SODA TAXES AND THE PRICES OF SODAS AND OTHER DRINKS:
EVIDENCE FROM MEXICO

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## ABSTRACT

To combat a growing obesity problem, Mexico imposed a nationwide tax on drinks with added sugar, popularly referred to as a "soda tax," effective January 2014. I analyze data on taxed and untaxed products collected as part of Mexico's Consumer Price Index program to estimate how prices responded to the tax. Prices of regular sodas jumped by more than the amount of the tax in the month that the tax took effect. The prices of other taxed drinks also rose, though by a smaller amount. Diet soda prices rose as well, suggesting that consumers may have substituted toward diet sodas after regular sodas became taxable. The prices of bottled water, pure (untaxed) juices, and milk were largely unchanged. A companion analysis of untaxed comparison products showed no general price increases around the time that the soda tax was imposed.

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## I. Introduction

Obesity is a major health problem. It is strongly linked to diabetes, heart disease, and other forms of chronic illness, which are leading causes of death in much of the world (Malnick & Knobler, 2006; World Health Organzition, 2014). Currently, 69 percent of American adults are overweight, meaning that their BMI (the ratio of weight in kilograms to the square of height in meters) is over 25. Thirty-five percent are obese, meaning their BMI is over 30 (Ogden, Carroll, Kit, & Flegal, 2014). Olshansky et al. (2005) argue that recent obesity trends may reduce the life expectancy of future generations of Americans.

Obesity is also a pressing problem elsewhere in the world. Over three-fifths of the world's obese individuals live in low- or middle-income counties (Ng et al., 2014). In Mexico, 73 percent of adults are overweight and 33 percent are obese (Gutierrez, Rivera, Shamah, Oropeza, & Avila, 2012). Analysts estimate that obesity-related disease accounted for 13 percent of Mexican health expenditures in 2008, and project that those costs will double by 2017 (Martinez, Lopez-Espinoza, & Lopez-Uriarte, 2015).

Obesity has been linked to sugar consumption, particularly to the consumption of sodas and other drinks with added sugar (Malik, Schulze, & Hu, 2006). Such beverages deliver many calories without simultaneously reducing appetite. Thus consumers who drink them tend not to offset their calories by reducing their consumption of other food or drink (DiMeglio & Mattes, 2000).

The link between sugary drinks and obesity has led many governments to impose taxes on drinks with added sugar. The theory is simple: a tax should raise the price paid by consumers, which in turn should reduce demand. Although that much is clear, theory

says little about how much prices should rise in response to a tax. In a competitive market, price should rise by no more than the tax. In monopoly markets, however, price may rise by less than the tax, by the amount of the tax, or even by more than the tax, depending on the shape of the demand curve. Models of intermediate market structure make a similarly broad range of predictions (Anderson, Palma, & Kreider, 2001; Delipalla & Keen, 1992; Hamilton, 2015; Stern, 1987). Since the health benefits of a soda tax depend strongly the extent to which the tax discourages consumption, it is important to quantify how the tax affects prices.

Another important question involves substitution patterns. Reductions in soda consumption could have substantial effects on weight if consumers substitute toward low-calorie beverages such as water. Conversely, if they substitute toward high-calorie beverages such as milk, weight may not fall much.

In this paper I analyze how Mexico's so-called soda tax has affected the prices of taxed and untaxed beverages. The tax was imposed beginning January 2014 not just on sodas, but on almost all drinks that contain added sugar. I estimate the effects of the tax on the price of such drinks by tracking the change in prices across 46 Mexican cities.

Figure 1 provides strongly suggestive evidence that the tax raised the price of sodas, an important class of taxable drinks. It plots the Mexican Consumer Price Index (CPI) for sodas (*refrescos* in Spanish) by month for the period January 2010 to March 2015. Prices jumped sharply in January 2014, the month that the tax took effect.

I also analyze the prices of other drinks with added sugar, as well as the prices of potential substitutes that are not subject to the tax, such as diet sodas, bottled water, pure

fruit juice, and milk. Basic economic theory predicts that if consumers substitute toward these products as the price of taxed drinks rises, and the supply curve of untaxed drinks is upward sloping, then the price of untaxed drinks should rise as well. Thus price changes of untaxed substitutes may provide indirect evidence on consumer substitution patterns in response to the tax.

A challenge for estimation is that the soda tax took effect at the same time nationwide. If other economy-wide factors were putting pressure on prices in early 2014, then the change in drink prices that I attribute to the tax may instead be the result of those other factors. To address this issue, I analyze the prices of untaxed comparison products, on the grounds that any economy-wide price pressures should appear in the prices of untaxed as well as taxable goods. I find no noteworthy increases in the prices of the untaxed comparison products.

In the next section of the paper, I provide further background information about Mexico's soda tax, its market for soft drinks, and about previous studies on the links between soda taxes, soda prices, and consumption. In section III I discuss the data and estimation. Section IV presents results and Section V concludes.

**II. Background**

*A. Mexico's tax on drinks with added sugar and its soft-drink market*

Mexico's tax on drinks with added sugar (DWAS) was passed in the fall of 2013 and took effect on January 1, 2014. It imposes a specific tax of 1 peso/liter on non-alcoholic drinks that include added sugar. Thus regular sodas, which contain sugar, are taxed, whereas artificially sweetened diet sodas are not. Likewise, juice and water drinks that

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contain added sugar are taxed, whereas pure fruit juices and water drinks that do not contain sugar are not.  The one exception is for milk products, which are exempt even if they include added sugar.  The nominal incidence of the tax falls on producers and importers, who remit monthly payments to Mexico's tax authority (Procuraduria de la Defensa del Contribuyente, 2013).

In 2013 the average liter price of soda was about 11.4 pesos, or $0.86 US at the then-current exchange rate of 13.9 pesos/$US.  Thus the tax amounts to about 9 percent of the average pre-tax price of soda. In conjunction with the soda tax, the Mexican legislature passed an ad valorem junk-food tax of eight percent on calorie-dense foods, defined as foods with more than 275 kcal per 100 grams.  I limit my attention here to the tax on drinks with added sugar.

Table 1 compares Mexico's soda tax with similar taxes elsewhere in the world.  Panel A describes key features of soda taxes imposed by countries outside the US. Panel B lists sales tax rates in U.S. states for regular sodas sold in retail outlets such as grocery stores. Panel B is limited to states that tax sodas at a higher rate than other grocery products. With the exception of Illinois, these states impose no sales tax on food, so the tax on sodas represents the difference between sales taxes imposed on sodas and food.  In international comparison, Mexico's tax is on the low side, similar to soda taxes in Australia and Finland. At the same time, however, in relative terms, Mexico's tax is higher than that imposed by any US state.

How much of that tax might we expect to be passed on to consumers? Mexico's market for sodas is highly concentrated.  Coca Cola's market share for carbonated soft drinks is

over 70 percent, followed by PepsiCo at about 15 percent (Smolinski & Yuk, 2013). Those companies' US market shares, in comparison, are roughly 42 and 28 percent, respectively (Statista.com, 2015). Considering the level of market concentration in Mexico's soda market, it is conceivable on theoretical grounds that the soda tax could be overshifted to consumers, depending on the shape of the demand function.

Mexico's broader market for soft drinks, which includes other taxable drinks as well as pure juices and bottled water, is somewhat less concentrated. Coca Cola has a 45 percent market share, and the top three firms control 69 percent of the market (Euromonitor 2015). Thus it would be surprising to see overshifting in the market for other drinks with added sugar.

## B. Previous research on soda taxes and soda prices

Only a handful of studies have analyzed how soda taxes affect soda prices. The earliest may be Besley & Rosen (1998), who studied longitudinal data across cities to estimate how sales taxes affected the price of Coca Cola, among other products. They found evidence of overshifting. Bergman & Hansen (2010) analyzed price data collected by Statistics Denmark to compute the Danish CPI. They studied soda tax increases that took effect in 1998 and 2001 and a tax cut that took effect in 2003. They found overshifting in response to the tax increases, but undershifting in response to the tax cut. Berardi, Sevestre, Tepaut, & Vigneron (2013) estimate the effects of the French soda tax imposed in January 2012 using data provided by an online firm that intermediates drive-through purchases by consumers from existing brick-and-mortar retail outlets. They report that,

six months after the tax took effect, it had been fully passed through to soda prices. Taxes on other sugar-sweetened beverages were only partly passed through to consumers.

A related literature analyzes the relationship between soda prices or taxes, soda consumption, and in some cases, the consumption of potential substitute goods. Block, Chandra, McManus, & Willett (2010) experimentally manipulated soda prices in a large hospital and found that consumption fell 26 percent in response to a 35 percent price increase. Andreyeva, Long, & Brownell (2010) metaanalyzed 14 studies, published between 1938 and 2007, that estimated the own-price elasticity of demand for soft drinks in the US. They reported a mean elasticity of -0.79. Another metaanalysis, covering studies published between 2007 and 2012, estimated the own-price elasticity for sugar-sweetened sodas in the US to be -1.25 (Powell, Chriqui, Khan, Wada, & Chaloupka, 2013). Fletcher, Frisvold, & Tefft (2010) focused on youths, relating consumption of soft drinks and other beverages to state-level taxes on sodas. They reported that higher taxes led to moderate reductions in soda consumption, but also to substitution toward whole milk. Ritter (2015) analyzed the effects of sharp reductions in soda prices that resulted from the entry of a low-cost competitor into the Peruvian market for sodas. She estimated the own-price elasticity of demand for sodas to be -1.3. She found no evidence that consumers substituted for juice, milk, or bottled water. Finally, Instituto Nacional de Salud Publica (2014) summarizes results from a study of the Mexican soda tax based on data from January to March 2014, that is, the first three months after the tax took effect. That study analyzes the effect of the tax on consumption based on data from a consumer panel. It reports that consumption of sodas fell by about 10 percent during the first quarter of 2014 relative to the first quarter of 2013. It also reports that consumption of

untaxed beverages rose by about 7 percent during that same period, with consumption of plain water rising by 13 percent.

A virtue of the INSP study is that it uses data on actual consumption patterns. At the same time, basic economic theory indicates that one may be able to infer the way that consumption patterns change in response to a tax, if not the actual magnitude of the change, from data on prices. An important advantage of the current study is that I have 15 months, rather than 3 months, of post-tax data. This enables me to estimate how prices changed in response to the tax over a longer period, and to disentangle longer-term changes from potentially transitory responses after the tax was first implemented.

**III. Data**

*A. Monthly product prices by city*

The data I analyze are collected in order to calculate Mexico's Consumer Price Index. These price data are collected from retail outlets on an ongoing basis, following procedures spelled out by the ILO's Consumer Price Index Manual. Prices are obtained for 235,000 specific items each month from products categorized into 283 product categories. Price data are collected in 46 different cities across the country (Instituto Nacional de Estadistica y Geographica, 2013).

Each month, Mexico's National Institute for Statistics and Geography publishes the average price of each product in each city.[1] The products are specified in detail, including the brand, flavor (if relevant), container, and size of the package. Prices are generally quoted per standard unit, that is, per liter or per kilogram. Thus, for example,

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[1] The data are available at http://www.inegi.org.mx/sistemas/preciospromedio_inpc/.

one record indicates that, in January 2015 in the greater Mexico City area, the average

liter price of Coca Cola purchased in a six-pack of 12-ounce (355 ml) cans was 22.77

pesos. No information is provided about the number of observations underlying the

published averages, nor about the variance of the underlying item prices.

### B. Product categories

I use price data from the INPC product categories sodas, bottled water, juice, and milk.[2]

Some of these categories consist of a mix of taxed and untaxed products.  For example,

the sodas category includes both regular and diet sodas, as well as a few bottled water

products.  The bottled water category contains mostly plain water, but also a few flavored

water products that are sweetened with sugar. Likewise, the juice category includes both

100 percent juice products, which are untaxed, plus juice drinks, which are taxed because

they contain added sugar.

In order to distinguish between taxed and untaxed products, I created six product

categories from the original four.  These are regular sodas, other drinks with added sugar,

diet sodas, bottled water, milk, and pure juice.  Regular sodas consist of sugar-sweetened

carbonated beverages.  Other drinks with added sugar consist of juice drinks and flavored

water products that are sweetened with sugar.  Diet sodas consist of artificially sweetened

carbonated beverages.  Bottled water consists of plain water products plus flavored water

products that are not sweetened with sugar.  Milk contains all milk products and pure

juice contains all juices that do not contain added sugar.

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[2]  These correspond to the categories *refrescos envasados, agua embotellada, jugos o néctares envasados,* and *leche pasteurizada y fresca*.

To determine the sugar content of the various products, I relied partly on naming conventions and also conducted a combination of automated and manual searches of several Mexican online shopping sites that provide product ingredient lists.[3] These searches identified the sugar content of various products with varying degrees of certainty. Some naming conventions revealed the sugar content of the product with certainty, such as the word "diet" in a product name. Likewise, the great majority of products could be identified with certainty online. However, I inferred some products' sugar content from that of a closely related product with the same brand name. For a few products, I was unable to find any information. I exclude this last group of products from the analysis.

## C. Descriptive statistics

Table 2 presents means and standard deviations by year for real prices of products in each of the six categories. I used the monthly Mexican CPI for all products to convert nominal prices to real values, setting the base period to December 2013. I also deleted from the estimation sample a small set of observations that were either gross outliers or obviously quoted prices per package (e.g., per six-pack) rather than prices per liter.

Real prices for regular sodas, shown in column (1), were roughly constant between 2011 and 2013. They jumped by 1.28 pesos between 2013 and 2014, then remained roughly constant. The price of other drinks with added sugar also rose between 2013 and 2014, although by less than the amount of the tax, and then fell a bit in 2015. The price of diet sodas, a potential substitute for the taxed drinks, rose between 2013 and 2014 then remained roughly constant. Water and milk prices were largely unchanged between 2013

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[3] These sites include www.walmart.com.mx, www.superama.com.mx, and www.tudespensa.com/supermercado.

and 2015.  The price of pure juice rose a bit between 2013 and 2014, but then fell

substantially in 2015.

### D. Estimation

To estimate more systematically how prices change in response to the tax, I regress prices

on period dummies, city dummies, brand dummies, and where applicable, dummy

variables for container type, container size, and packaging.  That is, I estimate regressions

that take the form

$$p_{ict} = \beta_0 + \sum_{\substack{s=1 \\ s \neq \tau-1}}^{T} \beta_s 1(s=t) + \gamma_c + \delta_{(i)} + \varepsilon_{ist} \qquad i=1,\dots,N_{ct}; \; c=1,\dots,C; \; t=1,\dots,T. \qquad (1)$$

The dependent variable $p_{ict}$ is the average price of product i in city c in period t.  There

are $N_{ct}$ products in city c in period t, C cities, and T time periods.  The term 1(A) is the

indicator function, defined as 1(A)=1 if A is true and 1(A)=0 otherwise. Thus the terms

under the summation sign represent a set of dummy variables, one for each time period in

the sample, from which one dummy has been excluded, corresponding to the period just

before the tax takes effect (denoted as period $\tau$ -1, where period $\tau$ is the period when the

tax takes effect).  The term $\gamma_c$ represents the city dummies and the term $\delta_{(i)}$ represents

sets of dummy variables for characteristics of the ith product, such as its brand, size,

container, and packaging. The term $\varepsilon_{ict}$ is an unobserved disturbance term.

The coefficients on the period dummies (the $\beta_s$ terms) are the parameters of interest.

They show how real prices changed before and after the soda tax took effect, relative to

the period immediately preceding the tax, controlling for city and characteristics of the

product. These period effects identify the effect of the tax under the condition that the tax was the only factor influencing real price changes in the period surrounding January 2014. If other economy-wide factors contributed to real price increases around that time, then the period effects in equation (1) do not identify the effect of the tax.

This problem arises because of the nature of the tax change: it took effect all across the country on the dame day. This means that other conventional approaches, such as the difference-in-difference estimator, are not available to estimate the effects of the soda tax. To bolster confidence in my before-and-after estimates of the effects of the tax, I take two steps.

First, I estimate two different specifications of equation (1) that involve different sets of period effects. The first is a monthly specification, in which I include a dummy for each month of the sample period, January 2011 to March 2015, excluding the dummy for December 2013. The second is an annual specification, in which I include a dummy for each year in the sample period, 2011 to 2015, excluding the dummy for 2013.[4]

The monthly specification shows the timing of prices changes in some detail. Presumably, sharp price increases that take place as the tax takes effect and then persist are more convincingly attributable to the tax than either gradual or transitory increases. At the same time, the monthly period effects may suffer from statistical imprecision, since they are based on relatively few observations. The period effects from the annual specification should be more precise, since they are based on more data, and thus complement the estimates from the monthly specification.

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[4] The model with year dummies also includes month-of-year effects to control for seasonality.

The other step I take is to apply equation (1) to a set of comparison commodities, that is, to products that are not subject to the soda tax and that are not obviously either substitutes or complements for the taxed commodities. The logic here is that, if increases in drink prices around January 2014 were caused by economy-wide price shocks, rather than the soda tax, then those price shocks should be observable in the prices of untaxed as well as taxable goods. Thus price increases among the comparison commodities that paralleled any price increases among the taxable goods would cast doubt as to whether the before-after approach identified the effects of the soda tax on the prices of drinks.

As comparison commodities I use butter, cheese, chicken, dried beans, and rice. All of these are staple goods whose consumption is not obviously linked to the consumption of drinks with added sugar. A more formal justification for using these commodities would invoke weak substitutability between commodity groups, one consisting of drinks and the other consisting of foods.

## IV. Results

### A. Monthly price estimates

I first present results from the monthly specification of equation (1). The estimates of $_s$, the monthly period effects, appear in Appendix Table 1. These estimates can be thought of as regression-adjusted prices, relative to the price in December 2013. To ease interpretation, I also plot the estimated period effects against time, together with 95 percent confidence intervals, in Figure 2. It is important to note that the scale of the y-axis varies from graph to graph in this figure, so as to clearly reveal price changes. The

variation of price movements differs greatly across products, so fixing a common scale would have obscured important changes in the prices of some goods.

The upper left graph in the Figure shows that the real prices of regular sodas were roughly constant through 2013, consistent with the annual price data reported in Table 2. Prices jumped sharply in January 2014 as the tax took effect. Between January 2014 and March 2015, prices fluctuated in a band between 1.19 and 1.57 pesos higher than those in effect in December 2013. These estimates are all significantly greater than one, meaning that the tax was overshifted onto consumers.

Period effects from the model for other drinks with added sugar appear in the left center graph. As with regular sodas, prices for these drinks jumped sharply as the tax took effect, rising by 0.71 pesos in January 2014 relative to the month before. Prices of other DWAS fluctuated more than the prices of regular sodas after the tax took effect, ranging from 0.37 to 1.24 pesos higher than prices in effect in December 2013. Of the 15 estimated period effects between January 2014 and March 2015, 12 are significantly different from zero, although two of the insignificant estimates occur in 2015. In summary, the prices of taxed drinks clearly rose after the tax took effect, but the prices of drinks in the other-drinks-with-added-sugar category may have fallen again by the end of the sample period.

I turn now to the prices of untaxed drinks, which under certain conditions can show how consumers changed their consumption patterns in response to the tax. Monthly regression-adjusted real prices for diet sodas appear in the bottom left graph of Figure 2. In January 2014, the price of diet sodas rose by 0.30 (standard error = 0.15). All of the

following post-tax period effects are positive; nine of the 15 coefficients are significantly different from zero. As discussed above, this may indicate that consumers substituted diet for regular sodas after the tax was imposed.

Monthly regression-adjusted real prices for water products not sweetened with sugar appear in the top right graph of Figure 2. For the most part, water prices did not change significantly after the soda tax took effect. Of the 15 post-tax coefficients, only two were significantly different from zero.

The center right graph shows how milk prices changed relative to December 2013. They fell by 0.11 pesos in January 2014, then fluctuated between -0.06 and -0.20. Most of these coefficients are significantly different from zero, although their economic significance may not be very great. Relative to the mean sample-period milk price of 14.16 pesos/liter (see Table 2), these changes amount to a reduction of between 0.4 and 1.4 percent.

Monthly regression-adjusted real prices for pure juices appear in the bottom right graph of Figure 2. After the first few months of the sample period, real juice prices were roughly constant during the period prior to the tax. In January 2014, they then rose by 0.68 (0.28) pesos compared to the month before. This is consistent with substitution from taxed drinks toward juices in the month the tax was imposed. However, the increase was not sustained. In the remainder of the post-tax period, juice prices fluctuated between -0.41 and 0.36 pesos, relative to the December 2013 price. None of those estimates is statistically significantly different from zero.

To summarize, these results show that the prices of regular sodas and other drinks with added sugar rose after the tax was imposed. Diet soda prices also rose, as did juice prices in the month that the tax took effect. As mentioned above, interpreting these changes as the causal effect of the tax requires the assumption that no other factors would have caused the prices of these goods to change in the event that the tax had not been imposed. To examine the plausibility of that strong assumption, I consider now price changes of goods that are not subject to the tax and are not obvious substitutes for drinks with added sugar.

For these products, the estimates of $_s$, the monthly period effects, appear in Appendix Table 2. Those estimates and their 95 percent confidence intervals are plotted against time in Figure 3. As in Figure 2, the y-axes of the graphs in Figure 3 have different scales.

Regression-adjusted real butter prices appear in the top left graph. They rose gradually before the tax was imposed, then largely leveled out. Real cheese prices were generally positive during the pre-tax period, relative to December 2013, then generally positive again during the post-tax period. For much of the sample period, however, real cheese prices were not significantly higher than they were in the month before the tax took effect. In the pre-tax period, 16 of the 27 positive coefficients were significant; in the post-tax period, 5 of the 15 coefficients were significant. Real chicken prices were subject to two sharp swings in the pre-tax period. They then rose in January 2014, fell again, then rose and fell again during 2014. Real prices of dried beans, shown in the upper right graph, peaked in mid-2012 and then declined smoothly for most of the rest of the sample period. Real rice prices, depicted in the next graph, fell more or less consistently starting in the

middle of the sample period. Bread prices, shown bottom right, were roughly constant after the soda tax took effect. Taken as a whole, these estimates provide little evidence that real prices in Mexico were rising generally in such a way that could explain the real price increases for regular sodas, other DWAS, and diet sodas that began immediately upon the imposition of the tax.

## B. Annual price estimates

Estimates of the period effects from the annual specification of equation (1) are reported in Tables 3 and 4. Whereas the monthly specification was useful for showing the timing of adjustment in response to the tax, the annual specification is useful because the period effects are based on more data and thus are more precise. The added precision may be particularly valuable for determining whether volatile price changes, such as those for juices, are persistent.

The first column shows that real regular soda prices were flat from 2011-2013 and then rose by 1.32 (0.05) pesos in 2014. This is consistent with overshifting of the tax. Prices rose a bit further in 2015.

The second column shows that the real prices of other drinks with added sugar rose by 0.63 (0.23) pesos between 2013 and 2014. They then fell a bit in 2015. The estimate for 2015 is not statistically significantly different from zero, but then neither is it significantly different from the 2014 estimate.

Turning to the untaxed drinks, the price of diet sodas rose by 0.61 (0.13) pesos in 2014 as compared with 2013, then remained roughly the same in 2015. Real prices for water products were largely unchanged between 2013 and 2015. Real milk prices fell by 0.15

(0.04) pesos between 2013 and 2014 then rebounded slightly in 2015. The real price of pure juice rose by 0.22 pesos between 2013 and 2014. However, that increase was not significant, and juice prices fell substantially the following year.

Estimated annual period effects for the comparison goods appear in Table 4. For five of those six goods, real prices fell between 2013 and 2014. They rose only for butter, albeit insignificantly. These estimates largely reinforce the conclusions drawn from Figure 3. There does not seem to have been any general increase in prices around the time that the tax took effect that can explain the increase in prices of regular sodas, diet sodas, and to a lesser extent, other drinks with added sugar.

*C. Robustness*

I address four issues here that bear on the robustness of the estimates. The first involves water without sugar, which is a heterogeneous product category. It includes products such as flavored water, sparkling water, still water that comes in small containers, as well as still water in large containers with capacities of four to 20 liters. One might think that the last of these product types is a poor substitute for drinks with added sugar, since water in large containers is often used for cooking as well as drinking. To investigate, I split the sample of water-without-sugar products according to the size of the container. Estimated period effects for both subsamples were similar to those for the full sample reported above.

The second issue involves the level of certainty with which I was able to assess the sugar content of some products, particularly those in the other DWAS, water without sugar, and pure juice categories. As mentioned above, I excluded from the estimation sample all

products about whose sugar content I could find no information. I also experimented with dropping products whose sugar content was gleaned indirectly from similar products. For the most part, this had little effect on the results. The exception involved pure juice products. When I restricted attention to products for which I had the most solid information, the price increases observed in 2014 became smaller and less significant than those reported above.

Third, some Mexican consumers may be able to circumvent the tax by crossing the border and purchasing drinks in the United States. To check against this possibility, I reestimated the models above after dropping cities near the border from the sample. With two exceptions, the estimates were essentially unchanged. One exception involved the 2014 coefficient for other DWAS, which fell to 0.50 but remained significant. The other involved the post-tax coefficients for pure juice, which fell and remained insignificant.

Finally, I considered a broader set of comparison commodities in order to further test for general price changes around January 2014 that could potentially provide an alternative explanation for the observed changes in drink prices. This broader set included clothing items such as men's and women's shirts, men's pants, women's skirts, outerwear, and shoes. None of these items exhibited notable real price changes around the time that the soda tax took effect in January 2014.

**V. Summary and conclusions**

Obesity and its consequences represent a pressing public health problem. To staunch the rise in obesity, Mexico imposed a tax, effective January 2014, on drinks that contain added sugar, commonly referred to as a soda tax. Mexico's tax is smaller than most

similar taxes imposed outside North America, but larger than taxes imposed by those U.S. states that tax sodas at a higher rate than other grocery items.

For soda taxes to be effective in reducing obesity, they must raise the price of taxable drinks. All else equal, the more that prices rise, the more effective the tax should be. To estimate how Mexico's soda tax affected prices, I analyzed city-level price data on taxable products collected as part of Mexico's Consumer Price Index program. The price of regular sodas jumped sharply when the tax took effect and rose by more than the amount of the tax. Such overshifting is consistent with economic models of oligopolized markets, such as Mexico's soda market. The price of other drinks with added sugar also rose shortly after the tax took effect, though by less than the amount of the tax. The initial price increase also may have faded over time. This phenomenon merits further attention, and at the same time highlights the importance of analyzing data from a lengthy sample period.

A limitation of this study is that the effects of the soda tax on drink prices are estimated using a before-and-after approach. The reason for this is that the tax took effect throughout the country at the same time. The problem with the before-after approach is that it assumes that the tax was the only economic factor acting to change real drink prices at the beginning of 2014.

Given this limitation, I took two steps to link the observed price changes to the tax. The first was to analyze monthly price changes. Those prices that changed when the tax took effect rose sharply in January 2014. This helps support a causal link between the soda tax and drink prices. I also analyzed the prices of comparison goods that were not subject

to the tax and unlikely to be either a substitute or a complement for the taxed goods. None of these goods exhibited sharp, sustained price increases beginning around January 2014.

My results suggest that Mexico's soda tax had a relatively powerful effect: a tax of roughly 9 percent raised the prices of regular sodas by 12 percent. Prices of caloric substitutes, such as juice and milk, did not rise, suggesting that consumers did not merely substitute taxed for untaxed calories. Ideally, one would like to analyze how the soda tax affects weight. Such an analysis will be difficult, since the nationwide adoption of the tax means that there are no unaffected consumers to serve as controls. Absent such direct evidence, the results here provide reason to think that the tax may ultimately lead to weight loss.

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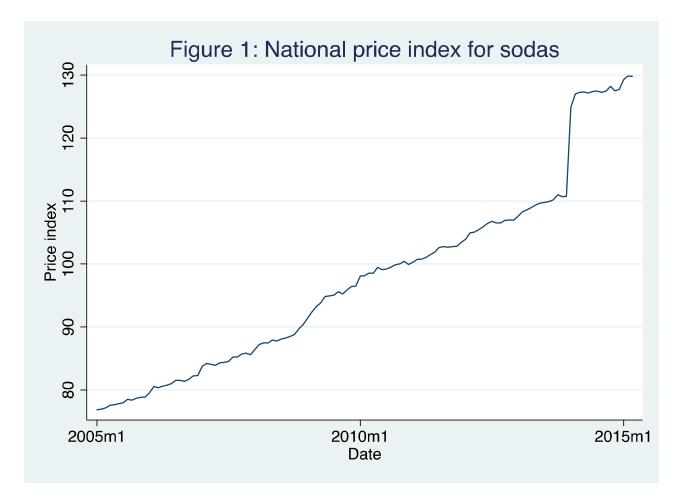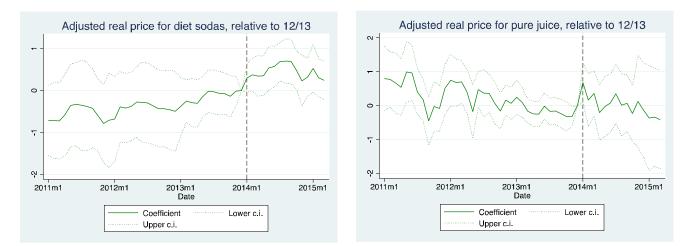
Figure 1: National price index for sodas

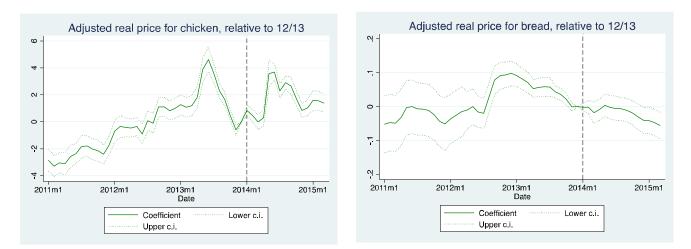Figure 2: Regression-adjusted real prices of drinks by month



Note: The graphs plot monthly period effects and confidence intervals based on standard errors that are clustered by city.

Figure 3: Regression-adjusted real prices of other goods, by month



Note: The graphs plot monthly period effects and confidence intervals based on standard errors that are clustered by city.

Table 1: Soda taxes by country and US state

Panel A: Countries outside the US

| Country | Year | Tax in % or $US |
|---|---|---|
| Norway | 1981 | VAT 25% + production tax at 0.23 $US/liter |
| Samoa | 1984 | 0.18 $US/liter |
| Australia | 2000 | 10% |
| French Polynesia | 2002 | 0.42 $US/liter (local) or 0.63 $US/liter (imported) |
| Fiji | 2006 | 5% import excise tax |
| Nauru | 2007 | 30% on imported products |
| Finland | 2011 | 0.09 $US/liter |
| France | 2012 | 0.90 $US/liter |
| Mexico | 2014 | 0.072 $US/liter |

Panel B: US states that tax sodas at higher rates than other grocery items

| State | Sales tax on regular soda sold at retail (%), 2014 |
|---|---|
| California | 6.50 |
| Colorado | 2.91 |
| Connecticut | 6.35 |
| District of Columbia | 5.75 |
| Florida | 6.00 |
| Illinois | 6.25 |
| Indiana | 7.00 |
| Iowa | 6.00 |
| Kentucky | 6.00 |
| Maine | 5.50 |
| Maryland | 6.00 |
| Minnesota | 6.88 |
| New Jersey | 7.00 |
| New York | 4.00 |
| North Carolina | 4.75 |
| North Dakota | 5.00 |
| Ohio | 5.75 |
| Pennsylvania | 6.00 |
| Rhode Island | 7.00 |
| Texas | 6.25 |
| Washington | 6.50 |
| West Virginia | 6.00 |
| Wisconsin | 5.00 |

Notes: Panel A is drawn from Mytton, Clarke, & Rayner (2012), Thow et al. (2011), Gustavsen and Rickertsen (2011) and Bergman and Hansen (2010). Local currency values in the original sources have been converted to $US using 2014 exchange rates. Panel B is from Bridging the Gap (2014).

Table 2: Means and standard deviations of real drink prices, by year

| Real price of: Year | Regular sodas (1) | Other DWAS (2) | Diet sodas (3) | Water w/o sugar (4) | Milk (5) | Pure juice (6) |
|---|---|---|---|---|---|---|
| 2011 | 11.38 | 17.37 | 15.66 | 6.65 | 13.92 | 19.32 |
| | (4.75) | (5.68) | (1.57) | (3.51) | (4.34) | (4.51) |
| 2012 | 11.37 | 17.01 | 15.61 | 6.63 | 14.07 | 19.19 |
| | (4.67) | (5.82) | (1.39) | (3.56) | (4.76) | (4.86) |
| 2013 | 11.41 | 16.59 | 15.88 | 6.52 | 14.30 | 18.67 |
| | (4.65) | (5.96) | (1.93) | (3.67) | (3.99) | (4.88) |
| 2014 | 12.69 | 16.80 | 16.51 | 6.51 | 14.28 | 18.82 |
| | (4.84) | (6.00) | (2.31) | (3.74) | (4.09) | (5.34) |
| 2015 | 12.71 | 16.65 | 16.44 | 6.48 | 14.34 | 18.03 |
| | (4.86) | (6.23) | (2.39) | (3.75) | (3.89) | (5.41) |
| Total | 11.77 | 16.92 | 15.92 | 6.57 | 14.16 | 18.96 |
| | (4.77) | (5.90) | (1.87) | (3.63) | (4.29) | (4.93) |
| N | 21551 | 8094 | 714 | 18655 | 23184 | 1494 |

Note: Standard deviations in parentheses. DWAS stands for drinks with added sugar.

Table 3: Estimated year effects for drink prices, relative to 2013

| Dependent variable is real price of: | Regular sodas | Other DWAS | Diet sodas | Water w/o sugar | Milk | Pure juice |
|---|---|---|---|---|---|---|
| Dummy for year | (1) | (2) | (3) | (4) | (5) | (6) |
| 2011 | 0.07 | 0.34 | -0.41 | 0.04 | -0.19 | 0.56 |
|  | (0.06) | (0.17) | (0.29) | (0.07) | (0.09) | (0.28) |
| 2012 | 0.06 | 0.27 | -0.26 | 0.09 | -0.21 | 0.43 |
|  | (0.04) | (0.13) | (0.27) | (0.04) | (0.05) | (0.15) |
| 2014 | 1.32 | 0.63 | 0.61 | -0.05 | -0.15 | 0.22 |
|  | (0.05) | (0.23) | (0.13) | (0.06) | (0.04) | (0.32) |
| 2015 | 1.42 | 0.40 | 0.64 | -0.07 | -0.07 | -0.55 |
|  | (0.08) | (0.34) | (0.16) | (0.08) | (0.07) | (0.70) |
| D.V. mean | 11.8 | 16.9 | 15.9 | 6.6 | 14.2 | 19.0 |
| R-square | 0.899 | 0.841 | 0.874 | 0.826 | 0.894 | 0.897 |
| N | 21548 | 8094 | 714 | 18655 | 23184 | 1494 |

Note: Standard errors, clustered by city, in parentheses. In addition to the variables shown, all regressions include city dummies, month dummies, brand dummies, package dummies, and size dummies. DWAS stands for drinks with added sugar.

Table 4: Estimated year effects for prices of other goods, relative to 2013

| Dependent variable is real price of: | Butter | Cheese | Chicken | Dried beans | Rice | Bread |
|---|---|---|---|---|---|---|
| Dummy for year | (1) | (2) | (3) | (4) | (5) | (6) |
| 2011 | -3.54 | -1.65 | -4.20 | -4.99 | -0.25 | -0.07 |
| | (1.02) | (0.74) | (0.28) | (0.45) | (0.19) | (0.04) |
| 2012 | -1.17 | -0.18 | -1.70 | 3.12 | 0.57 | -0.03 |
| | (0.69) | (0.50) | (0.24) | (0.40) | (0.11) | (0.02) |
| 2014 | 1.34 | -0.34 | -0.08 | -6.88 | -1.15 | -0.06 |
| | (0.98) | (0.39) | (0.20) | (0.47) | (0.20) | (0.02) |
| 2015 | 3.48 | 0.04 | 0.50 | -8.11 | -1.48 | -0.09 |
| | (1.24) | (0.59) | (0.30) | (0.48) | (0.26) | (0.03) |
| D.V. mean | 119.1 | 112.9 | 43.5 | 23.6 | 16.2 | 2.1 |
| R-square | 0.823 | 0.846 | 0.555 | 0.539 | 0.829 | 0.476 |
| N | 9257 | 46339 | 27493 | 18541 | 13914 | 13893 |

Note: Standard errors, clustered by city, in parentheses. In addition to the variables shown, all regressions include city dummies, month dummies, and brand dummies. Package dummies and size dummies are included where applicable.

Appendix Table 1: Estimated month effects for drink prices, relative to December 2013

| Real price of: | Regular sodas | Other DWAS | Diet sodas | Water w/o sugar | Milk | Pure juice |
|---|---|---|---|---|---|---|
| Dummy for month | (1) | (2) | (3) | (4) | (5) | (6) |
| 2011m1 | 0.08 | 0.76 | -0.71 | 0.08 | -0.23 | 0.79 |
| | (0.07) | (0.20) | (0.38) | (0.09) | (0.11) | (0.46) |
| 2011m2 | 0.07 | 0.92 | -0.72 | 0.09 | -0.26 | 0.78 |
| | (0.06) | (0.18) | (0.41) | (0.09) | (0.12) | (0.40) |
| 2011m3 | 0.07 | 0.68 | -0.72 | 0.06 | -0.27 | 0.67 |
| | (0.07) | (0.21) | (0.41) | (0.09) | (0.11) | (0.43) |
| 2011m4 | 0.11 | 0.60 | -0.58 | 0.05 | -0.27 | 0.55 |
| | (0.07) | (0.20) | (0.44) | (0.10) | (0.12) | (0.40) |
| 2011m5 | 0.24 | 0.70 | -0.36 | 0.12 | -0.14 | 1.00 |
| | (0.06) | (0.20) | (0.45) | (0.09) | (0.13) | (0.44) |
| 2011m6 | 0.26 | 0.68 | -0.33 | 0.15 | -0.10 | 0.96 |
| | (0.07) | (0.20) | (0.45) | (0.09) | (0.12) | (0.39) |
| 2011m7 | 0.28 | 0.63 | -0.35 | 0.13 | -0.19 | 0.40 |
| | (0.07) | (0.19) | (0.49) | (0.08) | (0.12) | (0.33) |
| 2011m8 | 0.30 | 0.50 | -0.38 | 0.09 | -0.27 | 0.17 |
| | (0.06) | (0.18) | (0.48) | (0.08) | (0.12) | (0.30) |
| 2011m9 | 0.29 | 0.22 | -0.43 | 0.09 | -0.28 | -0.46 |
| | (0.06) | (0.22) | (0.42) | (0.08) | (0.12) | (0.35) |
| 2011m10 | 0.24 | 0.05 | -0.60 | 0.05 | -0.28 | -0.03 |
| | (0.06) | (0.21) | (0.39) | (0.08) | (0.12) | (0.35) |
| 2011m11 | 0.11 | -0.14 | -0.79 | -0.01 | -0.39 | -0.08 |
| | (0.06) | (0.20) | (0.42) | (0.08) | (0.12) | (0.33) |
| 2011m12 | 0.06 | 0.08 | -0.71 | -0.01 | -0.38 | 0.51 |
| | (0.07) | (0.23) | (0.51) | (0.08) | (0.11) | (0.36) |
| 2012m1 | 0.04 | 0.23 | -0.68 | 0.04 | -0.38 | 0.75 |
| | (0.06) | (0.24) | (0.46) | (0.08) | (0.11) | (0.37) |
| 2012m2 | 0.08 | 0.27 | -0.39 | 0.07 | -0.34 | 0.68 |
| | (0.06) | (0.21) | (0.38) | (0.08) | (0.11) | (0.34) |
| 2012m3 | 0.14 | 0.08 | -0.42 | 0.10 | -0.33 | 0.70 |
| | (0.05) | (0.23) | (0.37) | (0.08) | (0.12) | (0.31) |
| 2012m4 | 0.24 | 0.22 | -0.38 | 0.15 | -0.22 | 0.40 |
| | (0.05) | (0.23) | (0.37) | (0.07) | (0.07) | (0.32) |
| 2012m5 | 0.32 | 0.33 | -0.28 | 0.18 | -0.12 | -0.17 |
| | (0.06) | (0.22) | (0.38) | (0.07) | (0.07) | (0.39) |
| 2012m6 | 0.27 | 0.64 | -0.28 | 0.18 | -0.14 | 0.48 |
| | (0.05) | (0.21) | (0.43) | (0.06) | (0.07) | (0.26) |
| 2012m7 | 0.24 | 0.58 | -0.30 | 0.18 | -0.24 | 0.37 |
| | (0.06) | (0.18) | (0.43) | (0.05) | (0.06) | (0.34) |
| 2012m8 | 0.20 | 0.61 | -0.36 | 0.18 | -0.32 | 0.36 |
| | (0.06) | (0.16) | (0.42) | (0.05) | (0.07) | (0.27) |
| 2012m9 | 0.15 | 0.64 | -0.43 | 0.14 | -0.35 | 0.08 |
| | (0.06) | (0.17) | (0.41) | (0.06) | (0.08) | (0.30) |
| 2012m10 | 0.15 | 0.42 | -0.43 | 0.08 | -0.22 | -0.16 |
| | (0.06) | (0.16) | (0.41) | (0.05) | (0.08) | (0.26) |
| 2012m11 | 0.09 | 0.28 | -0.46 | 0.04 | -0.09 | 0.16 |
| | (0.05) | (0.17) | (0.43) | (0.06) | (0.08) | (0.21) |
| 2012m12 | 0.08 | 0.50 | -0.50 | 0.06 | 0.02 | 0.07 |
| | (0.05) | (0.16) | (0.43) | (0.05) | (0.07) | (0.24) |
| 2013m1 | 0.08 | 0.46 | -0.39 | 0.05 | 0.02 | 0.25 |
| | (0.06) | (0.16) | (0.31) | (0.05) | (0.07) | (0.25) |
| 2013m2 | 0.05 | 0.22 | -0.25 | 0.01 | 0.03 | 0.09 |
| | (0.05) | (0.15) | (0.23) | (0.04) | (0.04) | (0.21) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2013m3 | 0.04 | -0.12 | -0.29 | -0.03 | -0.06 | -0.17 |
| | (0.05) | (0.18) | (0.26) | (0.04) | (0.04) | (0.17) |
| 2013m4 | 0.06 | 0.12 | -0.31 | -0.03 | -0.06 | -0.25 |
| | (0.05) | (0.16) | (0.26) | (0.04) | (0.04) | (0.18) |
| 2013m5 | 0.14 | 0.17 | -0.15 | 0.03 | -0.00 | -0.25 |
| | (0.05) | (0.16) | (0.22) | (0.04) | (0.04) | (0.18) |
| 2013m6 | 0.18 | 0.24 | -0.02 | 0.03 | -0.02 | -0.01 |
| | (0.04) | (0.16) | (0.23) | (0.04) | (0.04) | (0.19) |
| 2013m7 | 0.19 | 0.27 | -0.03 | 0.03 | 0.05 | -0.17 |
| | (0.04) | (0.15) | (0.24) | (0.04) | (0.05) | (0.19) |
| 2013m8 | 0.17 | 0.21 | -0.07 | 0.07 | 0.01 | -0.16 |
| | (0.04) | (0.16) | (0.24) | (0.05) | (0.05) | (0.20) |
| 2013m9 | 0.16 | 0.21 | -0.08 | 0.10 | -0.03 | -0.23 |
| | (0.04) | (0.16) | (0.22) | (0.04) | (0.03) | (0.20) |
| 2013m10 | 0.17 | 0.06 | -0.14 | 0.10 | 0.04 | -0.32 |
| | (0.03) | (0.13) | (0.22) | (0.04) | (0.03) | (0.21) |
| 2013m11 | 0.05 | -0.09 | -0.01 | 0.01 | 0.02 | -0.32 |
| | (0.02) | (0.09) | (0.16) | (0.02) | (0.03) | (0.14) |
| 2014m1 | 1.19 | 0.71 | 0.30 | -0.02 | -0.11 | 0.68 |
| | (0.05) | (0.16) | (0.15) | (0.03) | (0.03) | (0.28) |
| 2014m2 | 1.37 | 0.37 | 0.37 | -0.09 | -0.13 | 0.16 |
| | (0.07) | (0.13) | (0.18) | (0.04) | (0.04) | (0.38) |
| 2014m3 | 1.38 | 0.43 | 0.35 | -0.13 | -0.16 | 0.36 |
| | (0.06) | (0.14) | (0.22) | (0.06) | (0.03) | (0.32) |
| 2014m4 | 1.46 | 1.17 | 0.35 | -0.01 | -0.15 | -0.21 |
| | (0.06) | (0.36) | (0.21) | (0.06) | (0.04) | (0.40) |
| 2014m5 | 1.57 | 1.15 | 0.54 | 0.05 | -0.12 | -0.02 |
| | (0.06) | (0.36) | (0.24) | (0.06) | (0.04) | (0.43) |
| 2014m6 | 1.57 | 1.24 | 0.57 | 0.02 | -0.14 | 0.08 |
| | (0.06) | (0.41) | (0.22) | (0.07) | (0.06) | (0.42) |
| 2014m7 | 1.57 | 0.87 | 0.69 | 0.03 | -0.14 | 0.35 |
| | (0.06) | (0.45) | (0.21) | (0.06) | (0.05) | (0.42) |
| 2014m8 | 1.50 | 0.95 | 0.70 | 0.01 | -0.16 | 0.01 |
| | (0.06) | (0.37) | (0.24) | (0.07) | (0.05) | (0.45) |
| 2014m9 | 1.48 | 0.97 | 0.69 | -0.02 | -0.20 | 0.07 |
| | (0.05) | (0.38) | (0.24) | (0.07) | (0.05) | (0.41) |
| 2014m10 | 1.47 | 0.93 | 0.48 | -0.00 | -0.20 | -0.23 |
| | (0.06) | (0.35) | (0.21) | (0.08) | (0.05) | (0.40) |
| 2014m11 | 1.28 | 0.76 | 0.23 | -0.04 | -0.15 | 0.12 |
| | (0.06) | (0.34) | (0.28) | (0.08) | (0.05) | (0.66) |
| 2014m12 | 1.25 | 0.78 | 0.32 | -0.09 | -0.14 | -0.14 |
| | (0.07) | (0.31) | (0.20) | (0.07) | (0.06) | (0.68) |
| 2015m1 | 1.45 | 0.78 | 0.52 | -0.03 | -0.07 | -0.37 |
| | (0.07) | (0.35) | (0.26) | (0.07) | (0.06) | (0.75) |
| 2015m2 | 1.47 | 0.57 | 0.31 | -0.07 | -0.06 | -0.34 |
| | (0.06) | (0.39) | (0.21) | (0.07) | (0.06) | (0.71) |
| 2015m3 | 1.42 | 0.51 | 0.24 | -0.10 | -0.12 | -0.41 |
| | (0.06) | (0.39) | (0.21) | (0.07) | (0.06) | (0.71) |
| R-square | 0.899 | 0.842 | 0.876 | 0.826 | 0.895 | 0.899 |
| N | 21548 | 8094 | 714 | 18655 | 23184 | 1494 |

Note: Standard errors, clustered by city, in parentheses. In addition to the variables shown, all regressions include city dummies, brand dummies, package dummies, and size dummies. DWAS stands for drinks with added sugar.

Appendix Table 2: Estimated month effects for prices of other goods, relative to December 2013

| Real price of: | Butter | Cheese | Chicken | Dried beans | Rice | Bread |
|---|---|---|---|---|---|---|
| Dummy for month | (1) | (2) | (3) | (4) | (5) | (6) |
| 2011m1 | -7.90 | -2.05 | -2.87 | -4.15 | -0.22 | -0.05 |
| | (1.59) | (0.88) | (0.40) | (0.56) | (0.28) | (0.04) |
| 2011m2 | -5.60 | -2.56 | -3.29 | -4.20 | -0.23 | -0.05 |
| | (1.77) | (0.84) | (0.38) | (0.52) | (0.27) | (0.04) |
| 2011m3 | -5.28 | -2.15 | -3.04 | -3.54 | -0.23 | -0.05 |
| | (1.69) | (0.89) | (0.37) | (0.39) | (0.24) | (0.04) |
| 2011m4 | -5.99 | -1.50 | -3.10 | -3.49 | -0.16 | -0.03 |
| | (1.68) | (0.88) | (0.41) | (0.38) | (0.24) | (0.04) |
| 2011m5 | -3.55 | -0.24 | -2.57 | -3.44 | 0.05 | -0.00 |
| | (1.83) | (0.91) | (0.41) | (0.40) | (0.25) | (0.04) |
| 2011m6 | -2.21 | 0.65 | -2.36 | -3.61 | 0.02 | -0.00 |
| | (1.70) | (0.89) | (0.37) | (0.37) | (0.20) | (0.04) |
| 2011m7 | -3.06 | -0.18 | -1.84 | -3.64 | -0.25 | -0.01 |
| | (1.66) | (0.90) | (0.42) | (0.39) | (0.23) | (0.04) |
| 2011m8 | -5.24 | -0.87 | -1.80 | -3.18 | -0.34 | -0.01 |
| | (1.84) | (0.93) | (0.37) | (0.38) | (0.22) | (0.04) |
| 2011m9 | -5.10 | -0.83 | -2.03 | -2.03 | -0.29 | -0.01 |
| | (1.73) | (0.84) | (0.39) | (0.40) | (0.19) | (0.04) |
| 2011m10 | -4.10 | 1.86 | -2.14 | -1.35 | -0.10 | -0.02 |
| | (1.79) | (0.83) | (0.40) | (0.43) | (0.22) | (0.04) |
| 2011m11 | -3.38 | 1.74 | -2.42 | -0.71 | 0.39 | -0.04 |
| | (1.73) | (0.87) | (0.34) | (0.44) | (0.21) | (0.04) |
| 2011m12 | -3.18 | 1.91 | -1.75 | 1.10 | 0.94 | -0.05 |
| | (1.68) | (0.88) | (0.35) | (0.50) | (0.21) | (0.04) |
| 2012m1 | -3.63 | 1.77 | -0.70 | 2.58 | 1.07 | -0.04 |
| | (1.81) | (0.84) | (0.40) | (0.54) | (0.21) | (0.04) |
| 2012m2 | -2.56 | 1.41 | -0.36 | 3.67 | 0.95 | -0.03 |
| | (1.69) | (0.87) | (0.41) | (0.54) | (0.22) | (0.04) |
| 2012m3 | -3.53 | 0.58 | -0.42 | 4.04 | 0.78 | -0.02 |
| | (1.63) | (0.78) | (0.35) | (0.54) | (0.20) | (0.04) |
| 2012m4 | -2.49 | 0.81 | -0.47 | 4.85 | 0.70 | -0.01 |
| | (1.60) | (0.84) | (0.33) | (0.54) | (0.18) | (0.03) |
| 2012m5 | -2.53 | 1.74 | -0.35 | 6.20 | 0.75 | -0.00 |
| | (1.50) | (0.77) | (0.34) | (0.52) | (0.18) | (0.03) |
| 2012m6 | -1.75 | 1.10 | -0.91 | 6.67 | 0.70 | -0.02 |
| | (1.47) | (0.79) | (0.36) | (0.51) | (0.15) | (0.02) |
| 2012m7 | -1.33 | 0.78 | 0.09 | 6.89 | 0.79 | -0.02 |
| | (1.56) | (0.74) | (0.36) | (0.47) | (0.13) | (0.02) |
| 2012m8 | -1.52 | 0.15 | -0.11 | 7.03 | 0.86 | 0.03 |
| | (1.56) | (0.78) | (0.36) | (0.46) | (0.13) | (0.02) |
| 2012m9 | -1.83 | 0.47 | 1.10 | 7.04 | 0.87 | 0.08 |
| | (1.58) | (0.77) | (0.35) | (0.41) | (0.13) | (0.02) |
| 2012m10 | -1.21 | 0.87 | 1.11 | 6.27 | 0.81 | 0.09 |
| | (1.47) | (0.68) | (0.35) | (0.37) | (0.12) | (0.02) |
| 2012m11 | -1.69 | 1.55 | 0.83 | 5.26 | 0.72 | 0.09 |
| | (1.49) | (0.74) | (0.35) | (0.30) | (0.12) | (0.02) |
| 2012m12 | -2.04 | 2.31 | 1.01 | 4.90 | 0.60 | 0.10 |
| | (1.48) | (0.70) | (0.38) | (0.31) | (0.12) | (0.02) |
| 2013m1 | -1.66 | 2.40 | 1.26 | 4.58 | 0.54 | 0.09 |
| | (1.43) | (0.66) | (0.37) | (0.34) | (0.12) | (0.02) |
| 2013m2 | -2.41 | 1.78 | 1.07 | 3.63 | 0.30 | 0.08 |
| | (1.55) | (0.67) | (0.36) | (0.31) | (0.12) | (0.02) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2013m3 | -2.61 | 1.35 | 1.19 | 3.31 | 0.26 | 0.07 |
| | (1.61) | (0.60) | (0.37) | (0.28) | (0.12) | (0.02) |
| 2013m4 | -2.92 | 1.10 | 1.82 | 2.84 | 0.22 | 0.05 |
| | (1.55) | (0.59) | (0.40) | (0.28) | (0.11) | (0.01) |
| 2013m5 | -1.44 | 1.83 | 3.87 | 2.77 | 0.24 | 0.06 |
| | (1.70) | (0.52) | (0.45) | (0.27) | (0.11) | (0.01) |
| 2013m6 | -0.33 | 1.37 | 4.63 | 2.30 | 0.16 | 0.06 |
| | (1.35) | (0.56) | (0.45) | (0.25) | (0.10) | (0.01) |
| 2013m7 | 0.19 | 1.19 | 3.57 | 2.23 | 0.14 | 0.06 |
| | (1.15) | (0.54) | (0.35) | (0.22) | (0.10) | (0.01) |
| 2013m8 | -0.35 | 1.06 | 2.30 | 2.11 | 0.39 | 0.04 |
| | (1.35) | (0.50) | (0.28) | (0.23) | (0.08) | (0.01) |
| 2013m9 | 0.48 | 1.48 | 1.66 | 1.79 | 0.40 | 0.04 |
| | (1.06) | (0.43) | (0.24) | (0.15) | (0.08) | (0.01) |
| 2013m10 | -0.44 | 1.47 | 0.46 | 1.46 | 0.13 | 0.02 |
| | (0.92) | (0.43) | (0.18) | (0.13) | (0.15) | (0.01) |
| 2013m11 | -0.46 | 0.58 | -0.62 | 0.97 | -0.09 | -0.00 |
| | (0.43) | (0.34) | (0.18) | (0.11) | (0.15) | (0.01) |
| 2014m1 | -0.51 | -0.11 | 0.83 | -0.95 | -0.44 | -0.00 |
| | (0.58) | (0.34) | (0.19) | (0.13) | (0.14) | (0.01) |
| 2014m2 | -0.45 | 0.56 | 0.47 | -2.30 | -0.70 | -0.00 |
| | (0.69) | (0.42) | (0.23) | (0.22) | (0.16) | (0.01) |
| 2014m3 | -1.72 | 0.42 | -0.02 | -3.73 | -0.79 | -0.02 |
| | (0.99) | (0.53) | (0.27) | (0.34) | (0.16) | (0.02) |
| 2014m4 | 0.95 | 1.29 | 0.29 | -4.44 | -0.92 | -0.01 |
| | (1.01) | (0.53) | (0.29) | (0.37) | (0.17) | (0.02) |
| 2014m5 | 1.63 | 2.51 | 3.57 | -4.71 | -0.76 | 0.00 |
| | (1.13) | (0.53) | (0.48) | (0.43) | (0.19) | (0.02) |
| 2014m6 | 1.27 | 2.19 | 3.68 | -4.75 | -0.84 | -0.00 |
| | (1.06) | (0.58) | (0.29) | (0.45) | (0.20) | (0.02) |
| 2014m7 | 1.38 | 1.76 | 2.30 | -4.97 | -0.99 | -0.01 |
| | (1.01) | (0.54) | (0.27) | (0.49) | (0.20) | (0.02) |
| 2014m8 | 1.56 | 0.75 | 2.91 | -5.31 | -0.88 | -0.01 |
| | (1.09) | (0.56) | (0.24) | (0.52) | (0.22) | (0.02) |
| 2014m9 | 1.52 | 0.36 | 2.65 | -5.62 | -1.08 | -0.01 |
| | (1.05) | (0.62) | (0.33) | (0.56) | (0.23) | (0.02) |
| 2014m10 | 0.56 | 1.13 | 1.70 | -5.80 | -1.24 | -0.02 |
| | (1.11) | (0.54) | (0.27) | (0.54) | (0.25) | (0.02) |
| 2014m11 | -1.63 | 0.67 | 0.83 | -6.06 | -1.30 | -0.03 |
| | (1.05) | (0.52) | (0.25) | (0.54) | (0.24) | (0.02) |
| 2014m12 | -0.46 | -0.02 | 1.04 | -6.24 | -1.28 | -0.04 |
| | (1.07) | (0.54) | (0.29) | (0.52) | (0.23) | (0.02) |
| 2015m1 | 1.38 | 0.91 | 1.59 | -5.90 | -1.14 | -0.04 |
| | (1.14) | (0.57) | (0.37) | (0.48) | (0.22) | (0.02) |
| 2015m2 | 1.31 | 1.05 | 1.56 | -5.57 | -1.15 | -0.05 |
| | (1.07) | (0.67) | (0.35) | (0.42) | (0.23) | (0.02) |
| 2015m3 | 0.81 | 0.60 | 1.38 | -5.65 | -1.21 | -0.06 |
| | (1.07) | (0.67) | (0.34) | (0.42) | (0.23) | (0.02) |
| R-square | 0.824 | 0.847 | 0.558 | 0.568 | 0.830 | 0.477 |
| N | 9257 | 46339 | 27493 | 18541 | 13914 | 13893 |

Note: Standard errors, clustered by city, in parentheses. In addition to the variables shown, all regressions include city dummies, and brand dummies. Package dummies and size dummies are included where applicable.