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THE CASE OF BOULDER, COLORADO

John Cawley
Chelsea Crain
David Frisvold
David Jones

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The Pass-Through of the Largest Tax on Sugar-Sweetened Beverages: The Case of Boulder, Colorado

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ABSTRACT

We estimate the incidence of a relatively new type of excise tax, a tax on sugar-sweetened beverages (SSBs). We examine the largest such tax to date, which is two cents per ounce, in Boulder, CO. Using data that were hand-collected from stores and restaurants in both Boulder and two control communities, as well as internet data of restaurant menus, we find that the tax was largely, but not completely, passed through to consumers 5-7 weeks after implementation. Some retailers add the tax only at the register, indicating that estimates solely from posted prices would result in an underestimate of pass-through.

John Cawley
2312 MVR Hall
Department of Policy Analysis and Management
and Department of Economics
Cornell University
Ithaca, NY 14853
and NBER
JHC38@cornell.edu

Chelsea Crain
Department of Economics
University of Iowa
21 East Market Street
Iowa City, Iowa 52242
chelsea-crain@uiowa.edu

David Frisvold
Department of Economics
University of Iowa
21 East Market Street
Iowa City, IA 52242
and NBER
david-frisvold@uiowa.edu

David Jones
955 Massachusetts Avenue
Suite 801
Cambridge, MA 02139
United States
DJones@mathematica-mpr.com

The incidence of taxes is a classic topic in public finance. Economic theory indicates that the relative burdens of a tax are determined by the market power of firms and the elasticities of supply and demand (Kotlikoff & Summers, 1987; Fullerton & Metcalf, 2002; Weyl and Fabinger, 2013). For example, in a perfectly competitive market, if demand is completely inelastic or if firms face constant marginal costs, pass-through would be 100 percent and consumers would bear the entire burden of the tax. If the market is imperfectly competitive, taxes can be overshifted (price may rise by more than the tax) if oligopolists find it optimal to reduce output and charge higher prices in response (Anderson, de Palma, & Kreider, 2001; Bonnet & Requillart, 2013). Numerous studies have estimated the pass-through of taxes on products such as cigarettes and gasoline.¹

We estimate the pass-through of a relatively novel tax on sugar-sweetened beverages (SSBs). Numerous organizations, such as the World Health Organization, Institute of Medicine, American Academy of Pediatrics, and the American Public Health Association, have called for taxes on SSBs because SSBs contribute to obesity and poor health (Rudd Center for Food Policy and Obesity, 2014). In addition to being high-calorie and zero-nutrient, SSBs have a high glycemic load (i.e., they significantly raise blood sugar), which, independently of obesity, contributes to insulin resistance and diabetes (Malik & Hu, 2011).

Many countries recently implemented taxes on SSBs, including Australia, Denmark, Finland, France, Ireland, Mexico, and the United Kingdom (Thow et al., 2018). Within the U.S., several cities have adopted taxes on SSBs: first Berkeley, CA, in 2015; followed by Philadelphia, Boulder, and Oakland in 2017; and San Francisco and Seattle in 2018.² All of these city-level taxes are imposed on beverage distributors who sell to retailers.

Given the relative newness of the taxes, their effects are not well understood.³ Comparing

¹Empirical estimates of excise taxes on alcohol, clothing, cigarettes, and gasoline often find that 100 percent or more of the taxes are passed through to consumers (e.g., Besley & Rosen, 1999; Poterba, 1996). A smaller body of literature finds partial pass-through, in the range of 45 to 85 percent (e.g., Doyle & Samphantharak, 2008; Harding et al., 2012).

²Many states also impose sales taxes on soft drinks, although they are very small, are primarily a tool to increase revenue, and apply to diet as well as caloric soft drinks (Fletcher, Frisvold, and Tefft, 2010, 2015).

³There is also a literature examining the impact of SSB taxes outside of the U.S. Several studies find that more than 100 percent of the SSB tax in Mexico was passed through to consumers, although the studies lack geographic control groups and rely on pre-post comparisons and comparisons to untaxed non-substitute products (Colchero et al., 2015; Grogger, 2017).

changes in prices in Berkeley relative to those in control cities such as San Francisco, both Falbe et al. (2015) and Cawley and Frisvold (2017) estimated that 43-47 percent of the Berkeley tax was passed on to consumers, and the 95 percent confidence intervals rule out full pass-through of the tax. Cawley, Willage, and Frisvold (2017) examine the tax in Philadelphia within the Philadelphia airport, which straddles the city border; thus, some terminals are taxed and others are untaxed. Within the terminals in Philadelphia, the pass-through rate was 93 percent. In response, some stores in the untaxed terminals raised prices by the amount of the tax.

We contribute to this early literature on the pass-through of taxes on SSBs. Specifically, this paper is the first to estimate the pass-through of the largest city-level tax on SSBs to date, which is the tax of 2 cents per ounce in Boulder, CO that was implemented on July 1, 2017.⁴ Boulder's tax on SSBs is substantial; it represents 22 percent of the pretax price of a 20-ounce bottle, 68 percent of the pretax price of a 2-liter bottle, and 53 percent of the pretax price of a 12-pack of 12-ounce cans.⁵ Thus, its impact on retail prices may be different from that of the smaller taxes of 1 cent per ounce in Berkeley and 1.5 cents per ounce in Philadelphia. In addition, pass-through may differ across cities because of differences in the elasticities of supply and demand for SSBs, or the competitiveness of the local retail markets.

Another important strength of the paper is its rich and varied data. We collected data in person from stores in Boulder and two control communities in multiple periods before and after the tax. After the tax, we recorded posted (shelf) prices and purchased a taxed and untaxed beverage. The tax was levied on beverage distributors, in part, because excise taxes are more salient and, thus, more likely to reduce consumption (Chetty, Looney, Kroft, 2009). However, we find that not all retailers included the tax in the posted, or shelf, prices; some instead added it at the register, where it is less salient.

⁴The tax in Boulder passed by ballot initiative in November 2016, with 54 percent of voters in favor of the tax. It is an excise tax on distributors and took effect on July 1, 2017. The tax applies to SSBs with at least 5 grams of caloric sweetener per 12 fluid ounces. It does not apply to diet soda, products in which milk is the primary ingredient, alcoholic mixers, or coffee drinks. The tax is applied to the size of the prepared product; for example, the tax on the syrup used to prepare a 32 ounce fountain drink is 64 cents.

⁵These percentages were calculated using the mean price of SSBs in Boulder in April 2017, according to our hand-collected store data.

We additionally collected price data in person from restaurants in the same communities because restaurants are important points of purchase of SSBs, and the elasticity of supply of SSBs may differ between restaurants and stores, resulting in a different level of pass-through. Finally, we collected weekly data from online menus in these communities. Other strengths of the data include information about the prices of a wide range of taxed products: various sizes (e.g., 20 ounce and 2-liter bottles), various containers (bottles, cans, and fountain drinks), and a wide range of brands and products.

We estimate the pass-through of the SSB tax to consumers using a difference-in-differences design, comparing the changes in prices per ounce over time in Boulder to two comparison areas. We estimate that the tax increased prices immediately after its implementation on July 1, 2017 and that this increase remained relatively constant for the next four months. The posted prices increased by 1.1 cents per ounce on average, a 53.2 percent pass-through rate. However, twenty percent of the stores in Boulder do not include the tax in their posted prices but instead add it at the register. As a result, pass-through is larger when measured by the register prices: 1.6 cents per ounce, or 79 percent of the tax.

1 Methods

To estimate the pass-through of the SSB tax to retail prices, we use a difference-in-differences design, comparing the change in prices (in cents per ounce) over time in Boulder to that in the control communities of Boulder County (minus the city of Boulder) and Fort Collins, CO. In our primary specification, based on data from all retail stores and restaurants with two pre-tax periods (April and June) and two periods after the tax was introduced (August and October) that we collected in-person, we estimate:

$$Y_{isct} = \beta_0 + \beta_1(\text{Boulder}_c \times \text{April}_t) + \beta_2(\text{Boulder}_c \times \text{August}_t) + \beta_3(\text{Boulder}_c \times \text{October}_t) + \gamma_c + \delta_t + \theta_s + \psi_i + \epsilon_{isct}, \quad (1)$$

where Y_{isct} denotes the price per ounce of product i in store s in community c in month t ; *Boulder*

is a binary variable equal to one if store s is located in the City of Boulder (and 0 if the store is located in the rest of Boulder County or in Fort Collins); and *April*, *August*, and *October* are binary variables equal to one if the price is recorded in that month; June is the omitted reference month. When we estimate the equation using the weekly online menu data from OrderUp, we replace the month fixed effects with weekly ones. γ_c represents community fixed effects, with an indicator variable for Boulder County and another indicator variable for Fort Collins. δ_t represents month fixed effects.⁶ θ_s represents store fixed effects. ψ_i represents product fixed effects.⁷ ε is a stochastic error term.

The data include only three geographic clusters (Boulder, the rest of Boulder County, and Fort Collins).⁸ Cameron and Miller (2015) show that standard errors that do not account for the number of clusters can overstate precision unless the within-cluster correlation of errors is solely driven by a common shock process, which would be picked up by our store-level fixed effects. We cluster standard errors by store, following Cawley and Frisvold (2017).⁹ Clustering standard errors at the community level, using the wild cluster bootstrap method as recommended by Cameron, Gelbach and Miller (2008), yields similar, but slightly smaller standard errors on the coefficients of interest. As a result, we report the more conservative standard errors, clustered at the store level.

In the equation listed above, β_2 and β_3 are the coefficients of interest; they represent the difference-in-differences estimates of the impact of the Boulder tax on prices in the post-tax periods of August and October respectively, relative to the pre-tax period of June. Comparing β_3 to β_2 indicates whether the estimate of pass-through changed over time after the tax.

An important assumption underlying this specification is that, in the absence of the tax, the trends in prices in Boulder would be the same as the trends in the control communities of Boulder County and Fort Collins. The geographic proximity of these areas, similarities in demographic

⁶The results described below are not sensitive to also including day-of-the-week fixed effects and date-of-the-month fixed effects.

⁷We define a product based on the size and the name, so examples of products are a 20 oz. bottle of Pepsi, a 2 liter bottle of 7Up, a 12 pack of 12 oz. cans of Diet Coke, a 8.4 oz. can of Red Bull, and a small fountain drink.

⁸With only two geographic areas and two time periods, clustering can lead to degenerate standard errors (Donald & Lang, 2007; Cameron & Miller, 2015).

⁹To put our limited number of clusters into context, several previous studies of the pass-through of taxes on SSBs (e.g., Grogger, 2017) had data only for the treated country or state with no geographic control.

characteristics and locations of large, public universities in Boulder and Fort Collins are consistent with this assumption.¹⁰ Boulder County is an appealing control group because it has the advantage of proximity; any unobserved shocks to demand in Boulder around the time of the tax are likely experienced by the rest of the county. However, the disadvantage is that there may be spillover effects of the tax due to cross-border shopping by Boulder residents seeking to avoid the tax. Fort Collins has the relative advantage of being 45 miles to the north, which makes cross-border shopping from Boulder unlikely.

To investigate the plausibility of our identifying assumption of parallel trends in prices in the treatment and control areas, we assess the trends in prices in these areas over time. In addition, we examine the estimates of β_1 , which measure any trend in prices during the two pre-tax periods of April and June that differs between the treatment and control group.

We estimate the above equation for taxed and untaxed products separately. We estimate the impact of the SSB tax on untaxed products because the tax could cause substitution from taxed to untaxed products (e.g., from Coke to Diet Coke) that alters the price of the untaxed products.

For our primary estimates, we pool all products and sizes. However, because the price elasticity, and thus the pass-through, may vary by product size and brand, we also estimate pass-through separately for the most common product sizes and brands.

2 Data

We assembled three datasets: 1) hand-collected data of listed prices and purchase prices of beverages from all retail stores; 2) hand-collected data of listed prices of fountain drinks and coffee drinks from all limited-service restaurants; and 3) web-scraped data of prices from a selected sample of restaurant menus. Appendix Figures 1, 2, and 3 show the location of each retailer store and restaurant where we gathered prices in Boulder, Boulder County, and Fort Collins, respectively.

¹⁰The City of Boulder is fully enclosed within Boulder County. When referring to Boulder County as a community in the control group, we are referring to the area of Boulder County that excludes the City of Boulder.

2.1 Hand-Collected Data of Beverage Prices from Stores

We collected beverage prices at four points in time, twice before the tax (April and June 2017) and twice after the tax (August and October 2017). The four time points enable us to examine trends in prices before the tax and to compare the pass-through of the tax at two points in time after implementation.

We collected data from all grocery stores, pharmacies, and convenience stores in Boulder, Boulder County, and Fort Collins. We identified these stores and their addresses using the ReferenceUSA database, which includes approximately 24 million U.S. businesses and is updated monthly.¹¹ Data collectors visited and recorded prices from 174 retailers in April, 286 retailers in June, 287 retailers in August, and 288 retailers in October.¹² After the data collection in April, we expanded the set of retailers to include liquor stores.

We collected the prices of soft drinks, energy drinks, sports drinks, iced tea, juice, water, mixers for alcoholic drinks, and fountain drinks. We chose the most common sizes and brands to maintain consistency among the products and reduce the burden on data collectors in the field. We selected a mix of products that are taxed and untaxed. For example, we selected 20 oz. bottles, 2 liter bottles, and 12 packs of 12 oz. cans of Pepsi (taxed), Diet Pepsi (untaxed), Coke (taxed), and Diet Coke (untaxed). We also selected products that are consumed more commonly in Boulder, such as Hansen's soda (taxed), San Pellegrino (untaxed), and GT's Organic Raw Kombucha (untaxed).¹³ For all products, we collected the posted price and whether the product was on sale. If a store did not post prices, data collectors asked an employee for the price of the products. We collected this information for all products in each of the four periods, except that we began collecting the prices of Hansen's, San Pellegrino, and alcohol mixers in June (the second of the two pre-tax periods). The full list of products is shown in Appendix Table 1.

¹¹Specifically, we included all retailers with verified listings in Boulder County and Fort Collins, CO that are classified as supermarkets or other grocery stores (NAICS code 445110); convenience stores (NAICS code 445120); pharmacies and drug stores (NAICS code 446110); gasoline stations with convenience stores (NAICS code 447110); warehouse clubs and supercenters (NAICS code 452311), and beer, wine, and liquor stores (NAICS code 445310).

¹²More details on data collection are presented in Appendix Table 1.

¹³Fermented beverages with less than 11 grams of caloric sweetener per 12 fluid ounces were exempt from the tax. The GT's Kombucha products that were collected meet this criteria.

Failing to consider the register price could lead to an underestimate of the overall pass-through of the tax to consumers. To test this possibility, we construct the register price, which is equal to the posted price plus the amount of the tax that is itemized on the receipt, before sales tax is included. Specifically, in October (after the tax), in addition to collecting posted prices, data collectors purchased 20 oz. bottles of Pepsi and Diet Pepsi from each retailer and kept the receipt. If the store did not sell these products, the data collectors purchased another taxed SSB and a comparable untaxed product. Based on the receipts, we determine whether the posted price matches the price that retailers charge consumers (excluding sales tax).¹⁴ For most retailers, the posted price is equal to the register price. However, 16 out of 77 Boulder retailers (20.8 percent) did not include the tax in the posted price, and instead, itemized the amount of the tax on the receipt. If a retailer adds the tax at the register for the SSB we purchased, we assume that the retailer does the same for all SSBs in both periods after the tax was implemented.

2.2 Hand-Collected Data from Restaurants and Coffee Shops

We collected the price and number of ounces of all sizes of fountain drinks from restaurants, which are taxed if the drink is caloric (not diet). We also collected the prices of a 12 oz. drip coffee, a 12 oz. latte, a 12 oz. mocha latte, and a 12 oz. hot chocolate from coffee shops, which are all untaxed. Although a mocha latte and a hot chocolate are sweetened beverages, the City Council exempted milk-based products from the tax.

We collected data from all limited-service restaurants and coffee shop locations in Boulder County, including the City of Boulder, and Fort Collins.¹⁵ Data collectors visited each of these restaurants to determine whether the restaurant sold fountain drinks or coffee drinks and to record the prices and sizes. We collected this information from restaurants in April, June, August, and

¹⁴One retailer includes sales tax in the posted price. As a result, the receipt price, before the sales tax is included, is less than the posted price in all periods for this retailer.

¹⁵Specifically, using the ReferenceUSA database, we included all restaurants with verified listings in Boulder County and Fort Collins, CO that are classified as limited-service restaurants (NAICS code 722513) and snack and non-alcoholic beverage bars (NAICS code 722515), which includes all coffee shops listed under SIC code 581228. Limited-service restaurants are restaurants in which customers order at the counter.

October 2017, and from coffee shops in June, August, and October 2017. Data collectors visited 236 restaurants in April, 345 restaurants and coffee shops in June, 342 restaurants and coffee shops in August, and 340 restaurants and coffee shops in October.¹⁶

2.3 OrderUp Data of Restaurant Beverages

As a third source of data, we collected beverage prices from the menus of restaurants that participate in the OrderUp.com delivery platform in the City of Boulder and the Fort Collins area. There are no restaurants in Boulder County, outside of the City of Boulder, that participate in OrderUp. OrderUp is an online restaurant food ordering and delivery company that was founded in 2009 and serves customers in over 60 locations across 22 states.

We were able to collect these data more frequently because we collected these data by web scraping as opposed to in-person recording. We scraped the OrderUp data weekly, beginning every Wednesday, from March 22, 2017 through October 25, 2017. The frequency of the data provides us with greater detail on the timing and consistency of price changes after the introduction of the tax and of the trends in prices prior to the tax.

The data collection began with 219 restaurants, of which 158 appeared in all waves of data collection. Reasons for a restaurant not remaining in the sample include termination of use of the OrderUp system, closures, name or address changes (these are the two identifying variables for a restaurant), and technical errors occurring when the website is updated and the scrape incorrectly reads or saves a menu. Of the 158 restaurants consistently in the sample every week, 114 consistently have beverage items throughout the entire period.¹⁷ Of the 114 restaurants, 42 are located within the city of Boulder and 72 are located in the Fort Collins area.¹⁸

The types of beverages on the OrderUp menus are more varied than the hand-collected retail and restaurant data. The OrderUp beverage items in the final sample range from specific branded

¹⁶The number of restaurants selling each product in each time period are shown in Appendix Table 2.

¹⁷We identify products by item name, and size when applicable, thus menu updates that change either variable exclude the item from the balanced sample.

¹⁸For this sample, the Fort Collins area includes Fort Collins, Evans, Garden City, Greeley, Loveland, and Windsor.

items (e.g., Coke, Oogave Rootbeer) to general types of drinks (e.g., apple juice, tea). The full list of items is shown in Appendix Table 3. We categorize each beverage item into one of three categories based on the Boulder SSB tax law: taxed, untaxed, or unknown. Most OrderUp beverage items have names that we can categorize as taxed or not under the Boulder SSB law, but some items have generic names such as “Coke products”, which we cannot definitively categorize. Of the 877 beverage items in the balanced sample, 688 are identified as taxed or untaxed. Some beverage items contain information on fluid ounces, but the majority only contain the name of the item. The number of ounces of the product is only known for 67 of the 877 items. As such, for the OrderUp items, we report price per drink instead of price per ounce. We assume that the number of ounces did not change over time for the drinks for which size is not listed. Although this is untestable for all items, there was no change in size after the tax for the 67 drink items of known size, which supports the plausibility of this assumption.

3 Results

3.1 Evidence Regarding Parallel Trends

The difference-in-differences method assumes that the comparison community is a valid counterfactual for the treated community. To investigate the plausibility of this assumption, we examine whether there existed parallel trends in the outcome (prices per ounce) between the treatment and comparison communities prior to the treatment. We present the trends for taxed and untaxed drinks, for the hand-collected store data (Figure 1), hand-collected restaurant data (Appendix Figure A4), and web-scraped restaurant data (Appendix Figure A5). The trends in prices of all taxed products in Boulder are stable prior to the introduction of the tax in July and are comparable to the trends in prices of taxed products outside of Boulder over this same period (Figure 1). Graphs of the trends in prices for specific sizes (20 ounce bottle, 2 liter bottle, 12 pack of 12 ounce cans, and fountain drinks) and specific brands (Pepsi products, Coke products, and other brands) sold in stores show similar patterns. The trends in the price per ounce of fountain drinks in restaurants and the price

per drink from OrderUp are also stable in Boulder and parallel to the trends for taxed products outside of Boulder prior to the introduction of the tax (Appendix Figures A4 and A5).

3.2 Difference-in-Differences Estimates

Table 1 presents the difference-in-differences estimates for taxed and untaxed items, separately for the entire sample (i.e., unbalanced panel) and the balanced panel of products. Results for taxed items are shown for both posted prices and register prices. Column 1 presents results based on posted prices for the entire sample. The posted prices of SSBs increased from June (the last month prior to the tax) to August by 1.018 cents per ounce in Boulder, relative to the control communities.¹⁹ The tax is 2 cents per ounce, so the price increase represents a pass-through of 50.9 percent. In October (3 months after the tax), prices were 1.022 cents per ounce higher than in June. Thus, prices rose from June to August, which is the month following the implementation of the tax, and then remained constant through October. Importantly, the coefficient on the interaction term for *Boulder* \times *April* suggests that there was not a differential trend in prices between Boulder and the control communities prior to the tax.

Next, we examine pass-through based on register prices (the results discussed in this paragraph are not presented in Table 1). Approximately twenty percent of stores itemize the tax at the register; more than half of these (13 out of 16) are convenience stores. In contrast, only 8 out of 61 stores that only incorporate the tax into the shelf price are convenience stores. Stores that itemize the tax at the register also increased their prices on the shelf. The mean shelf price of taxed beverages in these stores increased by 0.438 cents per ounce (with a standard error of 0.101) from June to August, while the mean price for untaxed items increased by only 0.147 cents per ounce (with a standard error of 0.078). Since these stores also itemized the tax at the register, the mean price paid at the register of taxed beverages increased by 2.438 cents per ounce. In contrast, in stores that only incorporated the tax into the shelf price (and did not itemize the tax), mean prices increased by 0.965 cents per ounce (with a standard error of 0.150) for taxed beverages and 0.348 cents per

¹⁹The estimates are similar if we examine each control community separately, instead of combining Boulder County and Fort Collins.

ounce (with a standard error of 0.138) for untaxed beverages.

Column 2 of Table 1 shows the difference-in-differences estimates using the register prices for all stores. Prices in Boulder increased by 1.578 cents per ounce from June to August, for an estimated pass-through rate of 78.9 percent. Again, the estimate for October is very similar to that for August, implying that pass-through remained roughly constant in the months after the tax.

The third column of Table 1 reports results for untaxed beverages. The effect of the Boulder tax on the price of untaxed items is small in magnitude and not statistically significant. There is some evidence of a differential trend in the prices of untaxed products from April to June.

In the last three columns of Table 1, we find that the estimates are similar when we restrict the sample to the balanced panel of products that are consistently in the sample during all four periods. Thus, changes in products or stores do not drive the estimates for the entire sample.

We next examine whether the extent of pass-through varies by the size of the beverage, whether it is a fountain drink, and by store type. Pass-through could vary by size if demand is more inelastic for individual servings (e.g., 20-ounce bottles) than for larger volumes that are part of larger shopping trips in which people drive. Pass-through could vary by store type if the elasticities of demand and supply differ across store type, because of differences in the stores' marginal costs or because of differences in their clientele.

Table 2 displays difference-in-difference estimates using the entire sample and register prices for beverages by size (20 ounce bottles, 2 liter bottles, and 12 packs of 12 ounce cans), for fountain drinks, and for store types (convenience, grocery, pharmacies, and liquor). There are not major differences in pass-through by the size of the beverage; it is roughly 75 percent for each. Fountain drinks stand out because the tax is over-shifted onto their retail prices; prices on fountain drinks rise by roughly 2.8 cents per ounce or 140 percent of the tax. The pass-through estimates are smaller for pharmacies and for grocery stores than other types at 52 percent and 64 percent, respectively. In contrast, the tax is passed through at 84 percent for liquor stores and at 99 percent for convenience

stores.²⁰

Table 3 reports results using the hand-collected data on fountain drinks and coffee drinks from restaurants. The price of fountain drinks increased by 0.972 cents per ounce in Boulder from June to August, relative to the price in Boulder County and Fort Collins, implying a pass-through of 48.6 percent. In contrast to retail prices, the prices of fountain drinks in restaurants continued to rise after August. In October, the relative price per ounce in Boulder was 1.387 cents higher than in June, for a pass-through of 69.4 percent. As also shown in the table, the prices of untaxed products in coffee shops did not change as a result of the tax on SSBs. Again, estimates for the balanced sample of stores are similar to those for the entire (unbalanced) sample.

Table 4 displays results using the price data scraped from restaurant menus on OrderUp. An advantage of these data is that they could be collected more often, so we have greater ability to examine any difference in trends between the treatment and control communities prior to the tax, as well as changes in pass-through over time after the tax. A limitation of the OrderUp data is that we generally do not observe the size of the drink in ounces, so we observe price per drink rather than price per ounce, and while we can estimate the change in overall price we cannot estimate percent pass-through.

The interaction of the indicator variable for Boulder with months prior to the tax (March, April, and May) yields no evidence of a differential trend between the treatment and control communities, which is consistent with the identifying assumption of the regression model. For taxed beverages, the tax increased prices by 17.3 cents in August, 21.1 cents in September, and 20.2 cents in October. Prices also rose for untaxed beverages following the SSB tax: by 6.5 cents in August, 8.4 cents in September, and 7.8 cents in October. Beverages of unknown tax status (listed in column 3) experienced changes in price similar to those of untaxed items. Although we cannot estimate the percentage pass-through of the tax, these data serve the important purposes of confirming parallel trends for Boulder and the control communities prior to the tax, and for confirming that the retail

²⁰The estimates are similar for chain and independent stores. Pass-through rates do not vary based on the distance of the retailer within Boulder to the nearest competitor in an untaxed area. Pass-through rates are similar for soda, energy drinks, and sweetened teas, but lower for sports drinks at 53 percent in August. Appendix Table A4 displays estimates for specific products.

prices of taxed drinks rose more in Boulder than in the control communities after the tax.

4 Discussion and Conclusion

This paper provides the first evidence of the impact of the tax on SSBs in Boulder, CO, a tax that is noteworthy because it is the largest tax on SSBs passed by any U.S. city. Using hand-collected data from hundreds of retailers and hundreds of restaurants, we estimate that the tax was substantially, but not fully, passed through to consumers in the form of higher prices. Data from transactions at store registers indicate that 79.3 percent of the tax was passed through one month after the tax was instituted, and that the pass-through remained roughly constant for the next several months. The pass-through was similar across sizes of SSBs and was larger for liquor stores and convenience stores than in pharmacies. There is little evidence of any impact of the tax on the store prices of untaxed beverages. Data hand-collected from restaurants indicates that the pass-through of the tax was 69.4 percent on fountain drinks, and the tax had no detectable impact on the prices of untaxed coffee drinks. For restaurants, the increase in prices is slightly more gradual than retailers; this could be due to restaurants in general changing their prices less frequently than retailers.

It is commonly assumed that an excise tax will be incorporated into the shelf price (e.g., Chetty Looney, and Kroft, 2009). However, we find that not all retailers increase the posted price of SSBs in response to the tax. Among retailers in Boulder selling SSBs, 21 percent chose to add the tax at the register and itemize it on the receipt. Ignoring these decisions of retailers would lead to a substantial underestimate of the pass-through rate. The estimated pass-through based on posted prices is 51.2 percent; whereas, pass-through based on register prices is 79.3 percent.

Increasing the price at the register compared to the shelf could have important implications for the impact of the tax on purchases and the regressivity of the tax. The tax is more salient when it is included in the shelf price because it is observed at the point of decision-making; consumers may not notice it being added at the register. Consistent with this, Chetty, Looney, and Kroft (2009) find that alcohol purchases decrease more when the tax is incorporated into the posted price

instead of added at the register. Taubinsky and Rees-Jones (2018) find that consumers are less responsive to taxes that are not as salient on low-priced items, such as single-serving SSBs. Goldin and Homonoff (2013) suggest that cigarette taxes imposed at the register could be less regressive than similar taxes incorporated into the posted prices if low-income consumers are more attentive to prices at the register than high-income consumers.

Overall, our estimates suggest that the tax on SSBs in Boulder was substantially, but not fully, passed through to consumers. With the exception of fountain drinks and convenience stores, the 95 percent confidence intervals rule out 100 percent pass-through. The estimates of the pass-through of the tax in Boulder are larger than estimates of the pass-through of the SSB tax in Berkeley (Falbe et al., 2015; Cawley and Frisvold, 2017). They are lower than the estimates of the pass-through of taxes on SSBs in other countries (e.g. Colchero et al., 2015; Grogger, 2017; Berardi et al., 2016; Bergman and Hansen, 2010); although, this may be because those studies lack geographic control groups.

These results have implications beyond Boulder. Many cities have recently enacted taxes on SSBs, and their effects are not well understood. This paper contributes to the growing literature on the impacts of these taxes. These results also have implications for simulations of the effect of SSB taxes on consumption, which have often assumed that taxes will be fully passed through to consumers (e.g., Dharmasena, Davis, & Capps, 2014; Long et al., 2015; Wang et al., 2012). The results of this paper imply that consumers do not always bear the full burden of SSB tax (e.g., pass-through is not necessarily full) and that pass-through rates can vary across different localities.

Strengths of this analysis in Boulder include: (1) multiple periods of prices prior to the implementation of the tax, which allow us to assess whether the trends in prices are similar in the treated and the multiple comparison communities; (2) multiple periods of prices after the implementation of the tax, which allow us to determine how quickly restaurants and retailers respond to the tax; (3) prices from a wide range of products; (4) prices from all retailers and limited-service restaurants in the three communities, which minimizes sampling error; (5) large sample sizes of hundreds of stores and hundreds of restaurants; (6) weekly prices from online restaurant menus; and (7) both

posted and receipt prices from retailers.

We acknowledge that the comparison communities may be imperfect controls for Boulder, and we do not observe prices charged by the distributor to retailer. We also lack of information on sales, consumption, or consumer weight. Another limitation of this study is that we have a small number of clusters; we examine three geographic areas and four time periods (in the hand-collected data, with more periods in the web-scraped data). Despite these limitations, this paper presents important information about the incidence of the largest tax on SSBs in the United States.

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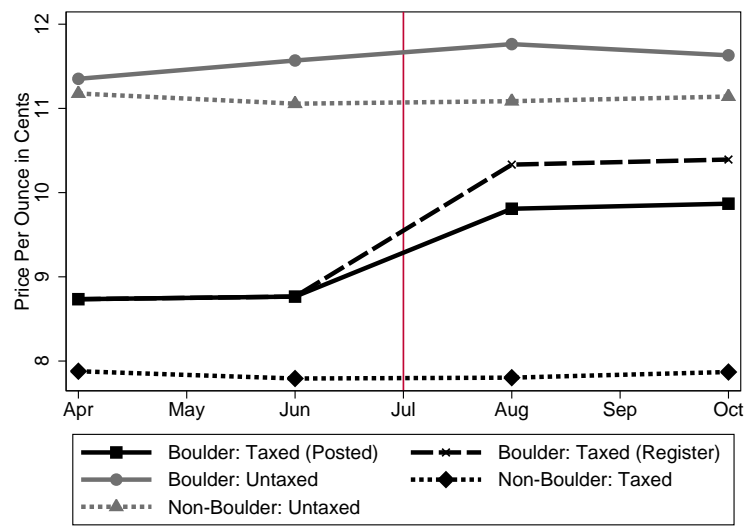
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5 Figures

Figure 1: Trends in the Price per Ounce of SSBs and Other Beverages at Retailers



Notes: Price per ounce is reported in cents. Taxed and not taxed items are defined according to whether the item is taxed under the law in Boulder. Posted prices are the prices shown on the shelf for each item. Register prices are constructed to account for stores that do not include the SSB tax in the posted price, and is equal to the posted price plus the amount of the tax that is itemized on the receipt. The data are balanced at the store-item level across all four waves of the data collection.

6 Tables

Table 1: Estimates of the Change in Retail Prices in Boulder after the SSB Tax

| | Taxed Products Posted Prices Full Sample | Taxed Products Register Prices Full Sample | Untaxed Products Posted Prices Full Sample | Taxed Products Posted Prices Balanced Sample | Taxed Products Register Prices Balanced Sample | Untaxed Products Posted Prices Balanced Sample |
|-----------------------|--|--|--|--|--|--|
| <i>Boulder × Apr</i> | -0.130 (0.109) | -0.152 (0.100) | -0.385 (0.184) | -0.155 (0.083) | -0.160 (0.082) | -0.339 (0.129) |
| <i>Boulder × Aug</i> | 1.018 (0.129) | 1.578 (0.139) | 0.127 (0.121) | 1.033 (0.210) | 1.557 (0.206) | 0.164 (0.226) |
| <i>Boulder × Oct</i> | 1.022 (0.122) | 1.581 (0.137) | 0.179 (0.129) | 1.026 (0.209) | 1.550 (0.201) | -0.023 (0.142) |
| <i>N</i> | 4078 | 4078 | 2625 | 1536 | 1536 | 919 |
| <i>N × T</i> | 11825 | 11825 | 7446 | 6129 | 6129 | 3676 |
| <i>Mean</i> | 7.907 | 7.907 | 11.613 | 7.985 | 7.985 | 11.181 |
| <i>R</i> ² | 0.957 | 0.957 | 0.929 | 0.977 | 0.977 | 0.953 |

Notes: Results in this table are calculated using the hand-collected retail data. The dependent variable is the price in cents per ounce. The estimates show the change in the number of cents per ounce of the retail price relative to the prices in June in Boulder County and Fort Collins. Posted prices are the prices shown on the shelf for each item. Register prices are constructed to account for stores that do not include the SSB tax in the posted price, and is equal to the posted price plus the amount of the tax that is itemized on the receipt. Standard errors, in parentheses, are clustered at the store level. Additional variables that are included, but not shown, are community fixed effects, month fixed effects, store fixed effects and product fixed effects. *N* represents the number of unique store specific items, *N × T* represents the number of unique store specific item observations across all waves. *Mean* is the pre-tax average price per ounce in cents.

Table 2: Heterogeneity in Estimates of the Change in Retail Prices in Boulder after the SSB Tax

| | 20oz | 2L | 12Pk | Fountain | Convenience | Grocery | Pharmacy | Liquor |
|-----------------------|------------------|-------------------|------------------|------------------|-------------------|-------------------|-------------------|------------------|
| <i>Boulder × Apr</i> | 0.182 (0.100) | -0.050 (0.138) | 0.018 (0.170) | 1.625 (0.278) | -0.099 (0.128) | -0.242 (0.218) | -0.203 (0.175) | |
| <i>Boulder × Aug</i> | 1.565 (0.157) | 1.450 (0.154) | 1.703 (0.169) | 2.792 (0.430) | 1.989 (0.201) | 1.274 (0.234) | 1.054 (0.350) | 1.679 (0.242) |
| <i>Boulder × Oct</i> | 1.533 (0.150) | 1.459 (0.159) | 1.584 (0.166) | 2.834 (0.440) | 1.933 (0.212) | 1.385 (0.215) | 1.013 (0.304) | 1.787 (0.246) |
| <i>N</i> | 1357 | 685 | 369 | 365 | 1643 | 1071 | 534 | 830 |
| <i>N × T</i> | 3953 | 1962 | 1153 | 1066 | 4527 | 3374 | 2077 | 1847 |
| <i>Mean</i> | 8.997 | 3.158 | 3.86 | 4.089 | 8.07 | 7.667 | 7.964 | 7.814 |
| <i>R</i> ² | 0.690 | 0.807 | 0.843 | 0.897 | 0.98 | 0.928 | 0.973 | 0.959 |

Notes: Results in this table are calculated using the full sample of taxed products from the hand-collected retail data and the prices charged at the register. The dependent variable is the price in cents per ounce. The estimates show the change in the number of cents per ounce of the retail price relative to the prices in June in Boulder County and Fort Collins. Standard errors, in parentheses, are clustered at the store level. Additional variables that are included, but not shown, are community fixed effects, month fixed effects, store fixed effects and product fixed effects. *N* represents the number of unique store specific items, *N × T* represents the number of unique store specific item observations across all waves. *Mean* is the pre-tax average price per ounce in cents.

Table 3: Estimates of the Change in Hand Collected Restaurant Prices in Boulder after the SSB Tax

| | Fountain Full Sample | Coffee Full Sample | Fountain Balanced Sample | Coffee Balanced Sample |
|-----------------------|-------------------------|-----------------------|-----------------------------|---------------------------|
| <i>Boulder × Apr</i> | -0.187 (0.316) | | -0.146 (0.342) | |
| <i>Boulder × Aug</i> | 0.972 (0.204) | -0.069 (0.234) | 1.013 (0.211) | -0.048 (0.236) |
| <i>Boulder × Oct</i> | 1.387 (0.267) | -0.125 (0.228) | 1.340 (0.275) | -0.100 (0.228) |
| <i>N</i> | 689 | 628 | 471 | 419 |
| <i>N x T</i> | 2250 | 1557 | 1830 | 1257 |
| <i>Mean</i> | 7.963 | 23.315 | 7.853 | 24.048 |
| <i>R</i> ² | 0.752 | 0.904 | 0.712 | 0.907 |

Notes: Results in this table are calculated using the hand-collected restaurant data. The dependent variable is the price in cents per ounce. The estimates for *Boulder × August* and *Boulder × October* show the change in the number of cents per ounce of the restaurant price relative to the prices in June in Boulder County and Fort Collins. Standard errors, in parentheses, are clustered at the store level. Additional variables that are included, but not shown, are community fixed effects, month fixed effects, restaurant fixed effects and product fixed effects. *N* represents the number of unique restaurant specific items, *N x T* represents the number of unique restaurant specific item observations across all waves. *Mean* is the pre-tax average price per ounce in cents.

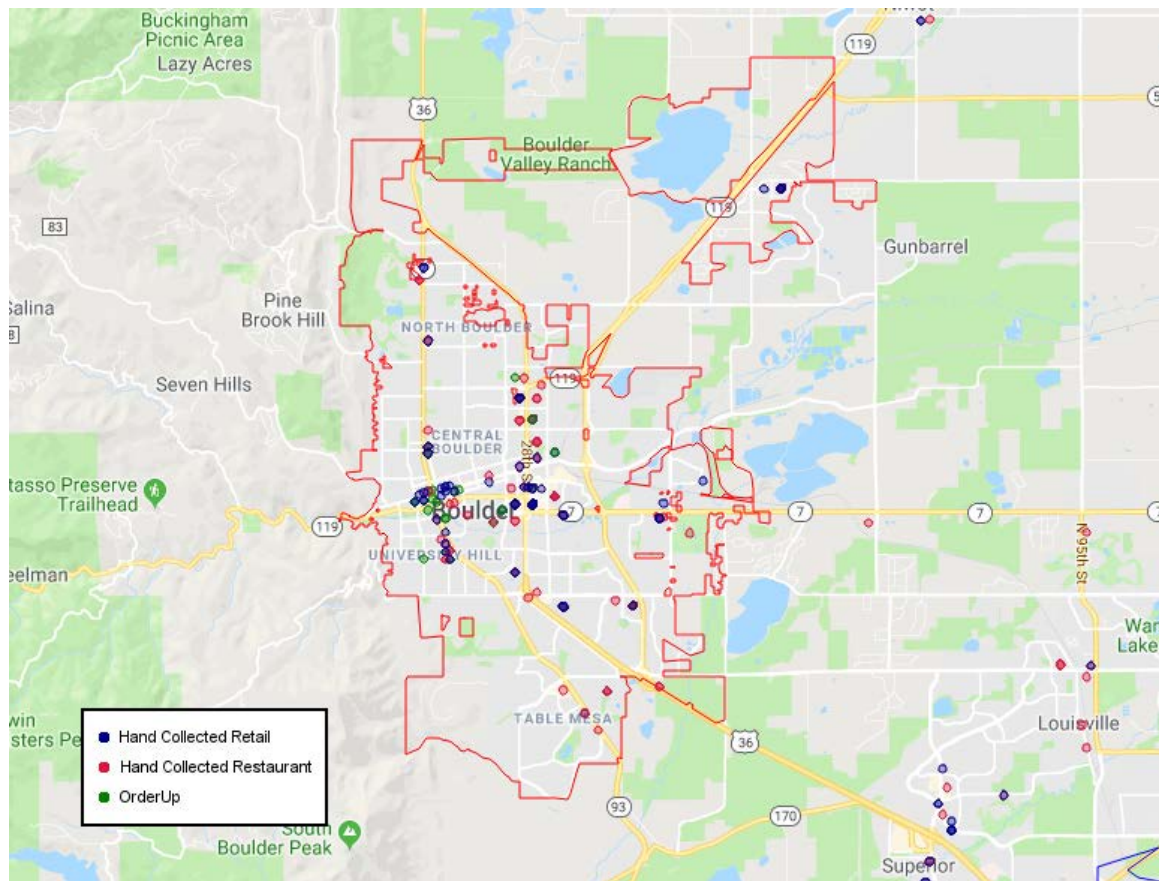
Table 4: Estimates of the Change in OrderUp Restaurant Prices in Boulder after the SSB Tax

| | Taxed | Untaxed | Unknown |
|-----------------------|------------------|------------------|-------------------|
| <i>Boulder × Mar</i> | 0.013 (0.021) | 0.011 (0.006) | 0.015 (0.018) |
| <i>Boulder × Apr</i> | 0.010 (0.009) | 0.011 (0.006) | -0.007 (0.012) |
| <i>Boulder × May</i> | 0.000 (0.003) | 0.007 (0.005) | 0.008 (0.014) |
| <i>Boulder × Jul</i> | 0.082 (0.041) | 0.027 (0.032) | 0.003 (0.020) |
| <i>Boulder × Aug</i> | 0.173 (0.067) | 0.065 (0.038) | 0.066 (0.032) |
| <i>Boulder × Sept</i> | 0.211 (0.087) | 0.084 (0.040) | 0.090 (0.039) |
| <i>Boulder × Oct</i> | 0.202 (0.089) | 0.078 (0.040) | 0.087 (0.039) |
| <i>N</i> | 343 | 345 | 189 |
| <i>N x T</i> | 10976 | 11040 | 6048 |
| <i>Mean</i> | 2.448 | 2.84 | 3.447 |
| <i>R²</i> | 0.921 | 0.753 | 0.745 |

Notes: Results in this table are calculated using the balanced sample of the OrderUp restaurant data. The dependent variable is the price in dollars per drink. The estimates show the change in the dollars per drink of the restaurant price relative to the prices in June in Boulder County and Fort Collins. Standard errors, in parentheses, are clustered at the store level. Additional variables that are included, but not shown, are community fixed effects, month fixed effects, restaurant fixed effects and product fixed effects. *N* represents the number of unique restaurant specific items, *N x T* represents the number of unique restaurant specific item observations across all waves. *Mean* is the pre-tax average price per drink in dollar.

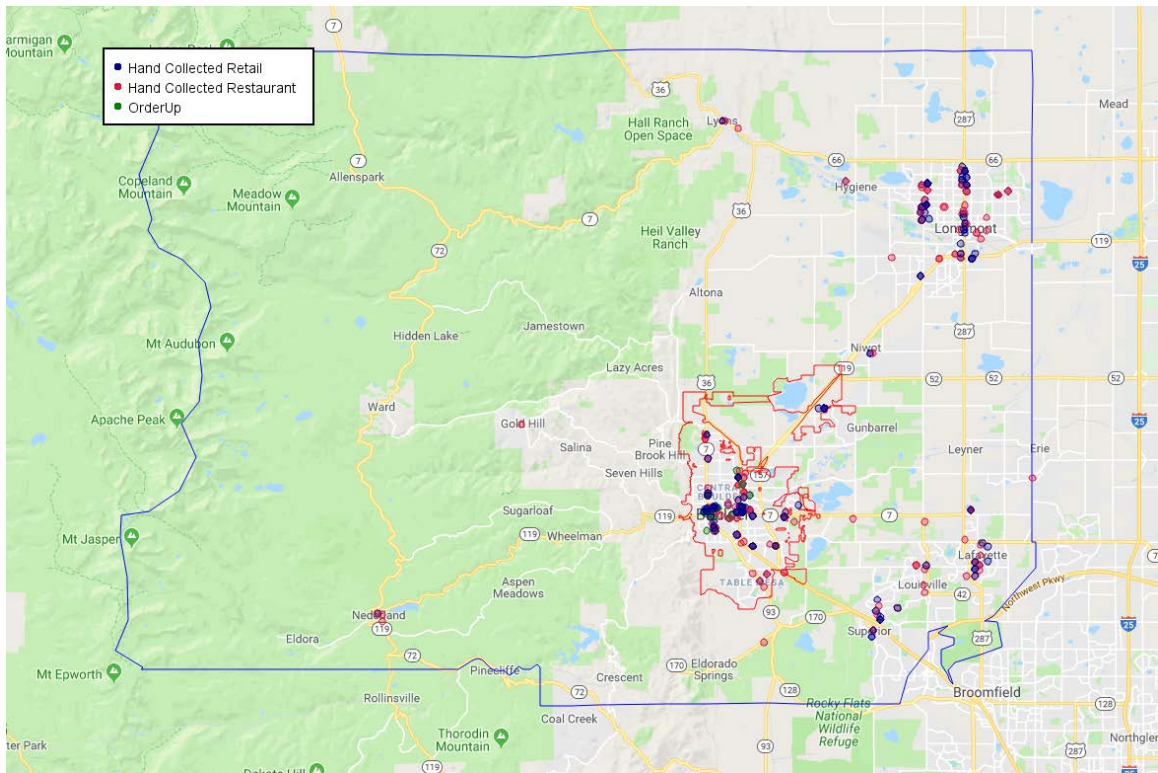
A Appendix

Figure A1: Geographic Location of Retail Stores, Hand Collected Restaurants, and OrderUp Restaurants in the City of Boulder



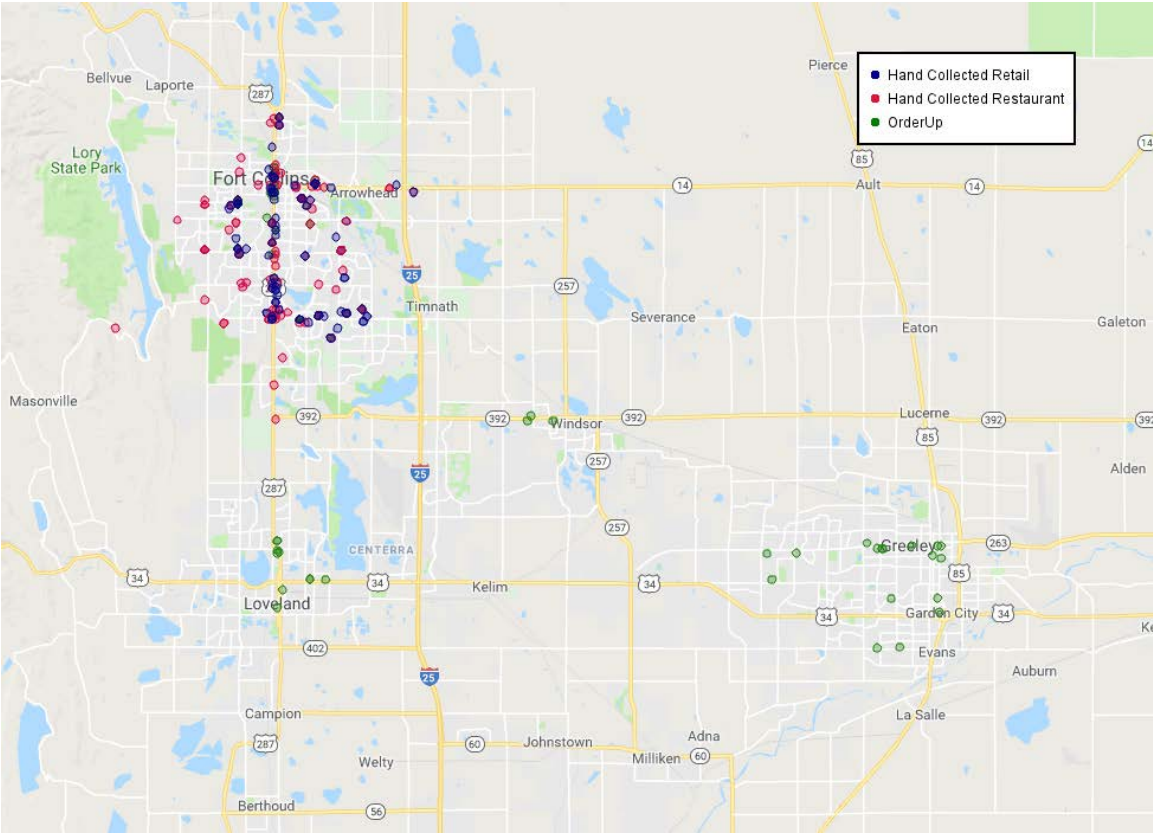
Notes: The red border signifies the city limits of Boulder. All hand collected retail stores and restaurants that had at least one observation throughout the four waves of data collection are included. In the city of Boulder, there are 77 hand collected retail locations and 113 hand collected restaurant locations. All OrderUp restaurants that are included in the balanced panel from March 22 to October 25, 2017 are included in the map. There are 42 OrderUp restaurants within the city limits of Boulder.

Figure A2: Geographic Location of Retail Stores, Hand Collected Restaurants, and OrderUp Restaurants in Boulder County



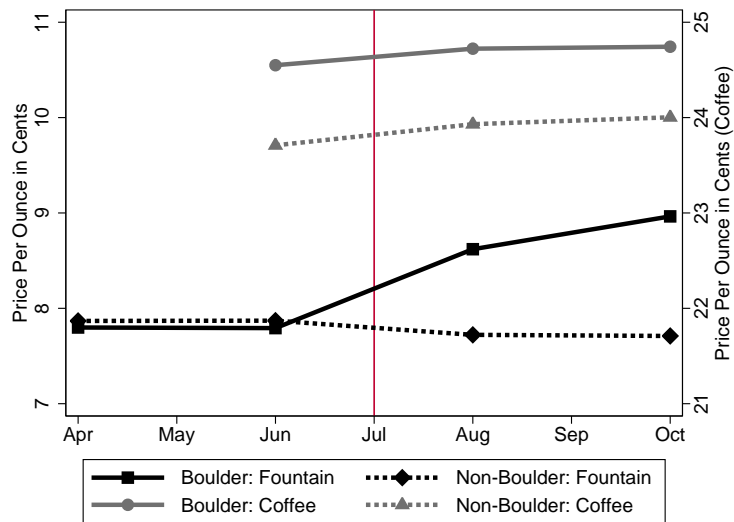
Notes: The red border signifies the city limits of Boulder. The larger, blue border signifies the county limits of Boulder County. All hand collected retail stores and restaurants that had at least one observation throughout the four waves of data collection are included. In Boulder County but outside of the city of Boulder, there are 102 hand collected retail locations and 132 hand collected restaurant locations. There are no OrderUp restaurants outside the city limits of Boulder but within Boulder County in the balanced panel.

Figure A3: Geographic Location of Retail Stores, Hand Collected Restaurants, and OrderUp Restaurants in Fort Collins



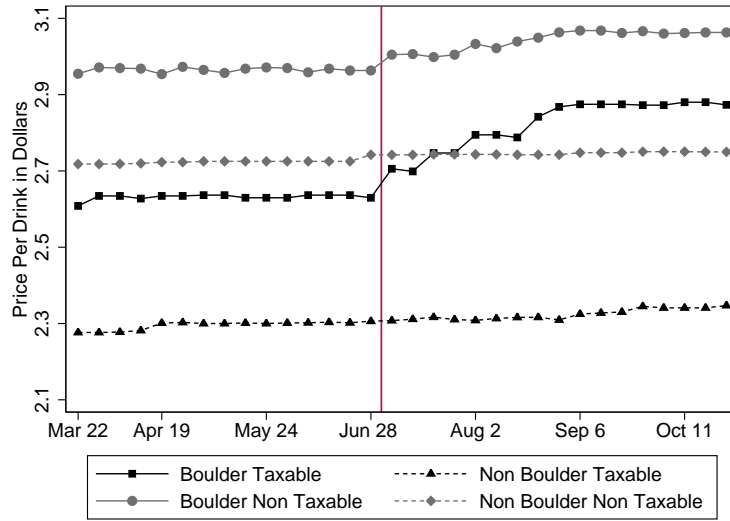
Notes: All hand collected retail stores and restaurants that had at least one observation throughout the four waves of data collection are included. Outside of Boulder County in the Fort Collins area, there are 113 hand collected retail locations and 140 hand collected restaurant locations. All OrderUp restaurants that are included in the balanced panel from March 22 to October 25, 2017 are included in the map. There are 72 OrderUp restaurants in the Fort Collins area, which includes Fort Collins, Evans, Garden City, Greeley, Loveland, and Windsor.

Figure A4: Trends in the Price per Ounce of Fountain Drinks and Coffee Drinks at Restaurants



Notes: Price per ounce is reported in cents. Fountain drinks are taxed items under the law in Boulder. Coffee drinks are not taxed under the Boulder law. The data are balance at the store-item level across all four waves of the data collection for fountain drinks, and across June, August, and October for the coffee drinks since those items were not part of the April data collection.

Figure A5: OrderUp Trends in the price per drink from March to October



Notes: Price per drink is reported in dollars. Taxed, not taxed and unknown items are defined according to whether the item is taxed under the law in Boulder. A complete list of the taxed status of items is shown in Appendix Table 3. The data are balance at the store-item level across all waves of the data collection.

Table A1: Description of Items from Retailers

| Category | Item | Size (oz) | taxed | Number of Stores | | | | |
|---------------------|---------------------------|-------------|--------|------------------|-----|-----|-----|-----|
| | | | | Apr | Jun | Aug | Oct | |
| Soda | Pepsi | 20 | Yes | 144 | 190 | 185 | 189 | |
| | Pepsi | 67.6 | Yes | 110 | 184 | 184 | 184 | |
| | Pepsi | 12 x 12 | Yes | 118 | 151 | 150 | 149 | |
| | Diet Pepsi | 20 | No | 140 | 181 | 179 | 185 | |
| | Diet Pepsi | 67.6 | No | 107 | 163 | 167 | 175 | |
| | Diet Pepsi | 12 x 12 | No | 115 | 142 | 150 | 144 | |
| | Mountain Dew | 20 | Yes | 139 | 187 | 181 | 189 | |
| | Mountain Dew | 67.6 | Yes | 104 | 167 | 175 | 182 | |
| | Coke | 20 | Yes | 137 | 191 | 179 | 193 | |
| | Coke | 67.6 | Yes | 113 | 198 | 203 | 198 | |
| | Coke | 12 x 12 | Yes | 113 | 157 | 155 | 160 | |
| | Diet Coke | 20 | No | 136 | 185 | 175 | 189 | |
| | Diet Coke | 67.6 | No | 108 | 181 | 189 | 191 | |
| | Diet Coke | 12 x 12 | No | 113 | 153 | 150 | 154 | |
| | Sprite | 20 | Yes | 136 | 181 | 174 | 190 | |
| | Sprite | 67.6 | Yes | 104 | 178 | 191 | 194 | |
| | 7Up | 20 | Yes | 118 | 159 | 153 | 147 | |
| | 7Up | 67.6 | Yes | 91 | 162 | 169 | 166 | |
| | Energy Drinks | Hansen's | 12 | Yes | 0 | 8 | 12 | 13 |
| | | Hansen's | 6 x 12 | Yes | 0 | 24 | 28 | 26 |
| San Pellegrino | | 11.15 | Yes | 0 | 26 | 31 | 35 | |
| San Pellegrino | | 6 x 11.15 | Yes | 0 | 49 | 63 | 56 | |
| Red Bull | | 8.4 | Yes | 129 | 199 | 206 | 217 | |
| Red Bull | | 4 x 8.4 | Yes | 99 | 116 | 131 | 134 | |
| Red Bull Sugar Free | | 8.4 | No | 119 | 193 | 191 | 217 | |
| Red Bull Sugar Free | | 4 x 8.4 | No | 66 | 96 | 99 | 111 | |
| Sports Drinks | | Gatorade | 20 | Yes | 79 | 138 | 156 | 157 |
| | | Gatorade G2 | 20 | Yes | 23 | 24 | 8 | 6 |
| Iced Tea | Arizona | 23 | Yes | 101 | 160 | 159 | 154 | |
| | Arizona | 128 | Yes | 50 | 56 | 58 | 57 | |
| Juice | Tropicana Orange Juice | 12 | No | 61 | 70 | 69 | 70 | |
| Water | Dasani | 20 | No | 101 | 120 | 119 | 124 | |
| | Aquifina | 20 | No | 110 | 132 | 133 | 150 | |
| Mixers | Jose Cuervo Margarita Mix | 33.8 | No | 0 | 38 | 36 | 47 | |
| | Jose Cuervo Margarita Mix | 59.2 | No | 0 | 66 | 61 | 69 | |
| | Tres Agaves Margarita Mix | 33.8 | No | 0 | 37 | 41 | 42 | |
| | Mr. T Bloody Mary Mix | 33.8 | No | 0 | 83 | 86 | 70 | |
| | Mr. T Bloody Mary Mix | 59.2 | No | 0 | 57 | 54 | 58 | |
| Other | GT Kombucha | 16 | No | 38 | 58 | 62 | 68 | |
| Fountain Drinks | Small | - | Yes | 60 | 91 | 101 | 100 | |
| | Medium | - | Yes | 52 | 86 | 95 | 95 | |
| | Large | - | Yes | 53 | 72 | 83 | 80 | |
| | Extra Large | - | Yes | 20 | 31 | 25 | 21 | |

Notes: These items were collected in April, June, August, and October 2017. The April round of data collection did not include Hansen's Sodas, San Pellegrino, mixers or formula. In the April wave, 3,359 total item prices were collected from 174 retailers. In April, data collectors visited retailers to record prices in Boulder between April 3 and April 21, in Boulder County between April 3 and April 22, and in Fort Collins between April 3 and April 26. On May 16, the Boulder City Council exempted alcoholic mixers from the tax. In the June wave, 5,250 total item prices were collected from 286 retailers. In June, data collectors recorded prices in Boulder between May 30 and June 16, in Boulder County between May 30 and June 16, and in Fort Collins between June 1 and June 15. The tax was implemented on July 1. In the August wave, 5,337 total item prices were collected from 287 retailers. In August 2017, data collectors visited retailers in Boulder between August 4 and 19, in Boulder County between August 4 and 17, and in Fort Collins between August 8 and 21. In the October wave, 5,478 total item prices were collected from 288 retailers. In October 2017, data collectors recorded prices in Boulder between October 11 and 23, in Boulder County between October 9 and 27, and in Fort Collins between October 11 and 29.

Table A2: Description of Items from Hand Collected Restaurants

| Category | Item | Size (oz) | taxed | Number of Restaurants | | | |
|-----------------|---------------|-----------|-------|-----------------------|-----|-----|-----|
| | | | | Apr | Jun | Aug | Oct |
| Fountain Drinks | Small | - | Yes | 235 | 228 | 222 | 226 |
| | Medium | - | Yes | 208 | 201 | 202 | 203 |
| | Large | - | Yes | 126 | 125 | 119 | 121 |
| | Extra Large | - | Yes | 22 | 21 | 27 | 27 |
| Coffee Drinks | Drip Coffee | 12 | No | - | 161 | 128 | 129 |
| | Latte | 12 | No | - | 133 | 129 | 128 |
| | Mocha Latte | 12 | No | - | 127 | 126 | 123 |
| | Hot Chocolate | 12 | No | - | 121 | 126 | 126 |

Notes: These items were collected in April, June, August, and October 2017. The April round of data collection did not include coffee shops. In the April wave, 591 total item prices were collected from 236 retailers. In the June wave, 1,117 total item prices were collected from 321 retailers. In the August wave, 1,079 total item prices were collected from 318 retailers. In the October wave, 1,084 total item prices were collected from 317 retailers. The timing of data collection is the same as that described in the notes of Appendix Table 1.

Table A3: Description of Items from OrderUp

| Item | taxed | Number of Stores In Each Wave | Item | taxed | Number of Stores In Each Wave |
|-----------------------------|---------|----------------------------------|-----------------------------|---------|----------------------------------|
| 1% Low Fat Milk | No | 1 | Lassi | No | 8 |
| 100% Juice | No | 6 | Latte | No | 10 |
| 2% Milk | No | 2 | Lemonade | Yes | 18 |
| A&W Root Beer | Yes | 1 | Mango Juice | Unknown | 1 |
| Allegro Coffee | No | 1 | Matcha | No | 3 |
| Americano | No | 8 | Mello Yello | Yes | 1 |
| Amp Energy Drink | Yes | 1 | Mexican Coke | Yes | 1 |
| Apple Juice | Unknown | 10 | Mexican Fanta | Yes | 1 |
| Arabic Coffee | No | 2 | Mexican Soda | Yes | 1 |
| Arizona Flavored Tea | Yes | 9 | Milk | No | 25 |
| Banana Milk | No | 2 | Minute Maid | Unknown | 2 |
| Baristo | Unknown | 1 | Minute Maid Lemonade | Yes | 3 |
| Barq's Root Beer | Yes | 7 | Monster | Yes | 4 |
| Big Yellow Cup | Unknown | 4 | Mountain Dew | Yes | 9 |
| Black Tea | No | 2 | Mountain Dew Kick Start | Yes | 2 |
| Boba Tea | Unknown | 9 | Mr. Pibb | Yes | 2 |
| Blueberry Pomegranate Juice | No | 2 | Mug Rootbeer | Yes | 1 |
| Boylan Soda | Unknown | 7 | Nantucket Tea | Unknown | 1 |
| Cappuccino | No | 5 | NOS Energy Drink | Yes | 1 |
| Chai Tea | No | 18 | Oogave Ginger Ale | Yes | 1 |
| Cherry Coke | Yes | 1 | Oogave Rootbeer | Yes | 1 |
| Cherry Limeade | Yes | 1 | Oolong Tea | No | 2 |
| Cherry Pepsi | Yes | 1 | Orange Crush | Yes | 2 |
| Chocolate Milk | No | 17 | Orange Juice | Unknown | 17 |
| Coconut Water | No | 3 | Orange Pellegrino | Yes | 2 |
| Coffee | No | 38 | Orange Soda | Yes | 1 |
| Coke | Yes | 27 | Peach Tea | Yes | 1 |
| Coke Products | Unknown | 2 | Pepsi | Yes | 11 |
| Coke Zero | No | 2 | Pepsi Products | Unknown | 1 |
| Cold Brew | No | 6 | Perrier | No | 2 |
| Craft Soda | Yes | 1 | Pibb Extra | Yes | 1 |
| Cranberry Juice | No | 3 | Pink Lemonade | Yes | 1 |
| Dasani | No | 10 | Pomegranate Juice | No | 1 |
| Drink | Unknown | 51 | Pomegranate Pellegrino | Yes | 1 |
| Diet Barq's Root Beer | No | 1 | Powerade | Yes | 7 |
| Diet Coke | No | 27 | Raspberry Tea | Yes | 5 |
| Diet Pepsi | No | 10 | Red Bull | Yes | 6 |
| Dr. Pepper | Yes | 22 | Rockstar | Yes | 2 |
| Energy Drink | Yes | 2 | Rootbeer | Yes | 7 |
| Espresso | No | 2 | San Pellegrino | Yes | 4 |
| Fanta | Yes | 10 | Seltzer Water | No | 1 |
| Flavored Latte | No | 31 | Shirley Temple | Yes | 1 |
| Flavored Tea | Yes | 6 | Sierra Mist | Yes | 9 |
| Fountain Drink | Yes | 29 | Simply Apple Juice | No | 2 |
| Fruit Punch | Yes | 3 | Simply Lemonade | Yes | 2 |
| Gatorade | Yes | 6 | Simply Orange | No | 2 |
| Ginger Ale | Yes | 5 | Smart Water | No | 1 |
| Gold Peak Green Tea | Yes | 1 | Snapple | Yes | 2 |
| Gold Peak Sweet Tea | Yes | 3 | Sobe Life Water | No | 2 |
| Grapefruit Juice | Unknown | 1 | Soda | Unknown | 32 |
| Green Tea | No | 1 | Soy Milk | No | 1 |
| GT Kombucha | No | 1 | Sparkling Ginger Lime Juice | Yes | 1 |
| Herbal Tea | No | 1 | Sparkling Lime Juice | Yes | 1 |
| Hi-C | Yes | 4 | Sparkling Water | No | 1 |
| Honest Tea | Unknown | 2 | Sparkling Orange Drink | Unknown | 1 |
| Hot Chocolate | No | 9 | Sprite | Yes | 24 |
| Hot Cider | Yes | 1 | Sprite Zero | No | 1 |
| Hot Tea | No | 14 | Stewart's Soda | Yes | 1 |
| Hubert's Lemonade | Yes | 2 | Strawberry Lemonade | Yes | 4 |
| IBC Cream Soda | Yes | 1 | Sweet Tea | Yes | 14 |
| IBC Rootbeer | Yes | 1 | Tea | No | 9 |
| Iced Coffee | No | 2 | Thai Tea | No | 16 |
| Italian Soda | Yes | 1 | Tomato Juice | No | 2 |
| Izze | Yes | 2 | Tropicana Lemonade | Yes | 1 |
| Jarritos | Yes | 5 | Unsweetened Tea | No | 10 |
| Juice | Unknown | 5 | Vitamin Water | Yes | 4 |
| Kombucha | No | 2 | Water | No | 29 |
| Laeroix | No | 1 | Yoo-hoo | Yes | 1 |

Notes: These items were collected weekly from menus on OrderUp from March 22, 2017 to October 25, 2017, for a total of 32 weeks of observations. On these online menus, some beverage menu items have a general name (e.g. soda), and the customer must choose a more specific item when they check out (e.g. Coke). The webscrape only saves initial menu item names, thus the taxed status of some items is unknown.

Table A4: Heterogeneity in Pass-Through Estimates By Specific Items

| | Coke 20oz | Coke 2L | Diet Coke 20oz | Diet Coke 2L | Pepsi 20oz | Pepsi 2L | Diet Pepsi 20oz | Diet Pepsi 2L | Mt. Dew 20oz | Mt. Dew 2L |
|-----------------------|------------------|-------------------|-------------------|-------------------|------------------|-------------------|--------------------|-------------------|------------------|-------------------|
| <i>Boulder × Apr</i> | 0.018 (0.140) | -0.006 (0.212) | 0.096 (0.122) | -0.075 (0.189) | 0.169 (0.105) | -0.101 (0.167) | 0.175 (0.098) | -0.097 (0.150) | 0.195 (0.132) | -0.125 (0.165) |
| <i>Boulder × Aug</i> | 1.670 (0.204) | 1.424 (0.191) | 0.213 (0.155) | 0.216 (0.212) | 1.634 (0.195) | 1.528 (0.207) | 0.262 (0.154) | 0.215 (0.172) | 1.696 (0.227) | 1.664 (0.207) |
| <i>Boulder × Oct</i> | 1.462 (0.209) | 1.370 (0.199) | 0.218 (0.150) | 0.169 (0.192) | 1.797 (0.206) | 1.536 (0.205) | 0.213 (0.143) | 0.189 (0.188) | 1.784 (0.211) | 1.572 (0.213) |
| <i>N</i> | 227 | 247 | 222 | 238 | 222 | 224 | 218 | 210 | 222 | 214 |
| <i>N x T</i> | 700 | 712 | 685 | 669 | 708 | 662 | 685 | 612 | 696 | 628 |
| <i>Mean</i> | 9.148 | 3.227 | 9.172 | 3.225 | 9.247 | 3.156 | 9.272 | 3.141 | 9.249 | 3.16 |
| <i>R</i> ² | 0.875 | 0.879 | 0.844 | 0.854 | 0.87 | 0.874 | 0.874 | 0.824 | 0.865 | 0.891 |

| | Sprite 20oz | Sprite 2L | 7 Up 20oz | 7 Up 2L | Red Bull 8.4oz | SF Red Bull 8.4oz | Gatorade 20oz | Arizona Tea 23oz | Dasani 20oz | Aquafina 20oz |
|-----------------------|------------------|-------------------|-------------------|-------------------|-------------------|----------------------|-------------------|---------------------|-------------------|-------------------|
| <i>Boulder × Apr</i> | 0.028 (0.131) | -0.046 (0.265) | -0.177 (0.253) | -0.093 (0.184) | -1.820 (0.676) | -2.130 (0.733) | -0.559 (1.261) | -0.717 (0.407) | -0.209 (0.217) | -0.058 (0.206) |
| <i>Boulder × Aug</i> | 1.642 (0.207) | 1.526 (0.211) | 1.312 (0.381) | 1.394 (0.263) | 1.394 (0.355) | 0.083 (0.657) | 0.948 (0.391) | 1.661 (0.248) | 0.032 (0.153) | 0.212 (0.278) |
| <i>Boulder × Oct</i> | 1.504 (0.207) | 1.457 (0.215) | 1.128 (0.315) | 1.446 (0.244) | 1.243 (0.401) | 0.137 (0.444) | 0.849 (0.348) | 1.829 (0.319) | 0.037 (0.167) | -0.030 (0.123) |
| <i>N</i> | 223 | 241 | 211 | 214 | 256 | 250 | 197 | 197 | 165 | 178 |
| <i>N x T</i> | 681 | 667 | 577 | 588 | 750 | 720 | 530 | 574 | 464 | 525 |
| <i>Mean</i> | 9.202 | 3.221 | 8.859 | 3.074 | 28.693 | 28.63 | 8.103 | 4.321 | 7.758 | 7.948 |
| <i>R</i> ² | 0.875 | 0.894 | 0.877 | 0.824 | 0.792 | 0.621 | 0.803 | 0.778 | 0.939 | 0.899 |

Notes: Results in this table are calculated using products from the hand-collected retail data and the prices charged at the register. The dependent variable is the price in cents per ounce. Items that are taxed include Coke, Pepsi, Mountain Dew, Sprite, 7 Up, Red Bull, Gatorade, and Arizona Iced Tea. Untaxed items include Diet Coke, Diet Pepsi, Sugar Free (SF) Red Bull, Dasani Water, Aquafina Water. The estimates show the change in the number of cents per ounce of the retail price relative to the prices in June in Boulder County and Fort Collins. Standard errors, in parentheses, are clustered at the store level. Additional variables that are included, but not shown, are community fixed effects, month fixed effects, store fixed effects and product fixed effects. *N* represents the number of unique store specific items, *N x T* represents the number of unique store specific item observations across all waves. *Mean* is the pre-tax average price per ounce in cents.