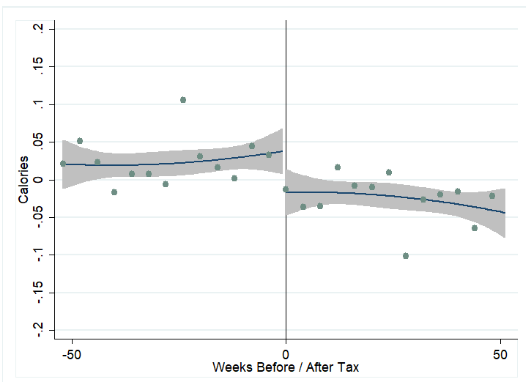
FIGURE II. TAX EFFECT ON LOG CALORIES PURCHASED



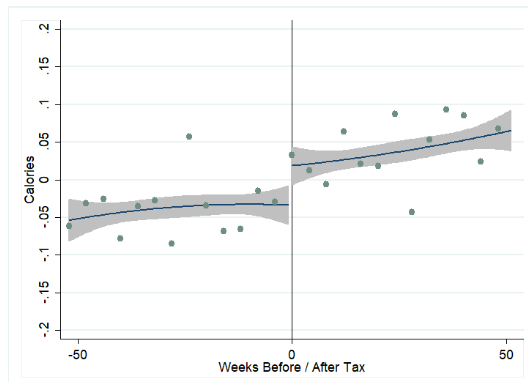
(a) Taxed Drinks (TD)



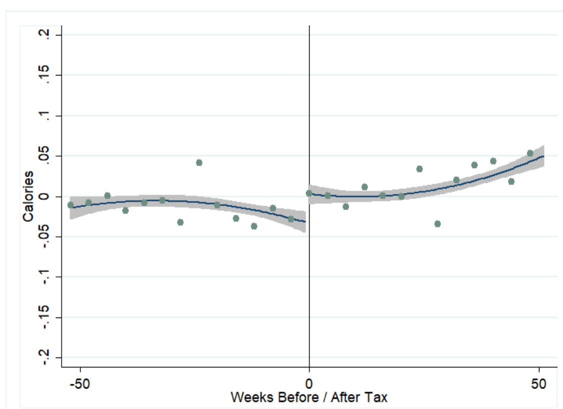
(b) Non-Taxed Drinks (NTD)



(c) Taxed Foods (TF)



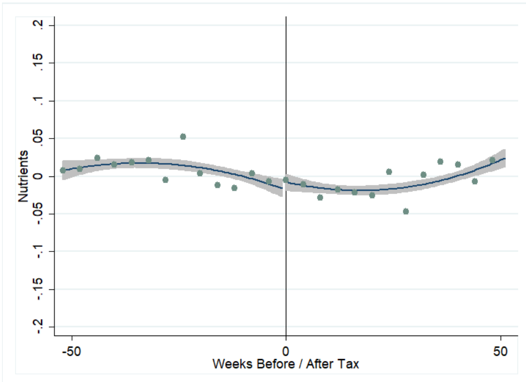
(d) Non-Taxed Foods (NTF)



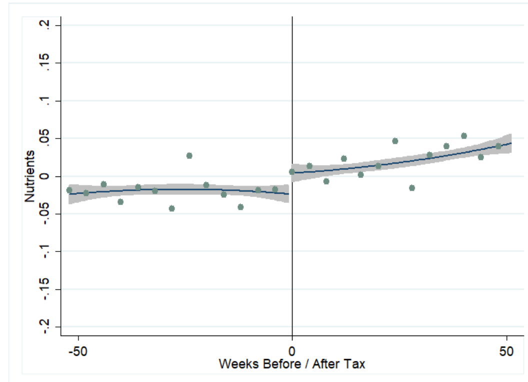
(e) Total Calories

Note: This Figure show the weekly evolution of the calories purchased by Mexicans in the KWP for our four baskets of goods (TD, NTD, TF, NTF) and the sum total across all foods. Each graph's horizontal axis covers all 2013 and all 2014. Week 1 corresponds to the first week of January 2014, when the tax started being collected. We sum calories purchased of food basket type $k \in \{TD, NTD, TF, NTF\}$ by each household i at the week level t, and therefore obtain C^k_{ity}. We then compute $ln(C^k_{ity} + 1)$ and calculate de-meaned and seasonally adjusted residuals from an OLS regression of $ln(C^k_{ity} + 1)$ on household fixed effects, 11 calendar month dummies (February, March,..., December), and a quadratic polynomial in weeks. We then use these residuals at the household week level to plot a month bin scatterplot, and fit a separate quadratic polynomial prediction to weeks corresponding to 2013 and those corresponding to 2014, along with a 95% confidence interval for the mean. The level change at the discontinuity corresponds to the inferred effect of the tax. Graphs were produced using the qfitci Stata command.

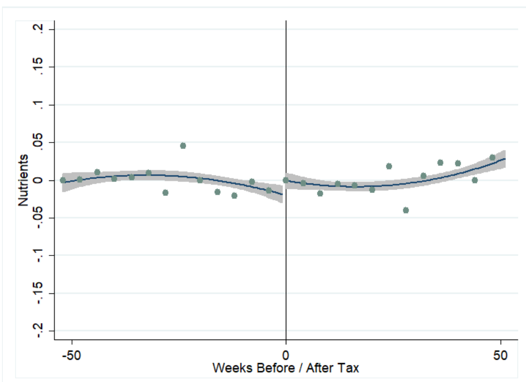
FIGURE III. TAX EFFECT ON LOG NUTRIENTS PURCHASED



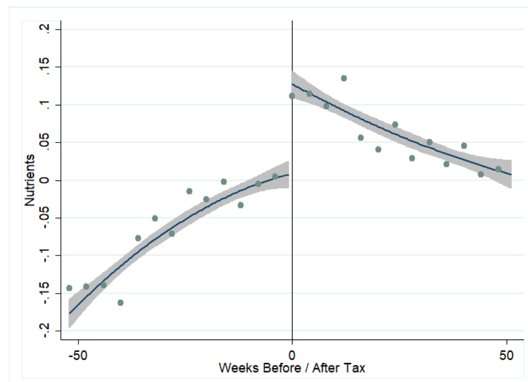
(a) Sugar



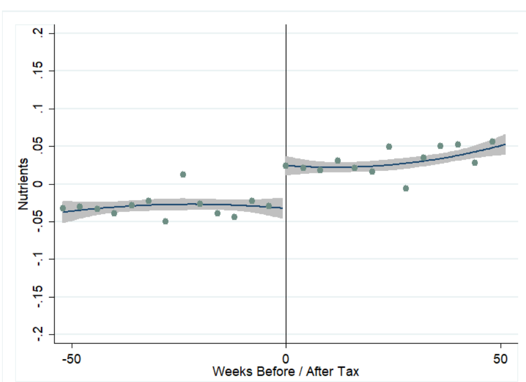
(b) Saturated Fat



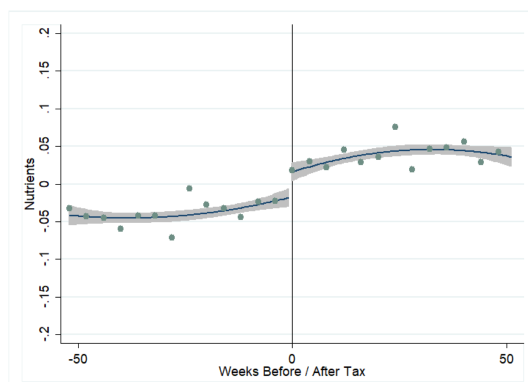
(c) Carbs



(d) Cholesterol



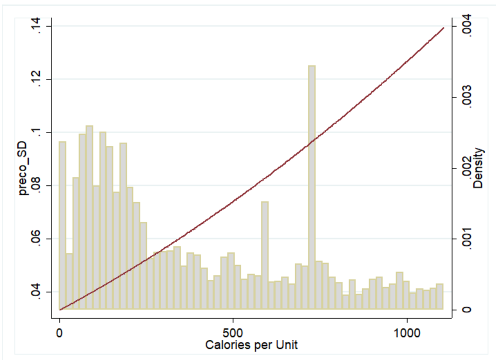
(e) Sodium



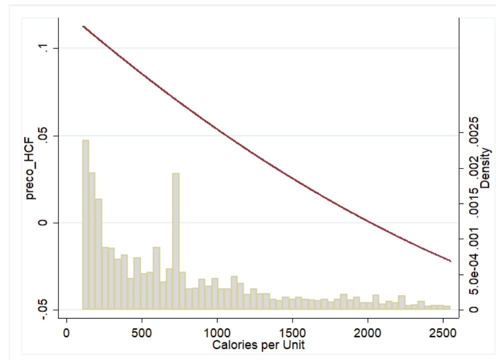
(f) Proteins

Note: This Figure show the weekly evolution of several nutrients purchased by Mexicans in the KWP. These correspond to totals, summing across TDs, NTDs, TFs, and NTFs. Each graph's horizontal axis covers all 2013 and all 2014. Week 1 corresponds to the first week of January 2014, when the tax started being collected. For each nutrient $N \in \{Sugar, SaturatedFat, Carbs, Cholesterol, Sodium, Proteins\}$, we sum the nutrient purchased by each household i at the week level t, and therefore obtain N^k_{ity}. We then compute $ln(N)_{ity} + 1)$ and calculate de-meaned and seasonally adjusted residuals from an OLS regression of $ln(N_{ity} + 1)$ on household fixed effects, 11 calendar month dummies (February, March,..., December), and a quadratic polynomial in weeks. We then use these residuals at the household week level to plot a month bin scatterplot, and fit a separate quadratic polynomial prediction to weeks corresponding to 2013 and those corresponding to 2014, along with a 95% confidence interval for the mean. The level change at the discontinuity corresponds to the inferred effect of the tax. Graphs were produced using the qfitci Stata command.

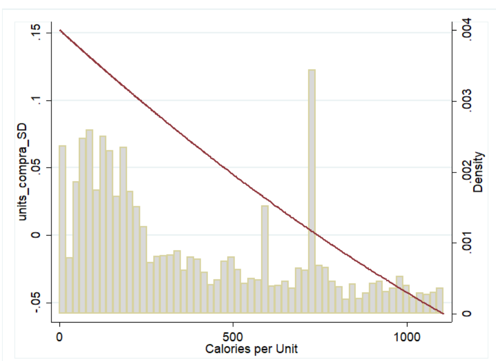
FIGURE IV. PRICE AND QUANTITY CHANGES BY CALORIES OF BARCODE



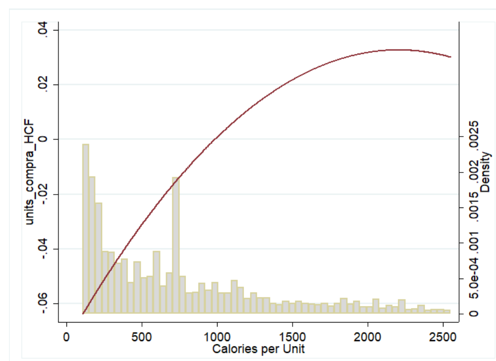
(a) %ΔPrice vs Calories, TD



(b) %ΔPrice vs Calories, TF



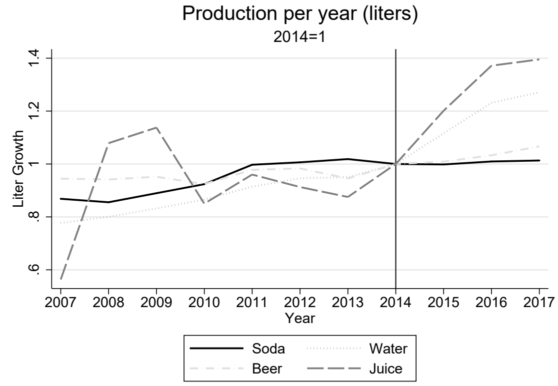
(c) %ΔQ vs Calories, TD



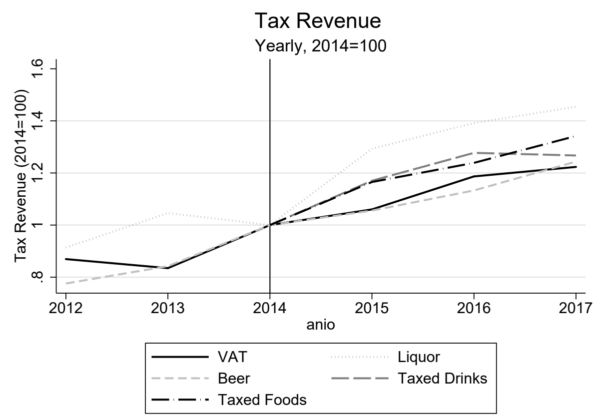
(d) %ΔQ vs Calories, TF

Note: These graphs illustrate the heterogeneous effect of the tax on price and quantities by the caloric content of each product. This is done separately for TD in Panels (a) and (c) or TF in Panels (b) and (d). We model the relationship between prices of barcodes p_b and calories per barcode c_b using a polynomial of degree q and parameters β: $h_q(c_b, \beta)$. We then allow this relationship to change after the tax is implemented. Equation 3 in the paper estimates this relationship. Having estimated the coefficients of regression 3, one can calculate the effect of the tax for barcodes with different calories as $\Delta(c_b) = [\hat{y}(c_b)|I(t > 2014) = 1] - [\hat{y}(c_b)|I(t > 2014) = 0]$, which will be a polynomial that is a function of barcode calories evaluated at the estimated parameters $\hat{\theta}$. This Figure plots $\Delta(c_b)$ as a red line separately for taxed foods and for taxed drinks, where the dependent variable is either prices or quantities. The figures also display a in the background a histogram of calories to show that barcodes cover the whole support. Panel (a) shows that prices increased proportionately more for units with more calories within the taxed drinks category. Panel (c) shows that higher calorie barcodes experience a decrease in purchases. The opposite happens for taxed foods: barcodes with *less* calories experienced *higher* price increases. Panel (d) shows that within TF consumers buy barcodes with *more* calories after the tax

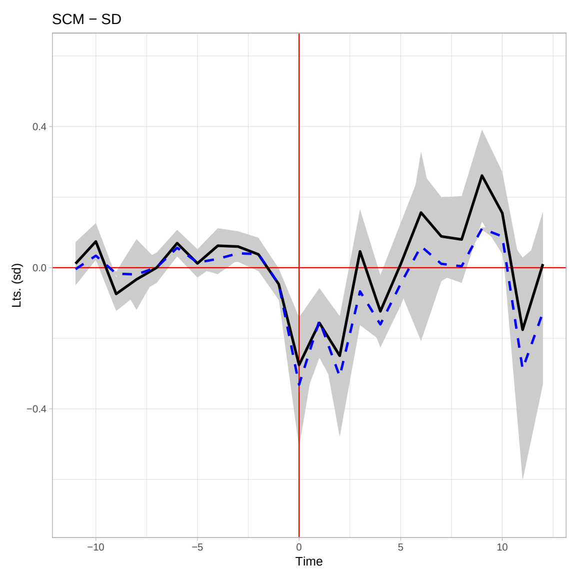
Figure V. Longer Run Analysis



(a) Production of Drinks (taxed and untaxed)



(b) Tax revenue by drink category



(c) Taxed Drinks

Note: This Figure presents outcomes 1 year or longer after enactment of the tax. Panel (a) uses public INEGI data on liters drinks produced in Mexico. Panel (b) uses public data from Mexico's tax authority (SAT). Recall that for taxed drinks one peso is collected for each liter, so tax revenue tracks taxed liters. While what we call Taxed Drinks and Taxed Foods began being taxed on January 2014, beer, alcoholic drinks and Energy drinks have been taxed for many years before that. We also include total VAT collected as a comparisob. For comparability we normalized revenues and production so that they equal 100 in 2014. Panel (c) plots causal estimates of the effect of the tax on soda consumption under the assumptions of the Sythetic Controls Method (SCM). Time=0 is January 2014. The Y-axis is measured in standard deviations of liters and kilos respectively. The solid line reports mean treatment effects and the dashed line median treatment effects, while the gray area correspond to 99 percent confidence intervals for the mean effect obtained by boostraping. A treated unit in our SCM is a mexican household after 2014. Control units are households in 6 central american countries as described in the text.

TABLE I—SUMMARY STATISTICS

Variable	KWP	ENIGH	ENSANUT
Household's Head Characteristics			
Age	46.7 [13.93]	48 [13.9]	49.4 [33.49]
Male (percentage)	0.78 [0.42]	0.72 [0.45]	0.75 [0.43]
Schooling Level			
Primary (percentage)	0.56 [0.5]	0.49 [0.5]	0.67 [0.47]
Secondary (percentage)	0.13 [0.33]	0.16 [0.37]	0.11 [0.31]
More than Secondary (percentage)	0.27 [0.44]	0.35 [0.48]	0.22 [0.42]
Body Mass Index (BMI)	27.5 [4.12]	-	28.34 [5.49]
Overweight (percentage)	0.48 [0.5]	-	0.39 [0.48]
Obese (percentage)	0.28 [0.45]	-	0.33 [0.33]
Household Assets			
TV (percentage)	0.91 [0.29]	0.96 [0.19]	0.93 [0.26]
Computer (percentage)	0.42 [0.49]	0.39 [0.49]	0.24 [0.42]
Car (percentage)	0.43 [0.49]	0.49 [0.5]	0.41 [0.49]
Expenditure[a]			
Total Expenditure	-	8835.59	-
Food at home	-	2414.99	-
KWP goods[b]	1085.33 [673.63]	1193.84	-
Sugary Drinks	256.37 [234.15]	198.71	-

Note: This table compares summary statistics of the main database use in the analysis (Kantar World Panel), in Column 1, against the official expenditure survey (ENIGH 2014), Column 2, and official health survey (ENSANUT, 2012) in Column 3. ENIGH provides the national reference values for household demographics, expenditures and income. ENSANUT provides the national reference values for health and nutrition statistics. We apply the same filters in all the samples for comparative purposes (urban areas only, female household head for BMI measures, and dropped where household head was above 70 years old). The table has three panels: the first has descriptive characteristics of the household head; the second shows household assets; the third panel describes different me Total expenditures are measured in Mexican pesos per household per month. [a] ENIGH figures for expenditures come from the official figures, which can be consulted at `https://goo.gl/HpXMPu`. [b] KWP goods and sugary drinks cannot be perfectly matched to ENIGH's classification. Using the official figures classification, the authors selected those categories of food and beverages that most closey relate to KWP products.

TABLE II—IMPACT OF THE TAX ON PRICES AND LOG CALORIES.

Panel A. Dependent Variable: Price Index (Dec 2013=100)

	Total	Taxed Drinks (SD)	Untaxed Drinks (NSD)	Taxed Food (HCF)	Untaxed Food (NTF)
Tax	4.403***	9.684***	2.673***	6.020***	0.778***
	(0.0262)	(0.0413)	(0.0564)	(0.0805)	(0.0337)
Observations	721,213	721,089	721,213	720,980	721,213
Bias corrected effect	4.731	9.812	3.466	5.992	0.892
Robust Std. Error	0.0327	0.0519	0.0705	0.0977	0.0426

Panel B. Dependent Variable: Log(1 + Calories)

	Total	Taxed Drinks (SD)	Untaxed Drinks (NSD)	Taxed Food (HCF)	Untaxed Food (NTF)
Tax	0.0368***	-0.0853***	0.0677***	-0.0539**	0.0544***
	(0.00973)	(0.0209)	(0.0205)	(0.0237)	(0.0203)
Observations	721,213	721,213	721,213	721,213	721,213
Bias corrected effect	0.0353	-0.0774	0.0785	-0.0523	0.0520
Robust Std. Error	0.0132	0.0278	0.0273	0.0316	0.0272

This table estimates the effect of the tax on prices (Panel A) and calories (Panel B) using a RD methodology with time as running variable and Tax as the treatment dummy. Data employed for this estimation comes from the weekly KWP Mexico chapter for 2013 and 2014. The unit of observation is the household-week. In Panel A the dependent variable is a price index (P^k_{ity}) at the household i week t year y level after partialling out household and week of the year fixed effects. The price index is defined in equation 1, for our four baskets of goods: k $\in$ $\{$TD, NTD, TF, NTF, and ths sum total$\}$. The price index has is representative of the Mexican consumption basket in 2013 and normalized to 100 at December 2013. Since quantities are kept constant at their 2013 level, the jump observed in January 2014 is only attributable to changes in prices, not changes in consumer behavior. In Panel B the dependent variable is the log of one plus total calories purchased by household i in week t year y ($ln(C^k_{ity} + 1)$), described in section III.B. Each column corresponds to a separate regression. Column 1 shows the result for the aggregate consumption basket, while the remaining columns show the effect for subgroups (TD, NTD, TF, NTF). The *Tax* variable indicates that the purchase was done after January 1st 2014. All estimations consist of a local linear regression of a second degree polynomial with triangular kernel weights and a 52 week bandwidth, estimated using *rdrobust* in Stata.

TABLE III—IMPACT OF THE TAX ON THE PURCHASE OF LOG NUTRIENTS

Dependent Variable: Log(1 + Nutrients)						
	Sugar	Saturated Fat	Carbs	Cholesterol	Sodium	Proteins
Tax	0.00978	0.0313***	0.0198**	0.126***	0.0577***	0.0383***
	(0.00905)	(0.00913)	(0.00865)	(0.0132)	(0.0100)	(0.00912)
Observations	721,213	721,213	721,213	721,213	721,213	721,213
Bias corrected effect	0.00886	0.0281	0.0197	0.116	0.0564	0.0430
Robust Std. Error	0.0122	0.0123	0.0117	0.0175	0.0136	0.0122

This table estimates the effect of the tax on total purchase of nutrients using a RD methodology with time as running variable and Tax as the treatment dummy. Data employed for this estimation comes matching the KWP Mexico chapter for 2013 and 2014 with data on nutrients we collected ourselves. The unit of observation is the household-week. The dependent variable is the log of one plus total calories purchased by household i in week t year y — $ln(C^k_{ity} + 1)$— after partialling out household and week of the year fixed effects. The construction of this quantity is described in Section III.B. Each column corresponds to a separate regression, which shows the results for total purchases of sugar, saturated fat, carbohydrates, cholesterol, sodium and proteins. The *Tax* variable indicates that the purchase was done after January 1st 2014. All estimations consist of a local linear regression of a second degree polynomial with triangular kernel weights and a 52 week bandwidth, estimated using *rdrobust* in Stata.

TABLE IV—IMPACT OF THE TAX ON PRICES AND CALORIES BY TYPE OF HOUSEHOLD

	Price index (Dec 2013=100)		Log(1 + Calories)
	Taxed Drinks (TD)	Taxed Food (TF)	Total
Panel A. Baseline results			
Tax	9.684***	6.020***	0.0368***
	(0.0413)	(0.0805)	(0.00973)
Panel B. Heterogeneous effects by BMI			
Tax (normal BMI)	9.445***	6.309***	0.0669***
	(0.0967)	(0.131)	(0.0196)
Tax (overweight)	9.601***	6.075***	0.0530***
	(0.0581)	(0.140)	(0.0142)
Tax (obese)	10.03***	5.700***	-0.0110
	(0.0703)	(0.115)	(0.0185)
Panel C. Heterogeneous effects by SES			
Tax (SES=ABC)	9.740***	5.548***	0.0507**
	(0.0972)	(0.112)	(0.0258)
Tax (SES=CD)	9.753***	5.958***	0.0440***
	(0.0559)	(0.0609)	(0.0137)
Tax (SES=DE)	9.562***	6.325***	0.0193
	(0.0765)	(0.211)	(0.0162)

This table estimates the effect of the tax on prices and calories separately for different populations.The methodology and definitions are as before. For ease of comparison Panel A just copies the main results from Table II. Column 1 should changes in price for TD and column 2 for TF. Column 3 shows the effect on total calories. Panel B applies our estimators to different subsamples defined by the BMI of the household head, while Panel C splits the sample by socioeconomic status (which kantar gets from an function of assets) The *Tax* variable indicates that the purchase was done after January 1st 2014. All estimations consist of a local linear regression of a second degree polynomial with triangular kernel weights and a 52 week bandwidth, estimated using *rdrobust* in Stata.

TABLE V—EFFECT OF TAX ON INDUSTRY PRODUCTION AND NATIONAL SODA PRICES

Effects and Placebos						
	2014		2013		2012	
	Price	Liters	Price	Liters	Price	Liters
Tax	0.12	-0.069	-0.04	-0.01	-0.03	-0.02
	[0.006]	[0.026]	[0.01]	[0.02]	[0.015]	[0.015]
Month FE	yes	yes	yes	yes	yes	yes
Deg. Polynomial	Quadratic	Quadratic	Quadratic	Quadratic	Quadratic	Quadratic
Observations	107	107	107	107	107	107
R-squared	0.99	0.89	0.98	0.91	0.98	0.92

This table presents estimates of the effect of taxes using industry level *production* using survey data from the EMIM industry data, from INEGI. The data have the advantage that they constitute a good proxy for all sales in the country, not only in-home consumption, and that they are publicly available. They have the limitation that they are time series and have no cross-sectional element. Using monthly data from 2007 to 2015 on soda prices and quantities, we estimate by OLS the regression $log(Y_{ty}) = \alpha_t + \theta I(y \geq 2014) + f(ty) + \epsilon_{ty}$, where Y_{ty} refers to prices or volume produced, $f(.)$ is a second order polynomial in time, α_t are monthly dummies, and $I(y \geq 2014)$ is our variable of interest. The tax variable reports the θ coefficient from equation 3. Columns 1, 3 and 5 use the log of the price index as dependent variable. Columns 2, 4 and 6 present use log liters produced in the month as a dependent variable. Robust standard errors clustered at the date level in brackets.