

A case for zero effect of sin taxes on consumption? Evidence from a sweets tax reform^{*}

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Abstract

Excise taxes on soda or other unhealthy products have become increasingly popular measures attempting to tackle the increasing obesity problem. We study one such attempt in Finland: a sweets tax introduced in 2011, consequent reforms increasing the tax and abolishment of the tax in 2017. We study the pass-through to prices and the quantity elasticity of this excise tax that applied to sweets, chocolates, ice creams and soda. We are able to provide credibly causal estimates on the pass-through to prices and on the quantity elasticity because the tax reforms affected significantly the prices of sweets and soda and we can find credible control groups not affected by the reforms but resembling the sweets. We have access to a unique product- and week-level data on sales from a large Finnish retailer chain containing

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the key information on the products and hundreds of millions of observations. Our findings show that in general the tax was fully passed through to prices. Interestingly, we find that the general sweets tax reform-induced price increases did not reduce the demand for sweets or soda. But we find that a tax reform in 2014 that increased the tax rates for sugared soda while not affecting sugar-free soda did decrease the consumption of sugary soda and increased the consumption of sugar-free soda, suggestively through a substitution effect.

JEL Codes: H2, I18

Key words: sin taxes, food taxation, commodity demand, excise taxes, sweets, sodas

1 Introduction

Sweets and soft drinks consumption is increasing, among other countries, in Finland (Kotakorpi et al. 2011). This has been seen a public health issue and contributes to constantly rising health care costs. The worsening health of citizens creates negative externalities via the public health expenditure. The effectiveness of sweet taxes in curbing consumption likely depends on many factors, including the availability of close substitutes for taxed products, on the culture and on the size of the taxes. Although many papers do provide estimates for the demand of sweets, the range of demand elasticities in the literature is fairly wide and, thus, policy measures based on the existing literature is challenging (cf. a literature survey by Andreyeva et al. (2010) with the elasticity range for sweets and sugars of 0.05–1 and one for soft drinks of 0.06–3.18 in the US). Thus, there is a large gap in the literature in our knowledge of the actual effectiveness of health related tax policies, and on what factors the effects might depend.

This paper contributes to this literature by analyzing multiple reforms in a sweets tax scheme in Finland with extensive data and access to control groups. Our analysis provides precise estimates on the pass-through of the tax on prices and to what extent and under which circumstances the tax induced price changes affected demand for sweets. First, we are able to provide credible causal estimates by utilizing the introduction and consequent changes in the sweets tax policy. Meanwhile, the non-taxed similar products act as the control group. This setting allows us to investigate whether taxes have a differential effect on demand depending on how much they increase prices in relative terms from pre-tax levels. We also are able to study potential substitution effects within and across categories of taxed goods. We are able to provide some mechanisms analysis because the impact of the tax on the prices of sweetened products varies with the weight-to-price ratio of the products, thus creating variation in the treatment intensity.

Second, we have access to a unique data at a weekly level with ca. 324,400,000 observations. The data consists of the prices and the sales quantities of both treatment and control products both before and after the policy

change. The large size of the data allows us to provide precise estimates, which are needed to credibly identify demand effects, especially when they are relatively small. Moreover, our data source is sales records of a Finnish grocery store chain, the S-group, that is sufficiently large to represent the sweets consumption patterns of all the Finns because the chain has a market share of about 45% of grocery markets in Finland.

Third, we can provide some insights into when Pigouvian tax policies might work by analyzing changes in tax policies, where the closeness of substitutes vary. The introduction of the tax applied to all categories of products that seem close substitutes. Thus, avoiding the tax by switching to consuming from non-taxed categories was not easy. But in the tax change in 2014 sugary and non-sugary soda were treated differently. Thus consumers were able to avoid the tax hike by switching from consuming naturally sweetened soda to consuming artificially sweetened soda. By comparing the original tax hike for soda that treated all sodas equally to this latter tax change we can learn about the importance of the availability of close substitutes.

The sweets tax policy we analyze was introduced in Finland as an excise tax on sweets, chocolates, ice creams, chewing gums, and some other naturally or artificially sweetened products in January 2011. The tax rate amounted to 0.75€/kg for solid tax-liable products. In addition, the excise tax on sweetened drinks (soft drinks, juices) and flavored and unflavored waters was raised from 0.045€/l to 0.075€/l. There was a subsequent increase of the tax rates in January 2012. Importantly, whether a product is subject to the tax depends on its customs classification, not on its sugar content. For example, candies, chocolates and ice creams belong to tax liable customs categories. In contrast, for example chocolate biscuits that are very similar to the taxed goods remained untaxed, since they belong in the customs categories that are not tax liable.

Because the sweets tax depends on weight or volume of each product, the tax-induced price changes vary with the weight-to-price or volume-to-price ratios. For example, if two chocolates had the same price before the reform, but one was heavier than the other, their relative prices changed very differently with the introduction of the tax. Notably, candies tend to weigh

much less than a kilogram, hence, the tax did not affect their prices much. In contrast, many ice cream cans weigh close to a kilogram and, therefore, the tax affected their price substantially in comparison to candies. The tax was chosen to depend on the weight / the volume because monitoring the exact sugar content of all the products would increase the administrative burden substantially.

According to our results, the sweets taxes were in most cases either fully or over-shifted to prices. Due to its volume-based formula, the magnitude of the sweets tax from pre-reform prices varied, and larger the magnitude, smaller the degree of over-shifting. Moreover, for ice creams, which is the category with the largest tax impact, the sweets tax was slightly under-shifted to prices in the 2011 tax introduction. We also document interesting time patterns in prices after tax changes. After the initial introduction of the tax in 2011, the dynamics were such that there was an immediate increase in prices, and afterwards the prices started to increase gradually. In contrast, after the subsequent tax increases in 2012 and 2014 the prices jumped to the new price level almost immediately within the same week than the tax hike.

As for the changes in the quantities demanded, we document that the tax increase in 2011 and the subsequent tax increase in 2012 did not affect their demand, despite the substantial price hikes. Our results show overall estimates for quantities are very close to zero for products overall. Due to large data sample in the estimation, the confidence intervals are very tight for the zero estimate. This result suggests that the demand elasticity for sweets estimated in the general sweets tax implementation is zero.

Our second interesting result concerns the 2014 tax increase for sugary soda from 11 cent per liter to 22 cent per liter that left the tax of a very close substitute: non-sugary soda unchanged. A notable exception for the other quantity estimates is that here we see a sharp reduction in the consumption of sugary soda. When compared with a general control group of ice cream, chocolates and sweets, it seems that the consumption of non-sugary soda increased. This result could arise from the existence of the sufficiently close substitutes (e.g. Coke versus Coke Zero) that were not available in the other sweets tax reforms (e.g. candies vs cookies). The price increase of about 10%

is very similar in the 2011 tax introduction and 2014 tax increase for sugary soda. The significant difference between the reforms is that in the sweets tax reform all sweets and soda were treated with the tax increase while in the 2014 reform a close substitute of sugar-free soda was not affected by the tax increase.

Previous literature has often focused on studying the taxes on beverages sweetened with sugar or artificial sweeteners. Using the state-level variation in the US, Fletcher et al. (2010) document that while taxing soft drinks decreases the consumption, it increases calories from whole milk consumption and has no impact on health outcomes. Berardi et al. (2016) study the soda tax pass-through in France using a data set similar to ours, with outlet-level super market prices. However, they only focus on prices. They find that it took six months to reach the full pass-through and that the pass through differed by the retailing group and brand, and remained incomplete in the case of flavored waters.

Using the city-level average prices, Grogger (2015) documents overshifting in the prices as the response to the introduction of soda tax in Mexico. Similarly, Bergman and Hansen (2016) find that excise taxes are overshifted to sodas when analyzing the Danish micro-data. They also document that pass-throughs are asymmetric so that tax increases are overshifted more than tax cuts. In contrast, Cawley and Frisvold (2017) document a pass through of 43% in a context in which a tax on sugar-sweetened beverages was levied only within a rather limited geographic area, providing some evidence about the impact of the competition on the pass throughs.

The paper proceeds as follows: Section 2 describes the institutions more precisely, section 3 describes the data, and Section 4 shows the results. Section 5 concludes the study.

2 Institutional background

On 1 January 2011, Finland introduced an excise tax on sweets, chocolates, ice creams, chewing gums, and some other naturally or artificially sweetened

products and raised the existing excise tax on soft drinks¹. Together, these excise taxes are called the sweets tax, based on the custom categories. There were two subsequent tax rate increases in 2012 and in 2014 while the tax was scrapped since 1 January 2017.

The sweets tax is based on custom categories, not on the sugar content. As a result, some products are taxable while other, quite similar ones are not. For example, sweet pastries or snack bars are not tax liable while chocolates are. Moreover, since the tax is tied to the weight or the volume, the tax impact varies across the products depending on their weight or volume.

The sketch of the tax reform was first made public during the budget negotiations in August 2009. There had been a sweets tax in effect in Finland from 1926 until 1999 for fiscal reasons and also this tax was based on the custom categories. The soft drink tax was introduced in 1940. When the present reform was being prepared in August 2009–June 2010, the plan was to tax those custom categories that had been taxed under the previous sweets tax, in addition to extending the tax to some new product categories. During this preparatory phase, there was speculation about the tax rates in general as well as about the tax status of ice creams, which had not been taxed previously. The speculations concerning the tax status of ice cream were confirmed in 1 July 2010 when the government law proposal was made public. The only other time there had been strong speculation on the potential extensions of the tax base took place in 2012 when a sugar tax committee studied the prospects for introducing a tax based on the sugar content. Even then, there were serious doubts about the feasibility of such a tax.

The previous excise tax rate on the relevant liquids was 0.045 €/l. Since 1 January 2011, the sweets tax rates amounted to 0.75 €/kg for the solid taxable products and 0.075 €/l for the liquid taxable products. The rates were subsequently increased so that, from 1 January 2012 onwards, the valid rates were 0.95 €/kg for solid taxable products and 0.11 €/l for liquid taxable products.

¹These products are also subject to the reduced VAT rate (13% from July 2010 until December 2012 and 14% since January 2013). The VAT is calculated based on the sum of the price and the excise tax.

The tax rates were further changed on 1 January 2014 so that the tax rate for the liquids with a sugar content higher than 0.5 g per 100 g or 100 ml was raised to 0.22 €/l. The purpose of this differentiated tax change was to channel consumption into sugar-free products. The definition of the sugar-free liquids was based on the regulation (EC) No 1924/2006 of the European Parliament and of the Council of 20 December 2006 on nutrition and health claims made on foods. An existing legal definition for sugar-free products decreased the administrative burden as the companies were already familiar with the definition and monitored for its appropriate use. Furthermore, it was very clear whether a product would fit the definition since the products below the threshold value were clearly sugar-free, such as waters, or artificially sweetened so that there was no sugar involved in any manufacturing phase. This lack of borderline cases also lowered the administrative burden.

Any sweets, ice cream or soft drinks used for manufacturing sweets, ice cream, soft drinks or other food products or exported to the other EU countries by a registered storage keeper are untaxed. Also untaxed remain any sweets or soft drinks that are used for manufacturing medicine, alcoholic drinks, clinical nutritional products, infant formulas, children's foods or weight-loss products, provided such products comply with the definitions of the respective laws. Finally, small-scale production is also exempt from the tax². (Laki virvoitusjuomaverosta 17.12.2010/1127)

The sweets tax is carried out whenever products are provided for the consumption purposes from a tax-free warehouse or imported to Finland. Manufacturers, wholesale sellers and importers are the parties liable to tax. However, it is possible to export products from a tax-free warehouse without incurring tax liabilities. The Finnish Customs Office is responsible for carrying out the sweets tax collection and overseeing the producers.

There is no data on sweets smuggling but it has been unimportant (written communication with Veli Auvinen from Ministry of Finance, 17.1.2017). Since the law change was implemented, the Finnish Customs Office has paid

²Small-scale production refers to independent producers that annually produce for the consumption purposes at most 10,000 kg of sweets or of ice cream or 50,000 l of soft drinks.

special attention to inspecting companies that are tax-liable (Sokeriverotyöryhmän loppuraportti 2013).

3 Data

Our data source is a large Finnish retail company and the data consist of their product-specific sales figures of all the relevant food products at the outlet level aggregated to the weekly level from the last week of 2009 to the end of 2015. These outlets are evenly located all across the country and there are 1,077 of them. The total data consists of ca. 324,400,000 observations.

The relevant product universe consists of juices, juice concentrates, both flavored and unflavored soft drinks, ice creams, cookies, chocolates, candies, chewing gums, cakes, sweet and salty snack bars or pastries, sugars, honeys, and syrups. There are no alcohol products in the data. The control group consists of snack bars or pastries, sugars, honeys, and syrups while all the remaining products are tax liable. It should be noted that untaxed cakes, sweet snack bars and pastries are for the practical purposes indistinguishable from the tax liable cookies.

The data include the product name (e.g. Angry Birds Red Bird), its custom category (2106), its detailed product category (fruit xylitol chewing gums with a package size larger than 60 g), its net consumer package size³ in kilograms or liters (0.07 g) and whether this refers to liters or kilograms. The data also include the total number of the items sold and the monetary value of the items sold as well as information on the number of the discounted items and the total monetary values of these discounts. All the product-specific information is summed up for each outlet for each week. Finally, there is data on which chain each outlet belongs to and which region it is located in.

All the monetary data is in euros. There is no data on the wholesale prices or the identity of the producers. Based on the product names, the product categories and the custom categories, we impute which products are taxable and which are not. The wholly taxable custom categories are sweets without

³The definition refers to the package size net of packaging and non-edible ingredients, making it equivalent to the legal definition of the excise tax base.

cocoa (1704), chocolate and other food items with cocoa (1806), ice cream, popsicles, and other iced products (2105), non-fermented or non-alcoholic juices (2009), diverse food products (2106) that consist mainly of juice concentrates, unflavored or unsweetened waters (2201), flavored or sweetened waters or other non-alcoholic beverages not in the group 2009 (2202), and other fermented beverages or mixtures (2206). The partially taxable custom categories are products similar to 1704 but not sugared (2106), consisting of xylitol chewing gums, stevia-sweetened or sugar-free candies and syrups. The untaxed custom categories are plain bread, cakes, cookies and biscuits and other pastries (1905), food products made from grain or grain product by swelling or baking (1904), cane and beet sugars and chemically clean sucrose (1701), other solid sugars (1702) and natural honey (409) (Laki virvoitusjuomaverosta 17.12.2010/1127).

Table 1 describes the data. The first two columns give the average price and quantity sold per week as well as other statistics for these upper panel for taxable products and lower panel for the control group products. N is the number of observations in the data and N^* pieces is the total number of products sold underlying the data, derived by multiplying counting how many products were sold in each store per week and aggregating over the stores. The last three columns describe similar statistics in three different sub-groups of taxable products.

When imputing the mechanical full tax pass-through, we take into consideration the fact that the data consists of the retail prices, including the VAT. We impute the base price for each product as its mean price in November and the two first weeks of December prior to a tax change. Based on this product-specific base price, we impute the full pass-through as follows and take the logarithm over it:

$$\ln(p_{full,it}) = \ln \left((1 + \text{VAT rate}_t) \left(\frac{\text{base price}_{it}}{1 + \text{VAT rate}_t} + \text{new excise tax rate}_{it} - \text{old excise tax rate}_{it} \right) \right) \quad (1)$$

No excise tax was carried out for the solid products prior to 2011 so their old excise tax rate was 0€ in January 2011. In contrast, soft drinks,

juices and other similar drinks were excise tax liable even prior to 2011, albeit at a lower rate of 0.045€/l. In January 2011, the respective excise tax rates were raised to 0.75€/kg and to 0.075€/l. In January 2012, the respective excise tax rates were raised to 0.95€/kg and to 0.11€/l. Finally, in January 2014, the excise tax rate for the liquids exceeding a threshold value of sugar was raised to 0.22€/l. The foodstuff is subject to reduced VAT rates, which amounted to 13% from July 2010 until December 2012 and 14% since January 2013 (Laki virvoitusjuomaverosta 17.12.2010/1127). The logarithms of the product-specific pass-throughs are then averaged over for the relevant product group (ie. all the products, solids only etc.).

As the tax is added to the volume prices, cheaper the product, larger the tax impact of the 2011 and the 2012 tax reforms. In contrast, the differential tax impact of the 2014 reform was not related to the previous volume price but to the sugar content.

4 Results

We first examine the impacts of the sweets tax on prices and quantities in graphical event-study framework. The idea is to examine the trends between the treatment and control groups before the reforms and how the development in these trends might deviate at the time or after the reform. The graphs are based on an estimation of the following equation for the logarithms of various outcome variables y_{it} :

$$\ln(y_{it}) = \sum_{t=-\underline{T}}^{\bar{T}} \beta_t time_t + \mu_i + \epsilon_{it}, \quad (2)$$

where $time_t$ refers to either week or month indicators. \underline{T} refers to the starting of the examination interval, usually either first week or month of 2010 and \bar{T} to the end of the examination interval usually the last week or month of 2013. μ_i indicates the usage of product i fixed effects and ϵ_{it} is the error term. The outcome variables y_{it} consist of unit price, volume and number of products sold. The volume refers to kilograms or liters, depending on the product. The estimations are clustered at the product-outlet-level. In order to remove

the seasonal variation of the volumes and number of products sold, we use the residuals from a regression that regresses the respective quantity variable on the product category-calendar month effect. The product categories are at the very precise level and there are 447 of them in this sample.

All the graphs are normalized with the coefficient of the last time observation before the first reform studied.

Figure 1 presents the development of prices around the 2011 and 2012 reforms for all treated and control products. The figure shows that treatment and control group prices follow the same trend in the year before the reform. Then at the reform the treatment group prices exhibit a clear increase. The prices do not jump immediately to the new level, but rather the increase is gradual over the period of three months. The prices end up at a higher level than what the mechanical full-pass through, marked to the figure with the horizontal purple line, would have indicated. But because the control group prices also increase during the same time interval, it seems that the net effect to treatment group prices is about full pass-through. The development of prices is slightly different in the 2012 tax increase. The prices in the treatment group jump within two weeks to the new level after this reform. Moreover, it seems that the net price increase was higher than what full pass through would have implied.

To provide some estimates for different subcategories Figure 2 presents the development of prices separately for ice creams, soft drinks, sweets and chocolates (as a special category of sweets). The general time-pattern in these sub-groups is quite similar than the average pattern for all goods. The two notable exceptions are ice creams and soft drinks. Ice creams are an exception since the prices increase by the amount of the mechanical full pass-through both in 2011 and in 2012 (Figure ??), but because the control group prices also increase the net effect is less than full pass-through. This arises possibly due to the fact that the excise tax was larger relative to pre-reform prices among ice creams than among other taxed products. They tend to weigh more than other solid products and the tax impact increases with the weight. Soft drinks had the opposite feature to ice creams. For them the tax increase over the pre-existing tax for them was small relative

to the pre-reform prices, but the pass-through seems to be more than full.

Figure 3 presents the over time development of quantities for solid products. The figure was seasonally smoothed by taking away the typical month-effect by regressing log volumes resp. log number of items sold against four-week periods (e.g. the first four week of January) and then taking residuals from these. This was necessary because of the heavy seasonality of the sales of many products. The figure shows very clearly that the control and treatment groups develop on the same trend both before and after the 2011 and 2012 reforms. Thus, quite convincingly the reforms had no impact on the quantities. Thus, it seems that consumed quantities do not seem to change due to the sweets tax induced price hikes. This suggests that the demand elasticity with respect to price is close to zero in this case.

Figure 4 shows the development of volumes of soft drinks relative to their control group. The pre-reform trends do not develop quite as nicely in parallel in this case, but overall it seems to distinguish any clear effect after the reform either. Figure 5 presents the same four sub-groups as in the price analysis. The sweets and chocolate are quite similar than the overall analysis for solids. Ice creams and soft drinks (the same figure as above) have the same feature that their pre-trends are somewhat messy, but overall no clear impact of the reform is visible. The messy trends could be due to seasonality that we could not take into account.

We analyze the impact of the sweets tax reforms with a differences-in-differences (DiD) framework as well. This analysis aims to give average impact of the reforms. We estimate the following equation.

$$\ln(y_{it}) = \alpha_i + \beta_1 1(After * Treat) + 1(After)_t + 1(Treat)_i + \mu_t + \epsilon_{it}, \quad (3)$$

where $1(After)_t$ is an indicator taking value one for after the reform period, $1(Treat)_i$ is an indicator taking value one for the products in the taxable categories, $1(After * Treat)$ is the interaction of the two indicator terms and thus β_1 the main coefficient of interest for product i and period t . $\ln(y_{it})$ is the logarithmic outcome variable, either unit price or the volumes or items

sold. We may include product level fixed effects α_i in which case the indicator for the treatment group is not included in the regression. We include in the regression flexible time trends μ_t as indicators for each time period. ϵ_{it} is the error term.

Table 2 shows the results for prices of the 2011 and Table 3 of the 2012 reform. The results indicate that the average pass-through was full for the 2011 reform. Moreover, the table confirms the intuition from the graphical analysis that for ice creams the pass-through was less than full and for soft drinks more than full. In the 2012 reform the average pass-through was more than full. A possible general pattern from these observations is that the smaller the mechanical impact of the tax on prices, the higher is the pass-through and vice versa, when the impact of the tax is higher the lower is the pass-through. In numbers it seems that the sweets tax were increased by about 10% after the two reforms relative to the control group.

Table 4 shows the differences-in-differences estimate for quantities. The regression takes as the pre-period year 2010 and as after-period 2011 to 2013. Thus the regression combines the 2011 and 2012 tax increases. All the coefficients are close to zero. The preferred estimate is in column (2), which combines reforms 2011 and 2012 and adds product-level fixed effects. The estimate is -0.003 and is statistically not significantly different from zero with quite tight confidence intervals. Thus, we conclude also based on this estimate that the reform had no impact on the amount of sweets sales.

We next turn to studying the 2014 tax increase for sugary soda that left the tax on sugar-free soda unchanged, the 2014 tax change doubled the tax rate for sugared liquids from 0.11 €/kg to 0.22 €/kg. Figure 6 shows that the consumer prices responded immediately and increased rapidly by an amount of mechanical full pass-through immediately after the reform. The figure also shows the prices of sugar-free liquids and the prices of a control group. Relative to the control group it seems that the sugar-free drinks exhibit initially some price increase after the reform, but this subsidises and their prices return to the control group level.

Figure 7 shows the quantity evolution of sugary versus sugar-free drinks and Figure 8 the same comparison between the sugary and sugar-free soft

drinks. The figures show that the two groups are on a parallel trend prior to the reform and that there is a clear separation between the sales of the two groups precisely at the time of the reform. Figure 9 adds to the previous figure a third group, a common control group consisting of ice cream, sweets and chocolates. The control group illustrates that at the 2014 reform the consumption of sugary soda declined and the consumption of sugar-free soda increased. This suggests that there was a substitution effect from sugary soda to sugar-free soda.

Table 5 shows the DiD regression results of the 2014 reform for prices. The estimate in column (1) for all sugary drinks shows an increase of 9.7%, which more than full pass-through. The estimate for sugary soda in column (3) is 7.5% which is almost exactly full pass-through.

Table 6 shows the quantity regressions for the 2014 reform. Columns (1) through (3) are for all drinks and columns (4) through (6) focus on soda only. Column (1) shows that relative to a common control group the consumption of all drinks declined by about 1.6%. When separating the effects between sugary and sugar-free drinks, the effects are clearer and opposite: column (2) shows that the sugary drinks exhibit a decline of 4.2% while sugar-free drinks increase by about 5.6%. The total effect is negative because the group of sugary drinks is larger than the group of sugar-free drinks. The effects are to the same direction but more pronounced for soda. The total effect in column (4) shows a decline of 4.1%, and the consumption of sugary soda seems to have declined by 7.3% while the consumption of sugar-free drinks seems to have increased by 3%. We have to note that the division between the main and substitution effects is quite sensitive to the choice of the control group, and do not want to take the exact point estimates as certain. But in general we observe that there was a total effect on consumption of drinks due to this last reform and that there was a clear substitution from sugary drinks to sugar-free drinks. This last observations is also capable of explaining why we see such clear consumption effects here while earlier reforms having similar impact on prices did not have a clear impact on consumption of sweets or drinks for that matter.

4.1 Mechanisms

The summary of results thus far is that we observe that prices increase on average about 10% after the two tax increases in 2011 and 2012 relative to the control group. We also observe roughly similar magnitude of price increases in the 2014 tax reform for sugary liquids. Thus, the price results indicate that taxes increased prices in the 2011 and 2012 similarly as in the 2014 for sugary liquids. The quantity results are very different in these two reforms, though. In the first two reforms we could not find any significant quantity reductions, which would suggest a demand elasticity with respect to price of zero. Even though it remains possible that there is a small price response we could not estimate, the result is clearly very different from the quantity response in the 2014 reform. In that reform the quantity response was clearly negative. In fact, for sugary soda the response seems to imply a demand elasticity of one.

We think that the most obvious mechanism that explains the above summarized results is that substitution to non-sugary soda was much easier than substitution between candies and cookies. Thus far we can only provide anecdotal evidence supporting this hypothesis. One observation is that sugary soda is very similar to artificially flavored soda. For example, big brands like Coca Cola and Pepsi have both products in the market and they seem to advertise the artificially flavored ones. Thus, the markets exist for these products. Considering candies or cookies, the issue is that it is not easy to escape the tax and still be able to consume a very similar product. Switching between candies and cookies entail switching to a different type of product. Moreover, the candies and cookies tend not to be located next to each other in grocery stores. Instead, different types of soda are located next to each other. Thus also this is an anecdotal observation that support the hypothesis that it is easier to switch between different types of soda than between cookies and candies.

If the above assertions are true, it seems that the feasibility of substitution is a more important factor explaining demand responses than small variations in price. Thus, although substitution possibilities are recognized

in the literature, their significance is not highlighted as much as it should.

5 Conclusions

We study the pass-through and quantity elasticity of the sweets tax introduced in Finland in 2011 and subsequent tax increases in 2012 and 2014. Our very findings show that the sweets tax was fully passed through to prices in the 2011 reform and over-shifted in the 2012 reform that was a smaller increase in the tax.

We find that the tax introduction in 2011 and tax increase in 2012 did not affect the consumption of sweets, ice creams or soda at all. In contrast, we find that the 2014 tax increase for sugary soda did reduce the consumption of sugary soda. This reform left the tax of sugar-free soda, a close substitute, unchanged. We indeed find that there was substitution towards sugar-free soda.

This substitution effect could explain the different demand effect in the 2011 and 2014 reforms, in the former reform close substitutes that were not treated with a tax increase were not available. This suggests that when designing sin tax reforms the availability of healthier and close substitutes needs to be kept in mind.

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	Stat	Prices				
		Price	Pieces	Sweets	Ice	Drinks
Tax	Mean	1.89	11.73	1.86	2.62	1.99
	SD	1.31	28.75	1.51	1.57	1.12
	N	2.22e+08	2.22e+08	5.42e+07	3.74e+07	2.68e+07
	N*pieces	2.60e+09	2.60e+09	6.37e+08	3.17e+08	3.85e+08
	Products*stores	2.29e+06	2.29e+06			
Control	Mean	2.64	9.90			
	SD	2.21	57.99			
	N	9.04e+07	9.04e+07			
	N*pieces	8.95e+08	8.95e+08			
	Products*stores	1.01e+06	1.01e+06			

Table 1: Descriptive statistics

: Difference-in-difference estimates for the 2011 tax introduction: prices							
	(2)	(3)	(4)	(5)	(6)	(7)	
	All	Kg	Sweets	Chocolate	Ice cream	Soda	
***	0.072***	0.083***	0.067***	0.060***	0.137***	0.043***	
(3)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	

(8)	0.062	0.087	0.064	0.067	0.150	0.025	
1,759	96,952,759	68,413,067	43,200,452	33,741,918	37,331,691	33,605,331	
1	0.992	0.993	0.994	0.996	0.990	0.994	
	X	X	X	X	X	X	

kg/l based. The control group for the regressions in columns (3)-(7) consists of all the untaxed (and pastries). The regressions include only the observations from 2010 and 2011. Standard errors triplet level. *** p<0.01, ** p<0.05, * p<0.1

Table 3: Difference-in-difference estimates for the 2012 tax increase: prices

Vars	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	All	All	Kg	Sweets	Chocolate	Ice cream	Soda
DiD	0.045*** (0.001)	0.047*** (0.000)	0.042*** (0.001)	0.041*** (0.001)	0.039*** (0.001)	0.034*** (0.002)	0.058*** (0.002)
Tax dummy	-0.411*** (0.007)						
Full pass-thr.		0.023	0.020	0.015	0.015	0.033	0.021
N	93,736,671	93,736,671	65,322,911	40,699,710	32,395,559	35,392,988	32,222,605
R ²	0.067	0.994	0.995	0.996	0.997	0.992	0.995
Product fe		X	X	X	X	X	X

Note: The volume price is kg/l based. The estimates are very close for item prices. The control group for the regressions in columns (3)-(9) consists of all the untaxed products (mainly pastries) as all the products belonging to the respective categories are tax-liable. The regressions include only the observations from 2011 and 2012. Standard errors clustered at the product-outlet level. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Difference-in-difference estimates for the 2011 tax introduction and 2012 tax increase : quantities

	(1)	(2)	(3)
VARs	All	All	Sweets
DiD	0.007*** (0.002)	-0.003 (0.002)	0.007* (0.003)
Tax dummy	-0.002 (0.002)		
N 1,000s	33,388	33,388	22,317
R^2	0.012	0.134	0.137
Product fe		X	X

Table 5: Difference-in-difference estimates for the 2014 tax increase for sugary drinks on prices

Dep. variable	(1)	(2)	(3)	(4)
	Sugary drink	Sugar-free drink	Sugary soda	Sugar-free soda
DiD	0.097*** (0.001)	-0.010*** (0.001)	0.075*** (0.001)	-0.001 (0.001)
Full pass-through	0.081	-	0.074	-
N	51,588,608	36,457,156	34,236,966	30,107,380
R^2	0.992	0.992	0.991	0.992
Product fe	X	X	X	X

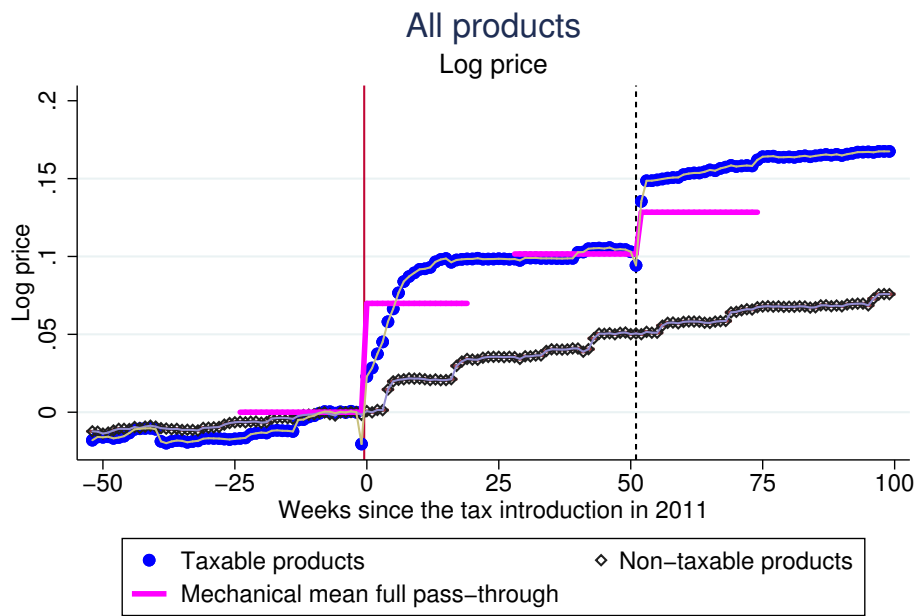
Note: The time period is Jan 2013 - Dec 2014. Includes controls for the tax status, the week resp. month effects (for prices resp. sales), and the product-outlet effects.

Table 6: Difference-in-difference estimates for the 2014 tax increase on sales

Dep. variable	(1)	(2)	(3)	(4)	(5)	(6)
	Drinks			Soda		
	All	Sugary	Sugar-free	All	Sugary	Sugar-free
DiD	-0.016*** (0.004)	-0.042*** (0.004)	0.053*** (0.003)	-0.041*** (0.003)	-0.073*** (0.003)	0.030*** (0.003)
N	18,622,752	16,303,592	12,278,244	12,411,675	11,715,429	10,655,871
R^2	0.252	0.250	0.236	0.237	0.235	0.228
Product fe	X	X	X	X	X	X

Note: The time period is Jan 2013 - Dec 2014. Includes controls for the tax status, the week resp. month effects (for prices resp. sales), and the product-outlet effects.

Figure 1: Development of volume-based prices



1st vertical line: tax introduced. 2nd line: tax increased on Jan 2012.

Figure 2: Development of log unit prices, various sub-categories of taxable products

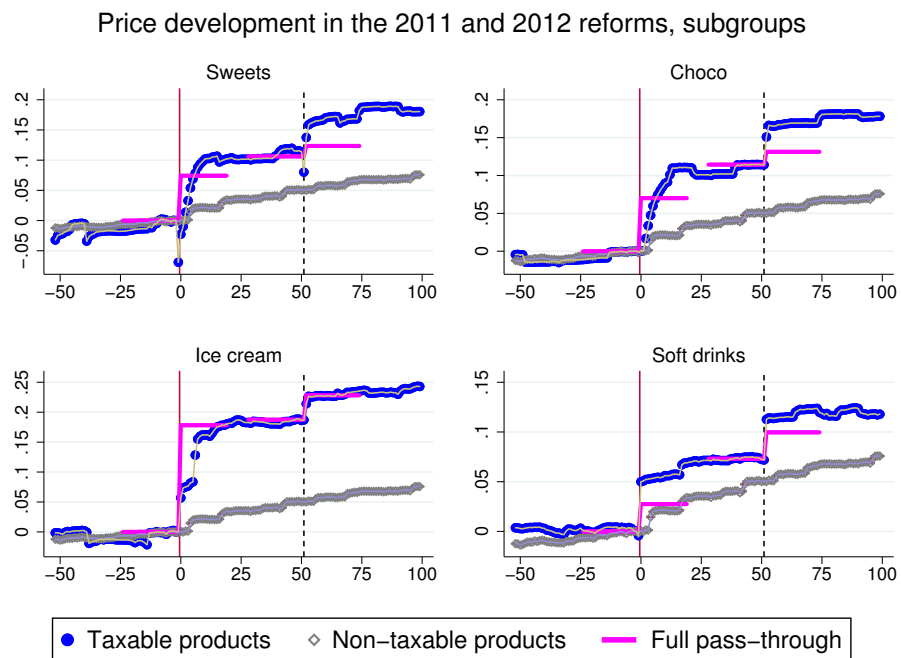
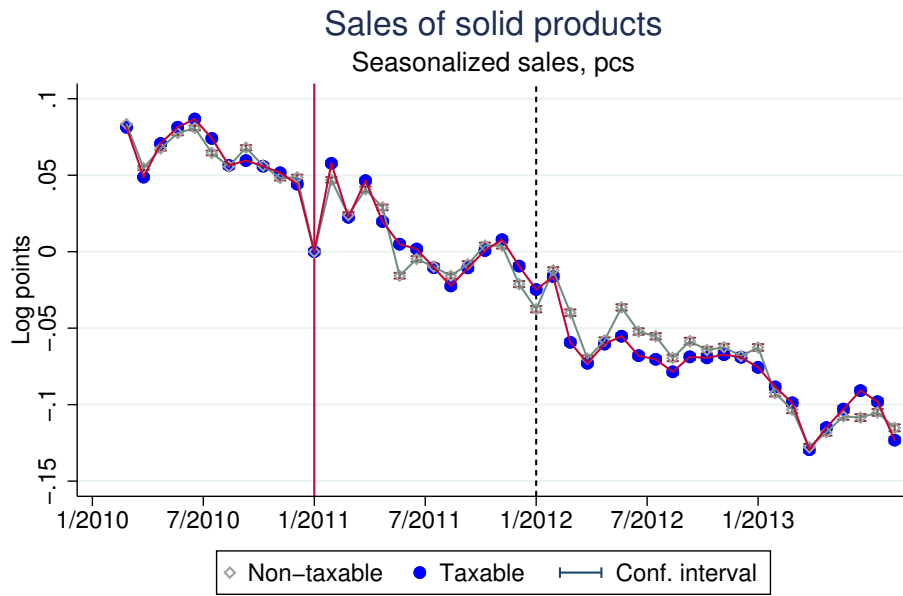


Figure 3: Development of sold volumes, solid products



1st vertical line: tax implementation at Jan 1st, 2011
2nd vertical line: tax increase at Jan 1st, 2012.

Figure 4: Development of sold volumes, soft drinks in the 2011 and 2012 reforms

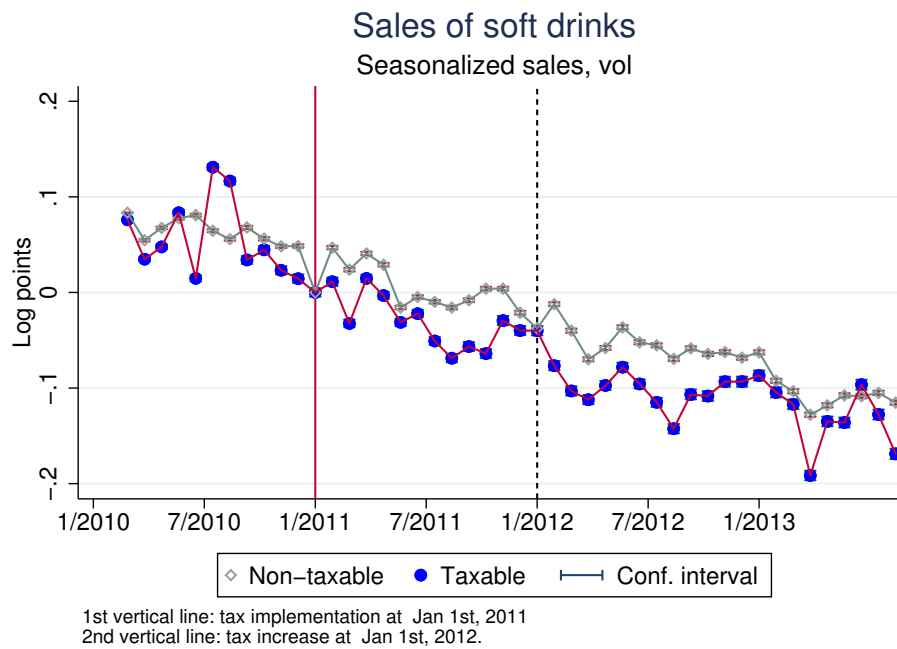


Figure 5: Development of sold volumes, soft drinks in the 2011 and 2012 reforms

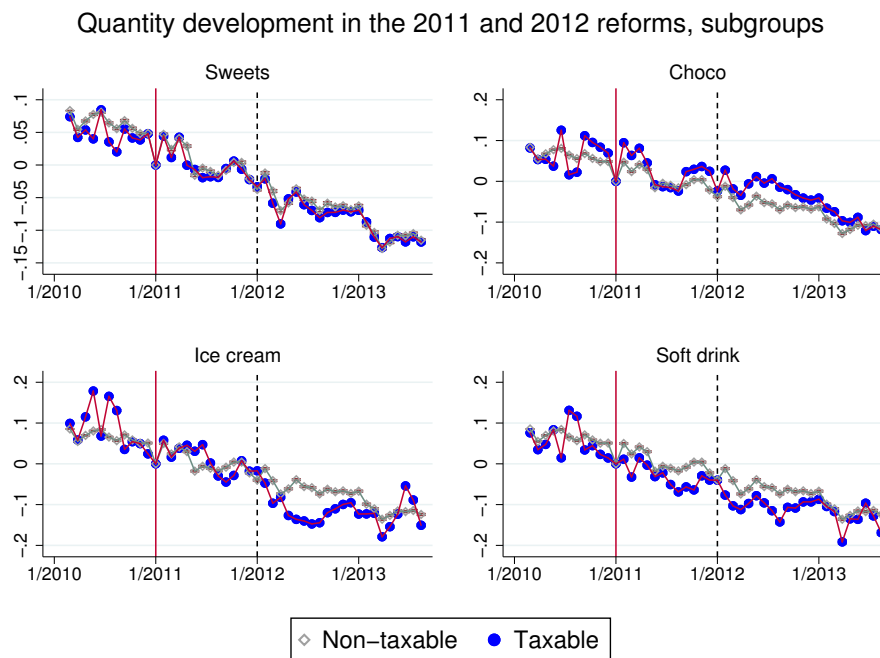
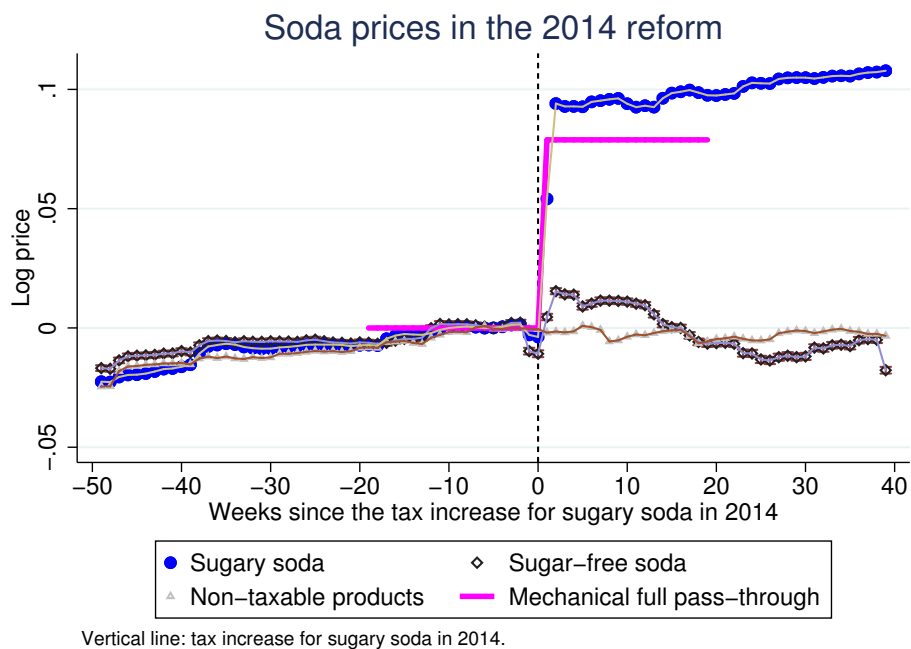


Figure 6: Development of log soda price by sugar content and control prices in the 2014 reform



Vertical line: tax increase for sugary soda in 2014.

Figure 7: Development of sugary vs sugar-free soda sales in the 2014 reform

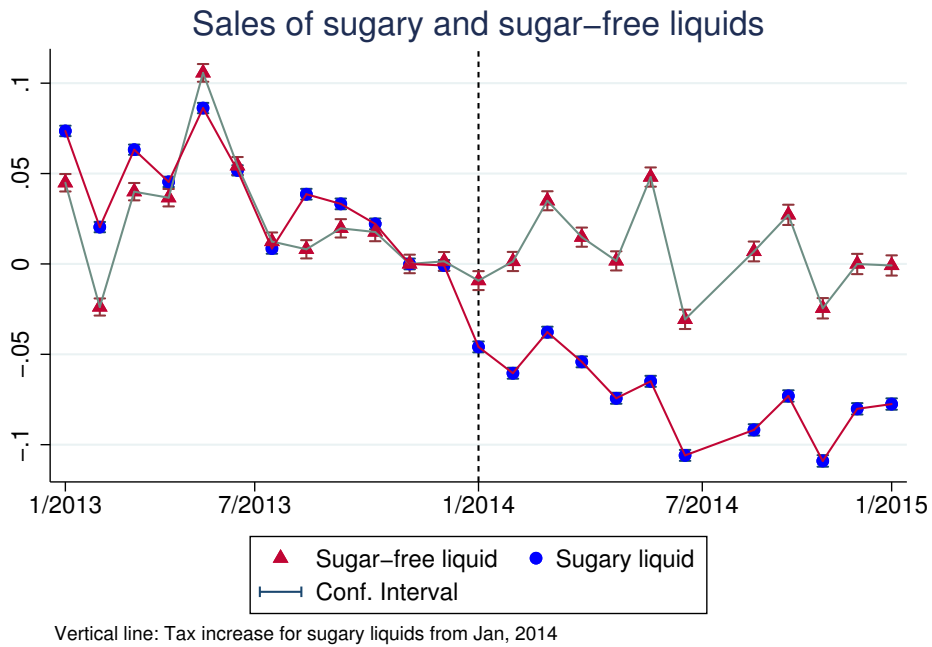


Figure 9: Development of sugary vs sugar-free soda vs common control group sales in the 2014 reform

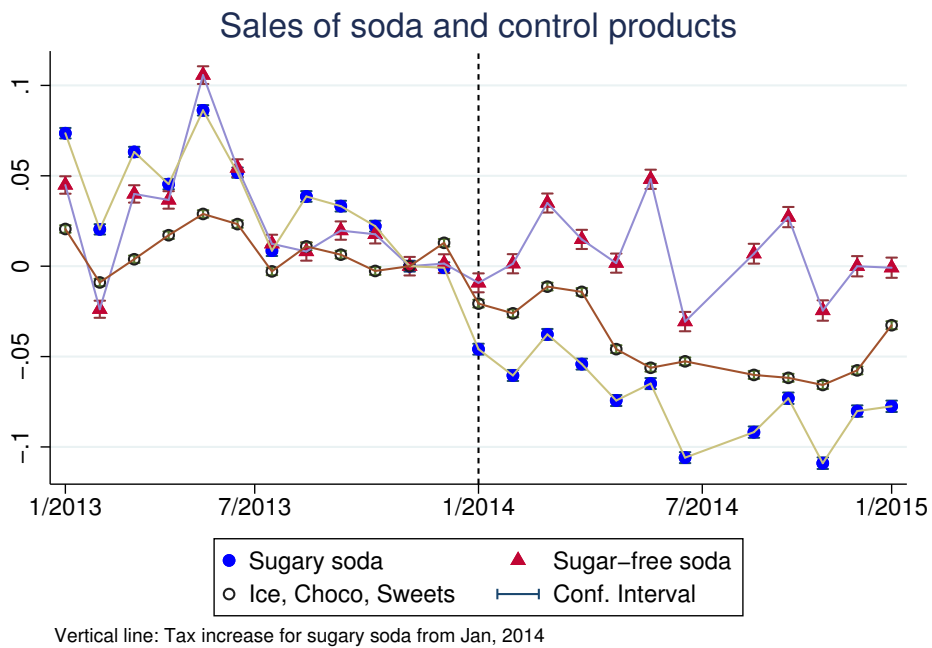
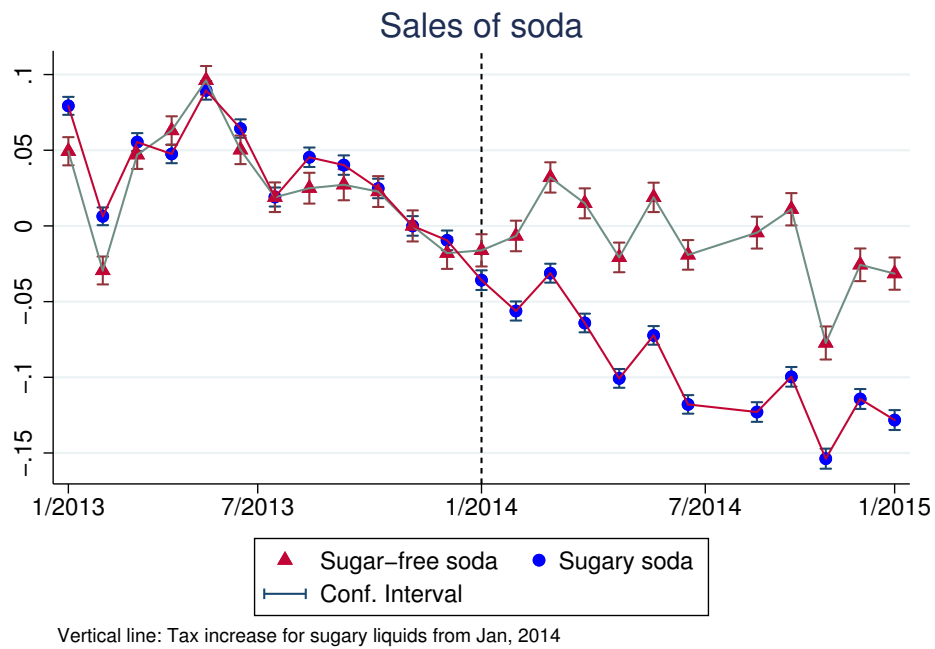


Figure 8: Development of sugary vs sugar-free soda sales in the 2014 reform



APPENDIX