Sin Taxes and Self-Control *

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Abstract

Theoretical studies show that "sin taxes" are welfare improving if consumers with low self-control are at least as price responsive as consumers with high self-control, even in the absence of externalities. In this paper, we investigate if consumers with low and high self-control react differently to sin tax variation. For identification, we exploit two sets of sin tax reforms in Denmark: first, the increase of the soft drink tax in 2012 and its repeal in 2014, and, second, the fat tax introduction in 2011 and its repeal in 2013. We assess the consumption response empirically using a detailed homescan household panel. Our unique dataset comprises a survey measure of self-control linked to the panelists, which we use to separate the sample in consumers with low and high levels of self-control. We find that consumers with low self-control reduce consumption less strongly than consumers with high self-control when taxes go up, but increase consumption to a similar extent when taxes go down. Hence, we document an asymmetry in the responsiveness to increasing and decreasing prices. We show theoretically that these observations are consistent with a model of self-control and rational habit formation. The results suggest that price instruments are not an effective tool for targeting self-control problems.

JEL-codes: H20, D12, I18
Keywords: self-control, soft drink tax, fat tax, sin tax, internality

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1 Introduction

The "global obesity epidemic" is a major public health challenge (WHO, 2000) and one of the leading risk factors for many non-communicable diseases like type 2 diabetes and coronary heart disease (Smith Jr., 2007). Poor diets that contain high levels of sugar and fat are among the main culprits of this phenomenon (Finkelstein *et al.*, 2005). Hence, the World Health Organization advises governments to consider the introduction of so-called "sin taxes" on unhealthy foods, e.g. taxes on sugar sweetened beverages (SSB). A number of countries have already implemented taxes on sugary beverages and other unhealthy foods, e.g. France, Mexico, the United Kingdom, and, until recently, Denmark.

There are two rationales for sin taxes: externalities and internalities. Externalities mean that high sugar consumers do not take the social costs of adverse health behavior into account and the tax is meant to internalize these costs. Internalities in the form of self-control problems imply that people underappreciate the long-term health costs that an unhealthy diet has on themselves. In this paper, we focus on the internality argument since it is very prominent in the public debate about sin taxes on foods.[1] The idea is that a sin tax could help consumers with low self-control to follow their long-run utility by increasing the instantaneous price. Such a tax can even be welfare-improving if the corrective gains for individuals with low self-control overweigh the distortionary costs for those without self-control problems. However, to ensure that this is the case individuals with low self-control have to reduce their purchases more than those with high self-control (O'Donoghue and Rabin, 2006; Haavio and Kotakorpi, 2011).

In this paper, we investigate empirically the causal effect of self-control on responsiveness to sin tax changes. For identification, we exploit exogenous variation in two Danish sin taxes: First, we consider the increase of the soft drink tax in 2012 and its complete repeal in 2014. Second, we investigate the fat tax on saturated fat, introduced in 2011 and repealed in 2013. We use a unique panel data set that comprises purchase records of 1,278 households who stay in the panel for the period of tax changes and who have also answered a well established survey on self-control (Tangney *et al.*, 2004). Using the survey, we stratify the sample into high and low self-control consumers. The validity of the measure is supported by the observation that panelists with low self-control have larger Body Mass Index and report both the intention to reduce their weight and to improve their eating habits. In our empirical analysis, we estimate the differential effect of tax changes on consumers with low and high self-control. Finally, we

[1] First, soft drink taxes are often advocated based on the premise that particularly children, who belong to the heaviest soft drinks consumers, ignore the long-run consequences of high sugar intake (Dubois *et al.*, 2019). Second, the effectiveness of these taxes is usually assessed by the reduction in consumption and not by tax revenue raised (for externality correction this distinction would not be as relevant). For example, on March 13, 2018, the former British finance minister and initiator of the British soft drink tax, George Osborne, tweeted: "In OBR *[Office for Budget Responsibility]* report today is news that our Sugar Tax is even more effective than hoped. Expected receipts halved [...]". (https://twitter.com/George_Osborne/status/973647500551827456, retrieved 09/23/19).

propose a theoretical explanation for our results using a model of rational habit formation (Becker and Murphy, 1988).

In our empirical analysis, we find that consumers with low self-control reduce their purchases significantly less than those with high self-control when the soft drink tax is increased. In contrast, in response to the tax repeal all groups increase their purchases to a similar extent. We find the same pattern for the introduction and repeal of the fat tax. Here, we look at butter since it experienced substantial tax variation due to its high content of saturated fat. To provide credibility to our empirical strategy, we show that the trends in the years before the tax changes do not differ between self-control groups. Moreover, we show that additionally controlling for heterogeneous demand responses by education, income, taste for unhealthy food, nutritional knowledge, and proximity to the German border does not account for the difference between self-control groups.

We provide a theoretical explanation for this asymmetry using a model of rational habit formation (Becker and Murphy, 1988; O'Donoghue and Rabin, 2001). Rational habit formation means that consumption today makes it more likely to also consume tomorrow and consumers are aware of that. This explanation is supported in our dataset since panelists with low self-control report to be more strongly habituated with respect to sugar and fats. In the model, consumers have to take into account that a tax does not just change the instantaneous price but also all prices in the future. Since consumers with low self-control discount the future (and, hence, the future prices) more, they react in general less strongly to tax changes. However, this effect is not symmetric if a tax hike is followed by a tax cut, as in our case. The reason is that there are more high self-control consumers who stop consuming due to the tax hike. Hence, they get used to not consuming and their habit stock decreases. Due to a lower habit stock, they are less likely to resume consumption when the tax is cut in the next period. Therefore, the difference in responsiveness between high and low self-control is smaller for the tax cut compared to the tax hike.

Our study is motivated by the theoretical literature on taxation of behavioral internalities like imperfect self-control. The idea is that a lack of self-control can lead consumers to over-consume goods that have long-run costs, which are not fully taken into account at the moment of consumption. A sin tax increases the instantaneous and future costs of consumption and reduces over-consumption. Gruber and Köszegi (2001) show that optimal taxes on cigarettes are substantially higher if addicted individuals are present-biased. O'Donoghue and Rabin (2006) and Haavio and Kotakorpi (2011) argue that an internality correcting tax can be welfare improving if individuals with low self-control are at least as responsive to a sin tax as those with high self-control. Further, the comprehensive model by Allcott *et al.* (2019), in which they study the welfare effects and the distributional implications of sin taxes, takes the correction of internalities into account. However, these papers do not make predictions

whether consumers with low self-control actually respond to sin taxes and leave this question to empirical research.

We contribute to the burgeoning empirical literature, which assesses targeting properties of sin taxes, by estimating heterogeneous tax responsiveness by self-control. Allcott *et al.* (2019) estimate in their empirical section the share of soda consumption that is due to a self-reported lack of self-control.[2] They find that bias-induced consumption is decreasing in income, which means that poor consumers can benefit more from the corrective effects of the tax. However, due to their focus on the regressivity of sin taxes, they do not consider if the price elasticity varies with the level of self-control. In contrast, we use actual tax variation and investigate if the tax actually targets individuals with low self-control. The targeting properties of a soft drink tax are also investigated by Dubois *et al.* (2019) in a structural demand model. They estimate price elasticities of different consumer groups and hypothesize that the high soda preference of certain groups (e.g. young people and high sugar consumers) is more likely due to biases. They find that young people are more price responsive, but that high sugar consumers are less price responsive than the average consumer. We complement these findings by employing an established measure of self-control and by exploiting exogenous variation in prices to provide a causal test of the impact of self-control on price responsiveness.

Furthermore, we contribute to the empirical literature that uses quasi-experimental variation in sin taxes to estimate the impact of taxes on purchases. We are first to use tax variation to study heterogenous responses by self-control. There is a longstanding literature that uses tax variation in tobacco and alcohol taxes to estimate price elasticities (see the surveys in Chaloupka *et al.* (2012) for tobacco and in Wagenaar *et al.* (2009) for alcohol). With the increasing prevalence of sin taxes on food, there are more and more evaluations of these policies. Jensen and Smed (2013) analyze the short-run effects of the fat tax in Denmark in a pre-post design and document a significant drop in average purchases of saturated fat from butter and margarine. Cawley *et al.* (2019) surveys the empirical literature on soft drink taxes and concludes that average purchases decrease after tax introductions. This is documented for US cities like Berkeley and Philadelphia using geographical control groups (e.g. Cawley *et al.*, forthcoming; Rojas and Wang, 2017) and for the tax in Mexico using pre-post designs (Colchero *et al.*, 2016, 2017).[3] In earlier work, we analyze the tax pass-through and average purchase response to the increase 2012 and repeal 2014 of the Danish tax on soft drinks using a pre-post design (Schmacker and Smed, 2019). We document that, on average, purchases respond to the tax increase with a price elasticity of approximately 1.1 and to the tax repeal with a price elasticity of 1.3. Whereas the focus in that paper was on the average change in

[2]They use the Nielsen household panel and classify panelists as low self-control who respond "Definitely" to the statement "I drink soda pop or other sugar-sweetened beverages more often than I should".

[3]Although a reduction in purchases is not necessarily equivalent with a reduction in (sugar) consumption. Seiler *et al.* (2019) show that many consumers avoid the tax in Philadelphia by shopping in neighboring jurisdictions and Aguilar *et al.* (2019) show that the reduction of calories from soft drinks due to the Mexican tax is offset by an increase of calories from untaxed sugary products.

purchases, in this paper we use the exogenous variation in prices to test if different levels of self-control imply different degrees of price responsiveness.

Finally, we contribute to the literature on habit formation and responsiveness to taxes by providing empirical and theoretical evidence that tax hikes and cuts can have different effects. The seminal paper by Becker and Murphy (1988) already argues that a permanent change in prices of a habit-forming good may have an initially small effect on consumption that grows over time until a new steady state is reached. Zhen *et al.* (2011) provide empirical evidence for habit formation in demand for sugar sweetened beverages using a demand system model. Colchero *et al.* (2017) evaluate the long-run response to the sugar sweetened beverage tax in Mexico and find that the long-run response is in fact stronger than the short-run response. We add a new perspective to this literature and show, both empirically and theoretically, that tax increases have a smaller effect on purchases of habit-forming goods for people with low self-control. However, this effect seems to be not symmetric for tax increases and tax cuts, suggesting that individuals with low self-control find it hard to reduce consumption when prices go up but react to price incentives when prices go down.

The remainder of the paper proceeds as follows. In Section 2, we present the conceptual framework that motivates our empirical analysis. Section 3 describes the institutional setting and the dataset that we are using. Section 4 specifies the empirical strategy. Section 5 presents the results and Section 6 provides a theoretical explanation for the results that we find. Section 7 concludes.

2 Conceptual Framework

In this section, we briefly summarize a key result of the sin tax literature that motivates our empirical investigation of heterogenous responses to sin taxes by self-control. O'Donoghue and Rabin (2006) and Haavio and Kotakorpi (2011) show that, in a simple two-good model, the optimal internality-correcting tax depends both on the average internality and on the covariance of the price responsiveness and the internality: The optimal tax is higher if individuals with low self-control respond stronger to price changes than individuals with high self-control and vice versa.

More formally, models in the literature typically assume that preferences can be characterized by a $\beta - \delta$ model of self-control (Laibson, 1997). That means, individuals maximize intertemporal utility:

$$U_t(u_1, ..., u_T) = u_t + \beta \sum_{\tau=t+1}^{T} \delta^{\tau-t} u_\tau. \tag{1}$$

Each period they receive instantaneous utility u_t and future utility is discounted by time-consistent discount factor δ and a hyperbolic discount factor β. If $\beta < 1$ the agents have a preference for immediate gratification (i.e. low self-control) and if $\beta = 1$ the agents behave time-consistently.

In a two-good model, consumer i decides whether to consume a sin good x_i that provides instantaneous utility $v(x_{it})$, but is associated with long-run costs $c(x_{i,t-1})$, and a numeraire good. Since consumers with low self-control ($\beta < 1$) underweigh the future costs of consumption, they overconsume the sin good. A social planner maximizing the long-run utility of all individuals (i.e. setting $\beta = 1$ for everyone), may decide to impose a tax t on the sin good to help consumers with low self-control to consume closer to their long-run utility. The idea is that the tax serves consumers with low self-control as a commitment device by increasing the instantaneous costs of consumption.

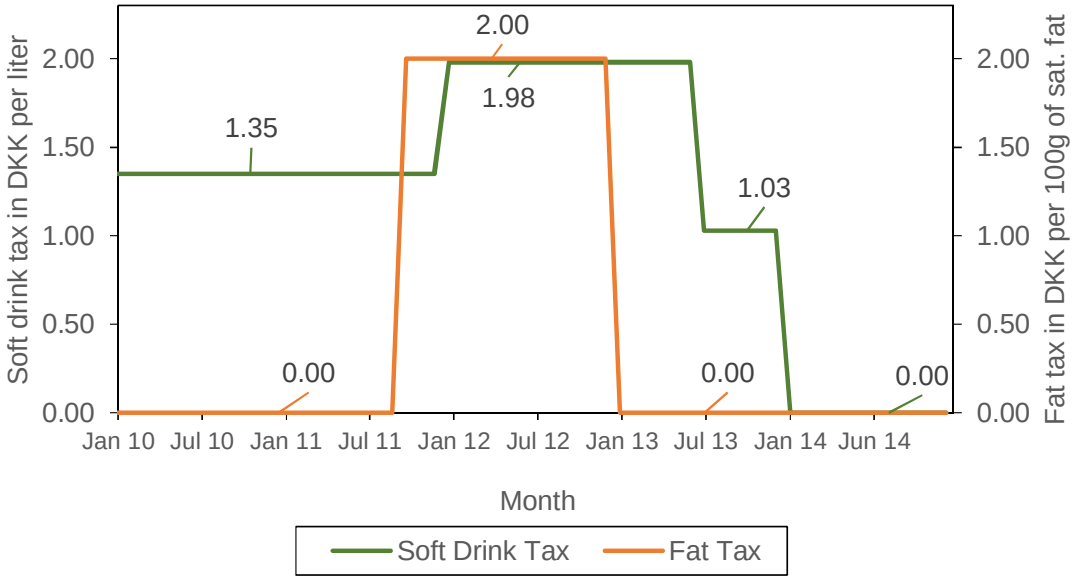
Haavio and Kotakorpi (2011) show that, in this case, the optimal tax is given by

$$t = \frac{1}{N}\sum_i (1-\beta_i)c'(x_i) + \frac{\text{cov}((1-\beta)c'(x), \frac{\partial x}{\partial t})}{\partial \bar{x}/\partial t}. \tag{2}$$

We provide the derivation of the optimal tax formular in Appendix A. The first term in the optimal tax is the average internality in the population, i.e., the marginal costs that are not accounted for due to a lack of self-control. This first term is corrected by the targeting efficiency of the tax that is represented by the second term. The targeting of the tax is described by the covariance between the internality due to a lack of self-control and the responsiveness of consumption to tax changes (weighted by the average responsiveness of sin good consumption to tax changes). Intuitively, the optimal tax is larger if those with the largest internality reduce their consumption more than those without lack of self-control. In that case, the tax is relatively effective in correcting the internality. However, the tax is smaller if consumers with low self-control respond less to the tax. In that case, the distortionary effect on consumers without self-control problem overweighs the internality-correcting effect.

According to the previous literature, it is *a priori* not clear whether the relationship between present-bias and price responsiveness is positive or negative and is merely an empirical question (O'Donoghue and Rabin, 2006). Hence, this is what we aim to investigate causally using the institutional setting described in the next section.

Figure 1: Soft drink and fat tax variation in Denmark, incl. 25% VAT



Notes: Graph shows soft drink and fat tax variation over time. The denoted taxes include 25% VAT.

3 Data

3.1 Institutional Background

For identification, we exploit variation in two different sin taxes: the soft drink tax and the fat tax. Both were part of the Danish tax reform of 2010. The goal was to reduce income taxes and instead increase taxes on consumption goods that have detrimental effects on public health or the environment (The Danish Ministry of Taxation, 2009). Besides the taxes on soft drinks and fat, taxes on sweets, chocolate, ice cream, and tobacco were increased. Moreover, a tax on the content of sugar in all goods was planned but never realized.

The tax variation is illustrated in Figure 1. The first tax that we study is the tax on sugary soft drinks. The excise tax on soft drinks in Denmark has a longstanding tradition. Both its introduction and subsequent tax reforms were mainly motivated by the goal to raise tax revenues (Bergman and Hansen, 2017). However, the increase of the tax in January 2012 from 1.35 DKK to 1.98 DKK per liter (excise tax plus 25% value-added tax) aimed to improve public health. This is also illustrated by the fact that the tax on diet soft drinks remained constant. In previous work (Schmacker and Smed, 2019), we estimate the pass-through of the tax using a regression discontinuity approach and document a price increase by 1.17 DKK (12.5 percent) in reaction to the tax hike (see Figure C.1a in the Appendix). Hence, the tax hike is substantially overshifted, which is consistent with the study of Bergman and Hansen (2017) for earlier soft drink tax increases. In April 2013, the Danish government announced

it would repeal the tax on soft drinks in order to secure jobs in the retail sector in the Danish-German border region and make up for tax revenue losses due to cross border trade. The tax first decreased to 1.03 DKK (incl. VAT) in July 2013 and completely eliminated in January 2014. In Schmacker and Smed (2019), we estimate a price drop of 2.29 DKK (23.4 percent) in response to the tax repeal, i.e. a bit more than full pass-through (see Figure C.1b in the Appendix).

The second tax variation is the introduction (October 2011) and repeal (January 2013) of the fat tax. The fat tax was applied to all products that contain more than 2.3g saturated fats per 100g. It amounts to 1.60 DKK per 100g saturated fat plus 25% VAT, i.e. 2.00 DKK per 100g of saturated fats. Vallgårda *et al.* (2015) analyze the political debate around the introduction and repeal of the fat tax. They conclude that a change in the framing from public health arguments to economic arguments (cross-border shopping, administrative burden, and regressive effects on the poor) led from the introduction to the repeal. Since the tax was proportional to the amount of saturated fat, the tax affects product groups very differently. In the analysis, we consider butter since it contains a high amount of saturated fats (approximately 50 percent) and has, therefore, experienced substantial tax variation. In Appendix D.1, we show that the tax introduction is associated with an almost symmetric increase in butter prices by 0.76 DKK per 100g and the repeal with a decrease by 0.61 DKK per 100g.

3.2 Dataset

To investigate the response in purchases to the tax variation, we use household panel data from GfK Consumertracking Scandinavia for the years 2009 to 2014. Panelists are asked to track all their food purchases on a weekly basis. GfK aims for a representative panel with respect to geography, age, education, and family size. Due to panel attrition, each year roughly 20 percent of the sample is replaced with new households having similar characteristics. Panelists report quantities and prices paid for grocery purchases that they bring into the home. Moreover, once a year, households fill in a questionnaire on demographic and socioeconomic characteristics.

When looking at quantity purchased, we aggregate the purchases to monthly observations to account for potential stockpiling. We assign months a zero where purchases are observed but none of these purchases is the good in question (soft drinks or butter). Moreover, we use individual quantities defined as observed quantity divided by the members of the household where children aged younger than six years count as 0.5 household members.[4] Thus, we assume that the purchased products are shared equally within the household.

[4]This weighting is based on 2003-2006 survey data on dietary habits in Denmark (DTU Fødevareinstituttet, 2008).

3.3 Measuring self-control

In 2013 and 2015, an additional survey containing a broad range of questions about self-control and dietary habits was sent to panelists. Self-control is measured using the scale developed by Tangney *et al.* (2004), which consists of 36 statements concerning different domains of self-control (see the items in Table B.1). The respondents indicate their approval to each of these statements on a 5-point Likert-scale. Whenever possible, we use the 2013 data and, if the panelist has not filled in the survey in 2013, we impute the missing data with data from 2015. Hence, we assume that self-control is a time-constant trait, which is supported by a high retest-reliability: among the 1,234 panelists, who have answered the self-control scale in both years, the scores from 2013 and 2015 correlate with r=0.783.

In order to reduce the large number of items and to find the latent dimension of self-control that matters for food choices, we perform a principal component factor analysis on the 36 items using all 2,387 panelists who filled in the self-control scale. Since we aim to identify the underlying factors of self-control, we do not restrict the sample to those panelists who report purchasing soft drinks or butter. Based on the original study by Tangney *et al.* (2004), we decide to extract five factors. In Appendix B, we describe the resulting factor structure.

In the analysis, we use the factor that is related to temptation tolerance and health-related habits, and, thus, is closest related to food choices. Based on the factor loadings and the responses given by the panelists, we compute a new variable that measures the level of self-control according to this factor. The 50 percent of individuals with the lowest parameter value are characterized as having low self-control and the individuals with the highest value as having high self-control.[5]

Table 1 illustrates that our measure of self-control correlates in meaningful ways with Body Mass Index and intentions to improve eating habits, even after controlling for socio-demographics like income, age, and education. Column (1) shows that people with low self-control have substantially higher BMI than those with high self-control and Column (2) shows that they are more likely to be obese. Importantly, in Column (3), we observe that respondents with low self-control indicate much more often that they would like to reduce their weight. Thus, individuals with different levels of self-control also differ in their intentions to achieve a healthy weight. Columns (4) and (5) show that the fraction of respondents who agree that they should eat less sugar and animal fat is significantly larger among panelists with low self-control. To sum up, individuals with low self-control are more prone to risky health behavior and are aware of it, but apparently a lack of self-control prevents them from changing their eating habits. Consequently, individuals who are identified as having low self-

[5]Since we do not want to make parametric assumptions about how self-control affects the responsiveness to tax changes, we use this non-parametric approach. In robustness checks, we show results for more granular sample splits and demonstrate that the results do not depend on the exact sample split.

Table 1: Correlations of self-control with characteristics and attitudes

	(1) Body Mass Index (BMI)	(2) Obesity (BMI>30)	(3) Intention to reduce weight	(4) "I should eat less sugar"	(5) "I should eat less animal fat"
Low self-control	2.124***	0.094***	0.202***	0.112***	0.115***
	(0.269)	(0.021)	(0.028)	(0.029)	(0.028)
Controls	Yes	Yes	Yes	Yes	Yes
Mean	26.021	0.175	0.620	0.483	0.354
Households	1237	1236	1197	1197	1197

Notes: The regressions control for income, age, education, labor market status, and number of children. Columns (1) and (2) are based on weight and height data from 2011. BMI is calculated as ([weight in kg]/[height in m]^2). Column (3) shows the fraction of respondents who indicate in the 2013 survey that they would like to weigh at least 1 kg less. Column (4) and (5) gives the fraction of respondents who indicate that they should eat "A lot less" or "A little less" sugar or animal fat to eat healthier. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

control by this measure are those who should be targeted by an internality-correcting sin tax.[6]

3.4 Descriptive statistics

In the analysis, we use data from 2009 through 2014, including only those households that report at least one purchase of the product in question per year and have responded to the self-control questionnaire. These restrictions leave us with 1,278 panelists. In Table 2, we show descriptive statistics of the overall sample used in the analysis, as well as descriptives of the sample split by self-control. Moreover, in the last column, we show descriptives for the unrestricted sample, which also includes panelists who report at least one purchase in every sample year but for whom we have no information on self-control.

The demographic characteristics appear quite similar across the different sample restrictions. However, there is an intuitive association between self-control and education, with high self-control respondents having higher education. In the robustness section, we address if the differential response by self-control is affected if we also control for heterogenous responses by education. Moreover, panelists who work full time are more likely to have low self-control than those working part-time and, further, the number of children is associated with lower self-control.

[6]In Table B.2, we show that these associations are substantially weaker or non-existent for the other extracted factors, highlighting that we have identified the most relevant factor of self-control in relation to food consumption.

Table 2: Descriptive statistics

	Overall	Low self-control	High self-control	Unrestricted sample
Equivalized household income in DKK				
<175K	18.7	17.8	19.6	19.3
175K-250K	26.1	28.0	24.4	26.0
250K-325K	18.2	17.4	18.9	17.8
325K-400K	19.6	20.1	19.1	19.5
≥400K	17.4	16.7	18.1	17.4
Age group				
<40	13.0	12.3	13.6	13.7
40-59	48.7	47.4	49.9	47.9
≥60	38.4	40.3	36.5	38.4
Labour market status				
Full time	38.7	42.3	35.2	38.5
Part time	27.2	24.4	30.0	27.7
Not employed	34.1	33.3	34.8	33.9
Education				
No tertiary education	59.4	62.8	56.3	59.4
1-3 years tertiary educ.	15.0	14.3	15.6	14.8
> 3 years tertiary educ.	25.6	22.9	28.1	25.8
Household size	1.921	1.942	1.901	1.909
	(0.985)	(1.041)	(0.928)	(0.988)
Number of child. age 0-6	0.066	0.090	0.044	0.068
	(0.321)	(0.382)	(0.249)	(0.326)
Number of child. age 7-14	0.130	0.147	0.113	0.128
	(0.458)	(0.501)	(0.413)	(0.454)
Number of child. age 15-20	0.100	0.102	0.099	0.099
	(0.367)	(0.365)	(0.370)	(0.365)
Households	1,278	623	655	1,412
Observations (Household-months)	78,086	37,940	40,146	85,349

Notes: Table shows descriptive statistics of the GfK Consumertracking Scandinavia data used in the analysis. Displayed are relative frequencies of values of categorical variables, as well as means and standard deviations (in parentheses) of continuous variables. Household income is equivalized using the OECD scale, i.e. dividing household income by the square root of the household size.

4 Empirical strategy

In order to test if the demand response to tax changes differs by self-control, we estimate the within-household variation in soft drink purchases the year before and after the tax changes. Due to our bandwidth of one year, we can keep seasonal variation before and after the tax constant and also can capture changes that occur with a lag due to habit formation.

The empirical model for estimating purchase quantity in month t by consumer i is

$$\text{quantity}_{it} = X'_{it}\alpha = \alpha_0 + \alpha_1 \text{tax}_t + \alpha_2(\text{tax}_t \times \mathbb{1}(\beta_i = \beta^{high})) + \gamma_i + \eta_t + \alpha_4 Z_{it} + \epsilon_{it} \tag{3}$$

where the dependent variable is either the observed quantity, the purchase incidence in a given month (extensive margin), or the log-transformed quantity given a purchase (intensive margin). The variable tax_t is a dummy variable that is one after the tax change and zero before. We interact the tax dummy with indicator functions that specify if individual i is characterized by low or high levels of self-control as defined in the previous section. Hence, α_2 estimates the differential effect of the tax change on purchase quantity for consumers with high self-control compared to those with low self-control. γ_i denotes household fixed-effects, that are included to control for time-invariant unobserved heterogeneity, and η_t denote quarter fixed effects. Z_{it} is a set of household-specific controls that includes the number of kids at age groups 0-6, 7-14, and 15-20, the household size, income group, and labor market status of the main shopper.[7] In the analysis of the soft-drink tax, Z_{it} also includes the monthly average temperature in Denmark.

Hence, our main coefficient of interest is the interaction effect of the tax dummy and the self-control indicator, α_2. In order to identify if the differential responsiveness is due to self-control, we must make the following assumptions. First, we assume that consumers with low and high self-control exhibit parallel trends in consumption. We demonstrate the credibility of this assumptions and show that trends are parallel in the years absent the tax reforms. Second, we assume that differences in price responsiveness are due to self-control and not due to other correlated characteristics, like income and education. Therefore, we investigate if the differential response by self-control remains when we also interact the tax dummy with measured income and education.

As is often the case with household-level consumption data, the distribution of purchases is characterized by a mass at zero and a right-skewed distribution. Using ordinary least squares on the untransformed data can yield biased and inefficient estimates (Manning and Mullahy, 2001). For example, the presence of extreme outliers can have an undue influence on the parameter estimates. We employ multiple measures to alleviate this issue. First,

[7] We do not control for education since there is little within-household variation overt time.

we winsorize the reported quantities at the 99 percent level, i.e., the largest 1 percent of reported quantities are set to the quantity at the 99th percentile. Second, we use a two-part model that estimates, first, the likelihood to consume any soft-drinks (extensive margin) and, second, the amount of soft-drinks provided that a positive quantity is observed (intensive margin). Consequently, the expected value of the quantity is the product of the predicted purchase probability ($X'_{it}\alpha^{ext.}$) and the conditional (and re-transformed) purchase quantity ($exp(X'_{it}\alpha^{int.})$):

$$E(quantity_{it}|X_{it}) = (X'_{it}\alpha^{ext.}) \cdot exp(X'_{it}\alpha^{int.}) \cdot D \tag{4}$$

where $D = 1/N \sum \exp(ln(q_{it}) - X'_{it}\beta)$ is the Duan smearing factor that is needed for retransformation since $E(\exp(\epsilon_{it}))$ is not zero (Duan, 1983).[8] We compute the predicted purchase quantity separately for consumers with low and high self-control.

For each tax event, we consider one year before the tax change and one year after the tax change but we omit the months January and December of each year. Otherwise, we might e.g. overestimate the effect of the tax hike in January 2012 due to customers stockpiling soft drinks in December 2011 and living off stock in January 2012. In case of the tax repeal, we compare the year before the tax cut (July 2012 until June 2013, without January and December) to the year after the complete repeal (February 2014 until November 2014).

5 Results

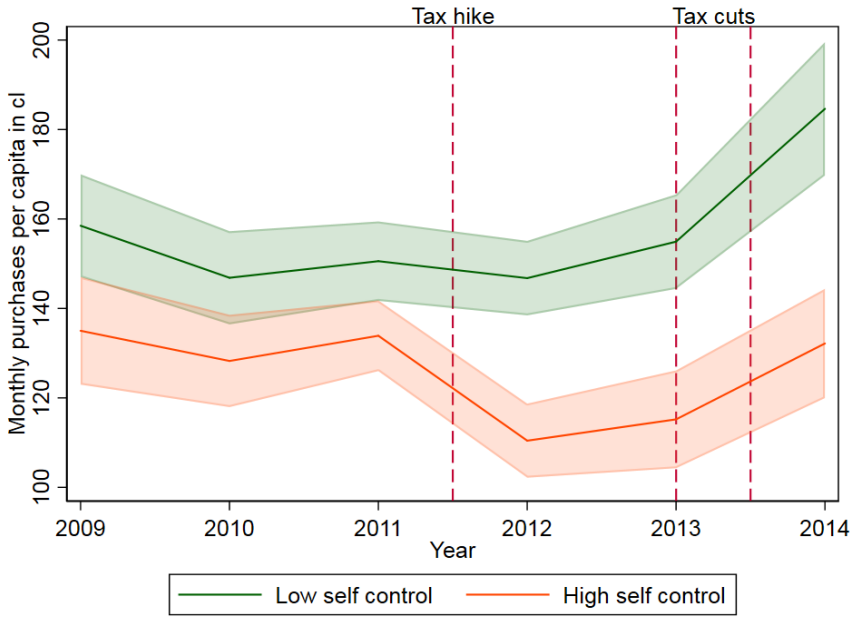
In the empirical analysis, we investigate the differential responsiveness by self-control, first, for soft drink tax changes and, second, for fat tax changes. In both cases, we provide graphical evidence on the development of purchases surrounding the tax changes, before we present the regression results.

5.1 Differential Responsiveness to Soft Drink Tax Changes

Figure 2 shows predicted values after controlling for household fixed effects and the control variables specified in Section 4. First, the purchases of consumers with low and high self-control seem to follow parallel trends in the years before the first tax change, thus lending support to our identification strategy. When the tax is increased in 2012, soft drink purchases by consumers with low self-control did not change significantly, while we observe a significant

[8] The retransformation procedure assumes that $E[\exp(\epsilon)|q > 0, x] = 0$, i.e. that the error term is homoscedastic (Mullahy, 1998). As a robustness check, we estimate the second part using GLM, which does not require retransformation, and, thus, does not assume homoscedasticity with respect to the covariates. The results are very similar and are available upon request.

Figure 2: Predicted values of monthly soft drink purchase quantity by self-control



Notes: Graph shows annual predicted values after controlling for household fixed effects and the control variables specified in the Methods section, using GfK Consumertracking data. Household quantities are individualized by dividing the observed household quantity by the number of household members (children aged 0 to 6 enter as 0.5 household members). The shaded areas represent 95% confidence intervals. The vertical lines indicate the timing of tax changes.

Table 3: Soft drink purchases in response to soft drink tax changes by self-control

	(1)	(2)	(3)	(4)	(5)	(6)
		Extensive	Intensive		Extensive	Intensive
	Quantity	Margin	Margin	Quantity	Margin	Margin
Panel A: Tax Hike						
Tax Hike	0.319	-0.014	0.022	-1.912	-0.016*	-0.002
	(6.543)	(0.010)	(0.040)	(6.559)	(0.010)	(0.041)
High self-control × Tax Hike	-21.663***	-0.032**	-0.086	-21.097***	-0.030**	-0.075
	(8.198)	(0.013)	(0.054)	(8.134)	(0.013)	(0.052)
Panel B: Tax Repeal						
Tax Repeal	28.512***	0.041***	0.127***	31.827***	0.046***	0.151***
	(6.967)	(0.010)	(0.036)	(7.351)	(0.011)	(0.039)
High self-control × Tax Cut	-3.667	0.001	-0.013	-3.613	0.002	-0.015
	(8.817)	(0.014)	(0.050)	(8.814)	(0.014)	(0.050)
Controls	No	No	No	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Table shows OLS regression results with standard errors clustered on household level. In columns (1) and (4) the dependent variable is monthly quantity in centiliter per household member. In columns (2) and (5) it is purchase incidence in a given month. In columns (3) and (6) it is log-transformed quantity. In Panel A, we run the estimations with 1,278 households (22,197 household months) and for the intensive margin estimations with 1,104 households (7,466 household months). In Panel B, we use 1,278 households (22,747 households months) and for the intensive margin estimations with 1,122 households (7,782 household months). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

drop for consumers with high self-control. In July 2013 the tax was cut in half and in January 2014 the tax is completely repealed. In response, we observe a marked increase in purchases by both consumer groups.

In order to quantify the purchase response to the tax variation, we show estimation results of the empirical model in Table 3 for the two parameters of interest (α_1 and α_2).[9] Panel A gives results for the tax hike and Panel B for the tax repeal. In the first column, we use the absolute quantity as dependent variable, in the second column the purchase incidence (extensive margin), and in the third column the log-transformed quantity given a purchase (intensive margin). In the fourth to sixth column, we add time-varying controls. The coefficients shown are the tax indicator variable, which gives the change in purchases by low self-control consumers (the reference category), and the interaction of the tax dummy with the high self-control indicator, which gives the differential change in purchases by high self-control consumers.

The results in Panel A reveal that consumers with high self-control have decreased their purchases significantly stronger than consumers with low self-control in response to the tax hike. Consumers with low self-control have not reduced their purchases significantly from zero as the coefficient of the tax hike dummy tells us. In the second and third columns, we show the

[9]The complete estimation tables are presented in Appendix E.

Table 4: Change in soft-drink purchases based on predicted values from Two-part model

	Low self-control	High self-control
Panel A: Tax Hike		
Relative change	-0.018	-0.190***
	$(0.041)^b$	$(0.034)^b$
Absolute change	-1.866	-20.247**
	$(11.979)^b$	$(10.301)^b$
Panel B: Tax Repeal		
Relative change	0.265***	0.274***
	$(0.042)^b$	$(0.036)^b$
Absolute change	24.804**	25.254**
	$(11.790)^b$	$(9.962)^b$

Notes: Table shows predicted values from the two-part model as described in Section 4. The predicted values are based on the extensive and intensive margin shown in Table 3. For the absolute change, the unit of measurement is in monthly centiliter per household member. Standard errors are bootstrapped with 400 replications and clustered on the household level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

results for the extensive and the intensive margin only controlling for household fixed effects, and in the fifth and sixth column, we add time-variant control variables. On the extensive margin, consumers with high self-control have reduced the purchase probability in a given month by 3.0 percentage points more than consumers with low self-control. Moreover, in the last column it can be seen that consumers with high self-control reduce their purchase quantity by 7.5 percent more than those with low self-control, given that a purchase is observed. However, the differential response is only significant on the extensive margin. In Table 4, we use the estimates from the extensive and intensive margin to calculate predicted values of a two-part model, as described in Equation (4). The pattern resembles the results from the OLS using the untransformed quantity in Column (1) of Table 3. Consumers with low self-control exhibit a change in purchases that is not significantly different from zero. In contrast, consumers with high self-control reduce their purchases significantly, both in relative and absolute terms.

In Panel B of Table 3, we conduct the same exercise for the tax repeal. Here, we compare purchases one year after the tax repeal to one year before the first tax cut. The tax repeal dummy shows that consumers with low self-control have increased their purchases of soft-drinks in absolute terms, both on the extensive and intensive margins. Again, the results are not strongly affected by adding time-variant control variables. While the probability to purchase a soft-drink in a given month increases by 4.6 percentage points, the quantity conditional on a purchase increases by 15.1 percent. However, this time we do not observe a differential response by high self-control consumers. In Panel B of Table 4, the predicted values from the two-part model reiterate that the absolute and relative increase in purchases is, in fact, very similar across the consumer groups.

Robustness of results

Our analysis rests on the assumption that, absent the tax changes, consumers with low and high levels of self-control would have exhibited the same trends. While we cannot directly test this assumption, we provide credibility for it by running the same estimation for placebo tax changes preceding the actual tax changes. In Table C.1, we complete this exercise for placebo tax changes on January 1, 2010, and January 1, 2011. We observe no differential change in purchases by high self-control consumers, thus lending support to the parallel trend assumption.

Another crucial assumption is that the change in purchases can really be attributed to differences in self-control and not to other correlated demographic variables like income and education. For example, one might suspect that self-control is positively correlated with income and that the reason for a differential response to the tax hike is liquidity constraints and not self-control.[10] Since we observe education and income in the data, we can address this concern by adding the triple interactions of tax and self-control with income and education to the main specification and check if the interaction with self-control becomes less pronounced.

In Columns (1) to (3) of Table C.2, we re-run our main specification for the tax hike but add an interaction with a dummy indicating whether an individual is in the top half of the distribution of equivalized incomes. In Panel A, we observe that the coefficients for the interaction of tax hike and self-control are of a similar magnitude compared to our main specification. As is expected when including further interaction terms, the standard errors of the coefficients become larger and the coefficient are less significant compared to the main specification. In Panel B, we observe that the same holds true for the tax repeal. We do not find evidence that high and low income earners respond differently to the tax variation.

Moreover, in Columns (4) to (6) of Table C.2, we add the triple interaction with an indicator for high education. High education means that the panelist has attended at least one year of tertiary education whereas low education indicates at most vocational education. In Panel A, the magnitude of the interaction coefficient of tax hike and self-control is almost unaffected compared to the main specification. Moreover, responsiveness to the tax hike does not differ significantly by education. In Panel B, we conduct the same exercise for the tax repeal. Again, there is not a clear pattern indicating that responsiveness to the tax differs by education. There is some evidence suggesting that for highly educated consumers there is a stronger differential response by self-control. However, as in our main specification we observe no significant interaction coefficient of the tax repeal and self-control.

It is conceivable that measured self-control is correlated with tastes for unhealthy food. To check if the differential response by self-control can be attributed to differences in taste,

[10] However, if that was the case, we would expect consumers with low self-control (and low income) to reduce purchases *more* than consumers with high self-control (and high income).

we add the triple interaction with a dummy variable that indicates if consumers approve to the statement "I believe I would make healthier food choices if unhealthy food was less tasty". In the first to third columns of Panel A in Table C.3, we observe that the interaction with high self-control remains of a similar magnitude irrespective of the taste for unhealthy food. While consumers who like unhealthy food seem to be less likely to reduce their purchases in response to the tax hike, this leaves the differential response by self-control almost unaffected. In Panel B, there is once again no significant differential effect by self-control.

Another alternative explanation is that our measure of self-control is associated with knowledge about the healthiness of food and that this drives the differential response. To account for that we add the triple interaction with a dummy indicating consumers who approve to the statement "I believe I would make healthier food choices if I had more information on how to eat healthy". In the fourth to sixth columns of Panel A in Table C.3, we show the results for the tax hike. Most importantly, the interaction with self-control remains of similar magnitude and significant. Further, in Panel B we observe that accounting for differences in nutritional knowledge does not alter the coefficient of self-control much.

As further robustness tests we re-estimate our main specification on the subsample of single households. Thereby, we can be sure that measured self-control coincides with the self-control of the individual who is solely responsible for the purchasing decisions. Table C.4 presents the results and reiterates the previous finding: High self-control individuals reduce their purchases significantly more than low self-control consumers when the tax goes up, and the interaction coefficient is even larger than in the full sample. However, there is no differential change that is significantly different from zero when taxes go down. Moreover, in Table C.5 in Appendix C.2, we re-run the estimations using a sample split of four self-control quartiles. For the tax hike, we observe that the higher the level of self-control the stronger is the reduction in purchases. For the tax repeal, there is no significant difference between the groups.

As mentioned above the tax on soft drinks was mainly repealed to reduce cross-border shopping in Germany. In general, this should not be a concern for our analysis since in the GfK Consumertracking data, consumers also report purchases abroad. However, one may be concerned that cross-border purchases are underreported and consumers engage differently in border-shopping depending on self-control. Hence, in Table C.6 we add the triple interaction of the tax dummy and self-control with a dummy variable indicating whether the consumers has access to the German border without using a toll bridge or ferry.[11] Thus, the "No Toll" indicator is a proxy for how easy and economic it is to buy groceries in Germany. In Panel A, we observe that for consumers in "Toll" regions (i.e. where the border is not easily accessible) the difference between low and high self-control is even stronger than in the main

[11] While households in Jutland and Funen do not have to use a toll bridge or ferry to reach the German border, households in Sealand, Copenhagen or Bornholm must. The costs to use the ferry or bridge for a standard car start at 30 Euros each way.

specification. However, the difference between low and high self-control is slightly smaller in "No Toll" regions, although the triple difference estimator is not statistically significant. This seems to suggest that consumers with high self-control do not reduce their purchases as much when there are close-by opportunities to avoid the tax. Unfortunately, we lack the statistical power to investigate the relation between self-control and cross-border shopping more closely. In Panel B, we observe that in the "No Toll" region (i.e. close to the border) consumers with low self-control increased their purchases more after the tax is repealed. But also here a closer investigation is not feasible due to a lack of statistical power.

5.2 Differential Responsiveness to Fat Tax

In the previous sections, we show that consumers with low self-control respond less to increasing soft drink taxes than consumers with high self-control. In contrast, when soft drink taxes are cut, there is not a systematically different response. In this section, we check whether this pattern is particular to soft drink tax changes or whether it also emerges for the fat tax introduction and repeal.

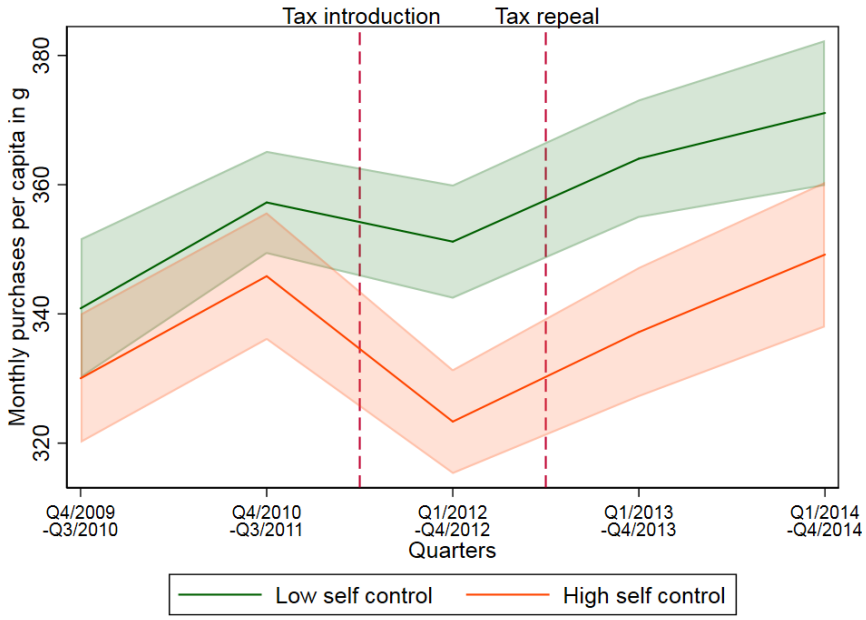
In the following, we look at butter as it is one of the goods that contains the most saturated fat and is frequently purchased. The analysis of the fat tax complements the soft drink tax analysis in several dimensions. First, unlike the soft drink tax, the magnitude of the fat tax variation is very similar for tax hikes and cuts (see Appendix D.1). Hence, we can exclude that a difference in responsiveness is due to low and high self-control consumers responding differently to larger and smaller tax variation. Second, by looking at butter, we can exclude that the differential responsiveness is explained by low and high self-control consumers having different preferences for sugar. If we find a similar pattern for butter, there is further evidence that the reason for the differential responsiveness is due to self-control.

We run the same estimations as described in Section 4 on the data for butter[12]. Figure 3 shows predicted values for butter purchases over the years. Since the tax was in place from the fourth quarter of 2011 (starting October 2011) until the end of the fourth quarter 2012 (ending December 2012), we must exclude one of the five taxed quarters to compare entire years.[13] We observe that in the pre-tax years, consumers with low self-control purchase more butter than those with high self-control, but the confidence intervals overlap. When the tax is introduced, we find, once again, that consumers with high self-control reduce their purchases significantly more than those with low self-control. Furthermore, when the tax is repealed,

[12]The estimations mirror the estimations for soft drinks. The only notable differences are, first, that we restrict the sample to households who report a butter purchase in the years 2010 through 2013 since the tax variation occurs earlier in time. Second, we do not include the average temperature as a control variable since temperature is arguably less relevant for butter demand than it is for soft drink demand.

[13]In Figure 3 we exclude the fourth quarter of 2011. In Figure D.2 we show that we observe a similar pattern when we alternatively exclude the fourth quarter of 2012.

Figure 3: Predicted values of monthly butter purchase quantity by self-control



Notes: Graph shows predicted values after controlling for household fixed effects and the control variables specified in the methods section. Household quantities are individualized by dividing the observed household quantity by the number of household members (children aged 0 to 6 enter as 0.5 household members). The shaded areas represent 95% confidence intervals. The vertical lines indicate the timing of tax changes.

Table 5: Butter purchases in response to fat tax by self-control

	(1)	(2)	(3)	(4)	(5)	(6)
		Extensive	Intensive		Extensive	Intensive
	Quantity	Margin	Margin	Quantity	Margin	Margin
Panel A: Tax Introduction						
Tax Introduction	-11.926**	-0.018**	-0.023*	-11.224*	-0.018**	-0.026*
	(5.908)	(0.008)	(0.014)	(5.974)	(0.008)	(0.014)
High self-control × Tax	-15.692*	-0.022**	-0.007	-16.440**	-0.022**	-0.008
	(8.416)	(0.011)	(0.019)	(8.380)	(0.011)	(0.019)
Panel B: Tax Repeal						
Tax Repeal	12.913**	0.018**	0.027*	10.208	0.017**	0.027*
	(5.996)	(0.007)	(0.014)	(6.562)	(0.008)	(0.016)
High self-control × No Tax	-0.183	0.002	-0.008	-2.291	0.002	-0.013
	(8.467)	(0.010)	(0.021)	(8.516)	(0.010)	(0.021)
Controls	No	No	No	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Table shows OLS regression results with standard errors clustered on household level. In columns (1) and (4) the dependent variable is monthly quantity in gram per household member. In columns (2) and (5) it is purchase incidence in a given month. In columns (3) and (6) it is log-transformed quantity. In Panel A, we run the estimations with 1,324 households (27,192 household months) and for the intensive margin estimations with 1,291 households (17,056 household months). In Panel B, we use 1,323 households (27,507 households months) and for the intensive margin estimations with 1,298 households (17,460 household months). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

both consumer groups increase their purchases to a similar extent, such that the difference in purchases between consumer groups remains until two years after the tax repeal.

We show estimation results of the coefficients of interest from the empirical model in Table 5.[14] Panel A illustrates that consumers with high self-control reduce their purchases significantly stronger than consumers with low self-control in response to the fat tax introduction. As seen in Columns (2) and (4), the difference is mainly driven by a response on the extensive margin. The predicted values from the two-part model in Panel A in Table 6 illustrate that both in relative and absolute terms, the purchase response by high self-control consumers is stronger.

In Panel B of Table 5, we run the estimation for the tax repeal. However, now we do not find a differential response to the tax repeal, as illustrated by the small and insignificant coefficients in the second row. Instead, we find an increase in purchases by all consumer groups. While the significance of the purchase response in Table 5 depends on the inclusion of covariates, it is strongly significant using the more robust two-part model, as seen in Panel B in Table 6. According to the two-part model, both the relative and absolute response is similar among low and high self-control consumers.

[14]The complete estimation tables are presented in Appendix E.

Table 6: Change in butter purchases based on predicted values from Two-part model by self-control

	Low self-control	High self-control
Panel A: Tax Hike		
Relative change	-0.053***	-0.094***
	$(0.014)^b$	$(0.013)^b$
Absolute change	-16.071**	-28.487***
	$(6.646)^b$	$(6.287)^b$
Panel B: Tax Repeal		
Relative change	0.053***	0.057***
	$(0.014)^b$	$(0.016)^b$
Absolute change	15.270**	16.920**
	$(6.712)^b$	$(7.415)^b$

Notes: Table shows predicted values from the two-part model as described in Section 4. The predicted values are based on the extensive and intensive margin shown in Table 5. Standard errors are bootstrapped with 400 replications and clustered on the household level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Robustness of results

In Table D.2, the results of placebo tax changes in January 2010 and October 2010 are shown. Most importantly, the coefficients in the second row for differential changes in response to the placebo tax changes are insignificant and close to zero. There is a significant common trend between 2009 and 2010, but the trend does not differ between consumer groups, as we show in Figure 3.

In Appendix D.3 we control for further interactions with education, income, tastes for unhealthy foods, and nutritional knowledge. As in the case of soft drinks, we find in Table D.3 that controlling for heterogenous responses by education does not explain the differential response by self-control to the tax introduction. Interestingly, we find in Table D.4 that the differential response by self-control to the tax introduction seems to be mainly driven by consumers with high income. In Columns (1) to (3) of Table D.5, we additionally control for heterogeneous effects by taste for unhealthy food. The interaction of the tax dummy with high self-control has a similar magnitude and is still significant. In Columns (4) to (6), we add the triple interaction with self-reported nutritional knowledge. Again, the magnitude of the interaction of the tax with self-control remains of a similar, but slightly smaller, magnitude. While the general pattern maintains, the results appear slightly more noisy than in the case of soft drinks. This could be explained by stronger controversies about the health effects of saturated fat (see the summary of the discussion in Denmark by Vallgårda *et al.* (2015)).

In sum, we find evidence supporting the findings of the soft drink tax analysis. Also in response to the fat tax, consumers with low self-control respond less to increasing prices. This difference is primarily driven by consumers with high income. When the tax is repealed, consumers with high and low self-control increase their purchases just as much.

Table 7: Correlations of self-control with habit and addiction

	(1) "I am addicted to sugar"	(2) "I am addicted to fat"	(3) "Hard to establish healthy eating habits"
Low self-control	0.098***	0.066***	0.177***
	(0.026)	(0.020)	(0.026)
Controls	Yes	Yes	Yes
Mean	0.297	0.131	0.287
Households	1197	1197	1197

Notes: The dependent variable in each column is the fraction of panelists in the GfK ConsumerTracking panel who answer "Somewhat agree" or "Totally agree" to the respective statement. The regressions control for income, age, education, labor market status, and number of children. The complete statement in Column (3) is "I find it harder to establish healthy eating habits than it is to establish unhealthy eating habits". Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6 Price Responsiveness in a Model of Habit Formation

In the empirical analysis, we document an asymmetry in responses to tax increases and decreases depending on self-control. This asymmetry is hard to reconcile with standard models since price elasticities are typically symmetric to prices going up or down. In the following, we show that the asymmetry is to be expected when taking into account habit formation (Becker and Murphy, 1988). Previous analysis of price responsiveness by self-control have ignored habit formation although there is evidence that many sin goods, as for example sugary soft drinks, are habituating (Zhen *et al.*, 2011) or have addictive properties (Ahmed *et al.*, 2013). Also in our dataset there is descriptive evidence that habit formation could play an important role for the differential responsiveness: Table 7 shows that consumers with low self-control are more likely to agree to the statement that they are addicted to sugar or fat and that they find it harder to establish healthy eating habits than unhealthy eating habits.

In the following, we derive results about the price responsiveness by self-control when rational habit formation is taken into account. In such a model, habit formation and addiction can be used interchangeably since they rest on the same mechanism: Consumption today increases the utility from consumption in the future due to intertemporal complementarities. If an individual is aware of this property and takes it into account, we call it rational habit formation. The model of rational habit formation is based on the exposition in O'Donoghue and Rabin (2001). From here on, we adopt their approach to model the discrete choice of an agent to either engage in a habit-forming activity or not (i.e. an individual can consume or abstain). However, unlike in that paper, we introduce heterogeneity in self-control and focus on differential responses to tax variation by self-control.

Agents get utility in each period $t = (1, ..., T)$ with $T \to \infty$ from either consuming a sin good ($a_t = 1$) or abstaining ($a_t = 0$). By consuming the sin good they build up a habit stock k that evolves according to

$$k_t = \gamma k_{t-1} + a_{t-1}. \tag{5}$$

The habit stock in period t depends on the stock in the previous period, which decays with $\gamma \in [0, 1)$ and replenishes if the agents have consumed in the previous period (Becker and Murphy, 1988). The instantaneous utility of consumption is given by

$$u_t(a_t, k_t) = \begin{cases} v_t - p_t - c(k_t) & \text{if } a_t = 1 \\ -c(k_t) - g(k_t) & \text{if } a_t = 0 \end{cases} \tag{6}$$

and depends on an exogenous preference for the sin good v_t, the level of habituation k_t, and the price p_t. Consuming sin goods is associated with a negative internality ($c(k_t) > 0$), i.e. having consumed sin goods in the past has a negative effect on utility today. The internality costs of past consumption are incurred irrespective of today's consumption as, for example, the adverse health effects of being obese. For simplicity, we assume the internality costs to be linearly increasing in k with $c'(k_t) > 0$ and $c''(k_t) = 0$. Moreover, quitting consumption is associated with withdrawal costs ($g(k_t) > 0$), which are higher the more habituated an agent is, i.e. consumption is habit-forming. We assume that the withdrawal costs increase with the habit level ($g'(k_t) > 0$) and are weakly convex ($g''(k_t) \geq 0$).

In this model, v_t is exogenously given and assumed to be constant over time: $v_t = (\bar{v}, ...)$. The price p_t can be changed by the policy-maker by changing the tax rate but the individual takes p_t as given and assumes that it will not change in the future. In contrast, k_t depends on past decisions. Forward-looking agents anticipate that their current decisions will impact their future utility and will maximize for all periods s in $t, t+1, ..., T$ with $T = \infty$:

$$U_t(a, k_t) = \begin{cases} u_t(a_t, k_t) + \beta \sum_{\tau=t+1}^{T} \delta^{\tau-t} u_\tau(a_\tau, \overbrace{\gamma k_{\tau-1} + 1}^{k_\tau}) & \text{if } a_t = 1 \\ u_t(a_t, k_t) + \beta \sum_{\tau=t+1}^{T} \delta^{\tau-t} u_\tau(a_\tau, \gamma k_{\tau-1}) & \text{if } a_t = 0 \end{cases} \tag{7}$$

where in the first case the consumer decides to consume and in the second case to abstain in period t. We assume that consumers follow the strategy to either consume forever or to abstain forever. The reason is that if consumption is habit-forming (if $g(k_t) > 0$), it becomes harder to quit tomorrow compared to today. Hence, a consumer who decides to quit would

rather quit today than at some point in the future.[15] An agent who consumes will eventually reach the steady-state habit stock $k^{max} \equiv \sum_{t=1}^{\infty} \gamma^{t-1} = \frac{1}{1-\gamma}$, while an individual who abstains approaches $k^{min} = 0$. In the following, we consider the case of naïve present-biased consumers, i.e. the consumers are not aware of their present-bias problem and believe they will behave as time-consistent individuals from the next period on.[16]

Assume consumers differ in their initial habit level k_{ti} and in their self-control β_i. Their initial habit level k_{ti} is independently drawn from a distribution that is characterized by a function K and their self-control β_i is independently drawn from a distribution F. Both K and F are continuous and have strictly positive density over their support $\beta \in (0, 1]$ and $k_t \in [0, k^{max}]$, respectively. Given their habit level k_{ti} and self-control β_i, a consumer would decide to consume if the utility from consumption starting today (i.e. $a_t = 1$ for all periods) exceeds the utility from abstaining starting today (i.e. $a_t = 0$ for all periods) :

$$(8) \quad \bar{v} - p_t - c(k_{ti}) + \beta_i \sum_{\tau=t+1}^{\infty} \delta^{\tau-t}[\bar{v} - p_\tau - c(\sum_{n=1}^{\tau-t} \gamma^{n-1} + \gamma^{\tau-t} k_{ti})] \geq -c(k_{ti}) - g(k_{ti}) + \beta_i \sum_{\tau=t+1}^{\infty} \delta^{\tau-t}[-c(\gamma^{\tau-t} k_{ti}) - g(\gamma^{\tau-t} k_{ti})]$$

Intuitively, an individual consumes the sin good if the utility from consumption, less the price and the internality costs in the current and all discounted future periods, are weakly larger than the internality and withdrawal costs incurred in this and the following periods due to the current level of k_{ti}.

We ensure a cut-off equilibrium in the sense that, for all k_{ti}, every individual (weakly) above a certain threshold ($\beta_i \geq \tilde{\beta}$) consumes the sin good ($a = 1$) and below the threshold ($\beta_i < \tilde{\beta}$) does not ($a = 0$). Formally, this threshold is defined by equation (8) with equality, or equivalently, by

$$(9) \quad \tilde{\beta} = -\frac{\bar{v} - p_t + g(k_t)}{\sum_{\tau=t+1}^{\infty} \delta^{\tau-t}[\bar{v} - p_\tau - c(\sum_{n=1}^{\tau-t} \gamma^{n-1}) + g(\gamma^{\tau-t} k_t)]}.$$

[15] O'Donoghue and Rabin (2001) show that for stationary preferences this is indeed the only perception-perfect strategy for time-consistent individuals with $\beta = 1$. For consumers with imperfect self-control ($\beta < 1$) there is another perception-perfect strategy where they plan to consume once and abstain thereafter (although they will not actually stop consuming). However, in this context, we do not consider the latter strategy.

[16] Naïve present-bias is a reasonable assumption for consuming soft-drinks as there is no effective commitment device that a sophisticated consumer could employ. See Gottlieb (2008) for a discussion.

While the numerator in (9) describes the utility from consumption in the current period and is positive, the denominator describes the utility from consumption in all future periods and is negative.[17] Define the utility from future consumption by Ψ.

To investigate how the cut-off type changes with the price, we differentiate (9) with respect to the price:

$$\frac{\partial \tilde{\beta}}{\partial p} = \frac{1 + \frac{\delta}{1-\delta}\tilde{\beta}}{\Psi} < 0 \tag{10}$$

The higher the price is, the lower is the level of self-control, below which an individual finds it still worthwhile to consume. The reason is that an increasing price decreases utility from consumption today and in all future periods. Hence, we expect a tax hike to decrease consumption and a tax cut to increase consumption.

In the following, we focus on the question whether consumers with high and low levels of self-control are more likely to respond to price changes. Therefore, we differentiate (10) with respect to $\tilde{\beta}$:

$$\frac{\partial^2 \tilde{\beta}}{\partial p \partial \tilde{\beta}} = \frac{\frac{\delta}{1-\delta}}{\Psi} < 0 \tag{11}$$

The higher the self-control, the more negative is the price responsiveness. The reason is that individuals with high self-control take the future price change more into account. Hence, we predict that consumers with high self-control respond more to taxes than consumers with low self-control.

Result 1. *Consumers with high self-control are more likely to react to price changes than consumers with low self-control.*

Next, we are interested in the question if consumers react symmetrically to a tax hike and a subsequent tax cut. Here, we have to take into account that the habit stock k_t changes from one period to the next. Since we expect more consumers with a high level of self-control to respond to a tax hike, there are more high self-control consumers whose habit stock decreases.

[17] Define the cut-off implicitly by $J(k_t, \tilde{\beta}) = \bar{v} - p_t + g(k_t) + \tilde{\beta} \sum_{\tau=t+1}^{\infty} \delta^{\tau-t}[\bar{v} - p_\tau - c(\sum_{n=1}^{\tau-t} \gamma^{n-1}) + g(\gamma^{\tau-t} k_t)]$. To ensure existence and uniqueness, we assume that for every k_t, an individual with $\beta \to 0$ consumes the sin good ($J(k_t, \beta) > 0$) and an individual with $\beta = 1$ does not ($J(k_t, \beta) < 0$). If $J(k_t, \beta)$ is monotonically falling in β, the cutoff $\tilde{\beta}$ exists and is unique. We know that this is fulfilled since the denominator in (9) is negative. The proof is by contradiction: Suppose not. Since $\beta \in (0, 1]$, we know that either the numerator or denominator is positive while the other is negative. If the assumption was true, the numerator would be negative and the denominator positive. But since $\gamma \in [0, 1)$, every individual summand in the denominator is smaller than the numerator. However, then the numerator cannot be negative while the denominator is positive, which contradicts the assumption.

In order to make predictions if the response to a tax cut is symmetric, we have to evaluate how the price responsiveness depends on the habit stock.

Therefore, we differentiate (10) with respect to k_t:

$$\frac{\partial^2 \tilde{\beta}}{\partial p \partial k_t} = -\frac{(2\delta\beta + (1-\delta)) \sum_{\tau=t+1}^{\infty} (\delta\gamma)^{\tau-t} g'(\gamma^{\tau-t} k_t) + \delta g'(k_t)}{(1-\delta)\Psi^2} < 0 \tag{12}$$

The derivative is negative. Hence, the lower the habit stock, the less negative is the price responsiveness. The intuition is as follows. Suppose an individual with $(\beta_i, k_{ti}) = (\tilde{\beta}, k_{ti})$ consumes. A tax is introduced that increases the price, leading the individual to stop consuming. Hence, the habit stock k_{ti} goes down. In the next period, the tax is repealed, leading the price to return to its original level. However, since the individual now has a lower habit stock, she no longer finds it appealing to resume consumption again. The described effect is more pronounced for individuals with high self-control since, according to Prediction 1, we expect them to respond more strongly to the tax hike.

Result 2. *The difference in price responsiveness between low and high self-control is smaller when a tax cut follows a tax hike.*

7 Conclusion

Both in the policy debate and in the economic literature it is argued that sin taxes can help consumers with low self-control to act more in accordance with their own long-run interest. However, this requires that consumers with low self-control respond to tax changes by reducing consumption. This paper presents evidence that consumers with low self-control respond systematically less to increasing soft drink and fat taxes than high self-control consumers. However, we find no difference between the groups when the tax is reduced, indicating that it is not just a difference in price elasticity between the groups. We show in a theoretical model that this pattern could be explained by (rational) habit formation, an aspect so far largely neglected in the literature. The idea is that consumers who buy, e.g., soft drinks establish a habit for it and know that they will be more likely to also purchase in the future. If the taxed good is habituating (which is reasonable for many sin goods), sin taxes of modest magnitude may be less effective than previously thought in correcting internalities.

Our results suggest that other policy measures may be required to help consumers with low self-control to act according to their long-run interest. It is worth to consider restrictions regarding the place and time when, e.g., sugar sweetened beverages can be sold, as we see in many countries for alcohol. Governments may also consider limiting the amount of sugar that beverages are allowed to contain or think about a ban on advertising sugary products.

It has to be noted that sin taxes can still correct externalities on public health, even if consumers with low self-control are not successfully targeted by these taxes. Sin taxes can make those consumers, who do not reduce their purchases, come up for the arising social costs of consumption. Furthermore, while consumers with low self-control may not respond to the price incentives themselves, smart sin tax design can still improve the diets of individuals with low self-control. If taxes are proportional to the harmful ingredient (e.g. sugar in soft drinks), producers are incentivized to make their product less unhealthy, as documented for the tiered soft drink tax in the UK (Public Health England, 2019). Since the Danish soft drink tax was volumetric, this incentive was not given. Moreover, taxes that increase the prices of the unhealthiest products the most, may invite consumers to substitute to less unhealthy alternatives (Grummon *et al.*, 2019).

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A Derivation of optimal sin tax

The following model closely follows O'Donoghue and Rabin (2003, 2006) and Haavio and Kotakorpi (2011) and derives the optimal tax formula in section 2.

An individual i in period t has intertemporal utility from consumption that is given by

$$U_t(u_1, ..., u_T) = u_t + \beta \sum_{\tau=t+1}^{T} \delta^{\tau-t} u_\tau \tag{13}$$

Each period she receives instantaneous utility u_t and future utility is discounted by time-consistent discount factor δ and by hyperbolic discounting factor β_i that differs between individuals. If $\beta_i < 1$, the agent has a preference for immediate gratification (low self-control) and if $\beta_i = 1$ the agent behaves time-consistent. For simplicity, we assume $\delta = 1$, i.e. there is no time-consistent discounting.

The instantaneous utility can be expressed as

$$u_t = v(x_t) - c(x_{t-1}) + z_t \tag{14}$$

and consists of the utility $v(\cdot)$ from consuming a sin good, e.g. soft-drinks, in the current period x_t, the health costs $c(\cdot)$ with $c'(\cdot) > 0$ from having consumed soft-drinks in the past x_{t-1} and utility from a numeraire good z_t. The price of soft-drinks is p while the price of the numeraire is normalized to one. Thus, the per-period budget constraint is $px_t + z_t = y$, where y is income.

Since decisions are independent from other periods, each period the agent chooses x such as to maximize $u(x^*) = v(x^*) - \beta_i c(x^*) + z$, which yields the first order condition $v'(x^*) - \beta_i c'(x^*) = p$. However, if the agent had perfect self-control she would maximize $u(x^o) = v(x^o) - c(x^o) + z$ and consume according to the first order condition $v'(x^o) - c'(x^o) = p$. It can immediately be seen that a present-biased consumer with $\beta < 1$ overconsumes soft-drinks compared to their long-run optimal consumption x^o. Assuming that taste for soft-drinks $v(x)$ is independent of self-control β, we can expect that consumers with low self-control ($\underline{\beta}$) consume on average more soft-drinks than consumers with high self-control ($\bar{\beta}$) since they underweigh the costs.

A social planner may now decide to impose a tax t on soft-drinks in order to correct for the internality that is due to the low self-control. The social planner redistributes the tax revenues lump-sum back to consumers and the individual budget constraint becomes $(p + t)x_t + z_t = y + t\bar{x}$ where $\bar{x}$ is the average soft-drink consumption in the economy. The tax is chosen such as to maximize the social welfare function

$$\Omega(t) = \sum_i [v(x_i) - c(x_i) + (y + t\bar{x} - (p+t)x_i)] \tag{15}$$

which is the sum of individual long-run utility of all individuals. Solving for the first order condition yields

$$\frac{\partial \Omega(t)}{\partial t} = \sum_i [(v'(x_i) - c'(x_i) - (p+t))\frac{\partial x_i}{\partial t}] + Nt\frac{\partial \bar{x}}{\partial t} = 0 \tag{16}$$

where $\frac{\partial \bar{x}}{\partial t}$ is the average response in soft-drink consumption due to the tax change. Inserting the demand condition that allows for imperfect self-control $v'(x^*) - \beta c'(x^*) = p + t$ and rearranging gives (similar to Haavio and Kotakorpi, 2011):

$$t = \frac{1}{N}\sum_i (1 - \beta_i)c'(x_i) + \frac{\text{cov}((1-\beta)c'(x), \frac{\partial x}{\partial t})}{\partial \bar{x}/\partial t}. \tag{17}$$

B Factor structure of self-control scale

In order to extract the latent dimension of self-control that matters for food choices, we perform a principal component factor analysis. Following the original study by Tangney *et al.* (2004), we extract five factors. In Table B.1, we show the rotated factor loadings of the five factors. The first factor (13.4 percent of the variance) measures a general capacity for self-discipline and loads high on a variety of factors, e.g. "I blurt out whatever is on my mind" (0.647). The second factor (9.1 percent of the variance) is related to healthy habits and resistance against temptations. It has the highest loadings on "I eat healthy food" (0.712), "I have many healthy habits" (0.708), "I am resistant against temptations" (0.644), and "I have a hard time breaking bad habits" (0.608). The third factor (7.4 percent of the variance) is related to reliability, e.g. it has the highest loading on "I am always on time" (0.738). The fourth factor (6.6 percent of the variance) relates to self-restraint and has the highest loading on "I am self-indulgent at times" (0.620). The fifth factor (4.0 percent of the variance) describes being impulsive and loads highest on "People would describe me as impulsive" (0.552). Thus, the factor structure is very similar to that of Tangney *et al.* (2004).

Table B.1: Rotated factor loadings after principal component factor analysis (varimax), N=2,387

	Factor1	Factor2	Factor3	Factor4	Factor5
I am good at resisting temptations	.213	.644	.109	.022	.051
(R) I have a hard time breaking bad habits	.298	.608	.004	.068	- .224
(R) I am lazy	.273	.439	.286	.135	- .299
(R) I often say inappropriate things	.551	.129	.130	.030	- .003
I never allow myself to lose control	- .150	.005	.111	-.152	.533
(R) I do certain things that are bad for me, if they are fun	.205	.231	.055	.539	.036
(R) Getting up in the morning is hard for me	.292	.173	.306	.084	- .405
(R) I have trouble saying no	.476	.234	.029	-.057	- .218
(R) I change my mind fairly often	.586	.104	.159	.008	- .154
(R) I blurt out whatever is on my mind	.647	.057	- .011	.063	.105
I refuse things that are bad for me	.114	.347	.152	-.284	.254
(R) I spend too much money	.340	.367	.177	.307	- .024
I keep everything neat	.082	.258	.512	.005	.088
(R) I am self-indulgent at times	.074	.029	- .024	.620	- .030
(R) I wish I had more self-discipline	.472	.459	.130	.054	- .142
I am reliable	.087	.058	.468	-.343	.306
(R) I get carried away by my feelings	.557	.134	-.062	.151	.043
(R) I do many things on the spur of the moment	.330	-.054	- .054	.450	.190
(R) I don't keep secrets very well	.470	-.041	.215	.045	- .040
(R) I have worked or studied all night at the last minute	.349	.097	.410	.300	-.208
I'm not easily discouraged	.258	.293	.245	-.514	.014
(R) I'd be better off if I stopped thinking before acting	.527	-.007	.128	.0367	.064
(R) Pleasure and fun sometimes keep me from getting work done	.338	.104	.314	.399	.003
(R) I have trouble concentrating	.550	.178	.229	-.076	-.253
I am able to work effectively toward long-term goals	.170	.305	.325	-.408	.122
(R) Sometimes I can't stop myself from doing something, even if I know it is wrong	.433	.316	.119	.407	.047
(R) I often act without thinking through all the alternatives	.575	.198	.106	.186	.220
(R) I lose my temper too easily	.537	.049	- .042	.001	.029
(R) I often interrupt people	.597	.062	.013	.071	- .027
I am always on time	.010	-.031	.737	-.011	-.043
People can count on me to keep the schedule	.048	.072	.719	-.014	- .042
(R) People would describe me as impulsive	.232	-.101	- .050	.307	.552
People would say that I have an iron self-discipline	.157	.397	.448	-.157	.083
I have many healthy habits	- .054	.708	.018	-.061	.021
I eat healthy foods	- .013	.712	.026	.007	- .015
(R) I sometimes drink too much alcohol	.085	.122	.139	.210	.188

Notes: (R) indicates that the item is reverse coded.

Table B.2: Correlations of self-control factors with characteristics and attitudes

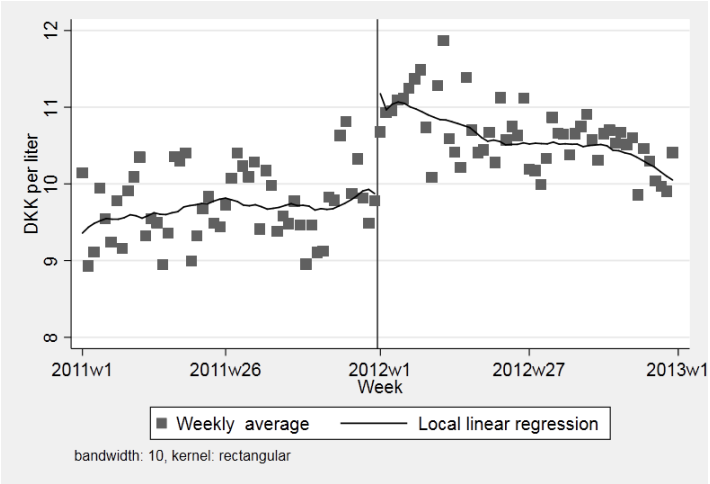
	(1) Body Mass Index (BMI)	(2) Obesity (BMI>30)	(3) Intention to reduce weight	(4) "I should eat less sugar"	(5) "I should eat less animal fat"
Low SC (Factor 1)	0.494*	0.032	0.089***	0.085***	0.057**
	(0.283)	(0.021)	(0.028)	(0.029)	(0.028)
Low SC (Factor 2)	2.124***	0.094***	0.202***	0.112***	0.115***
	(0.269)	(0.021)	(0.028)	(0.029)	(0.028)
Low SC (Factor 3)	0.453	0.026	0.021	-0.009	0.011
	(0.283)	(0.021)	(0.028)	(0.029)	(0.028)
Low SC (Factor 4)	0.727**	0.035	0.018	0.034	0.025
	(0.287)	(0.022)	(0.029)	(0.029)	(0.028)
Low SC (Factor 5)	0.175	-0.002	0.000	-0.063**	0.012
	(0.288)	(0.022)	(0.028)	(0.029)	(0.028)
Controls	Yes	Yes	Yes	Yes	Yes
Mean	26.021	0.175	0.620	0.483	0.354
Households	1237	1236	1197	1197	1197

Notes: Columns (1) and (2) are based on weight and height data from 2011. BMI is calculated as ([weight in kg]/[height in m]^2). Column (3) shows the fraction of respondents who indicate in the 2013 survey that they would like to weigh at least 1 kg less. Column (4) and (5) gives the fraction of respondents who indicate that they should eat "A lot less" or "A little less" sugar or animal fat to eat healthier. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

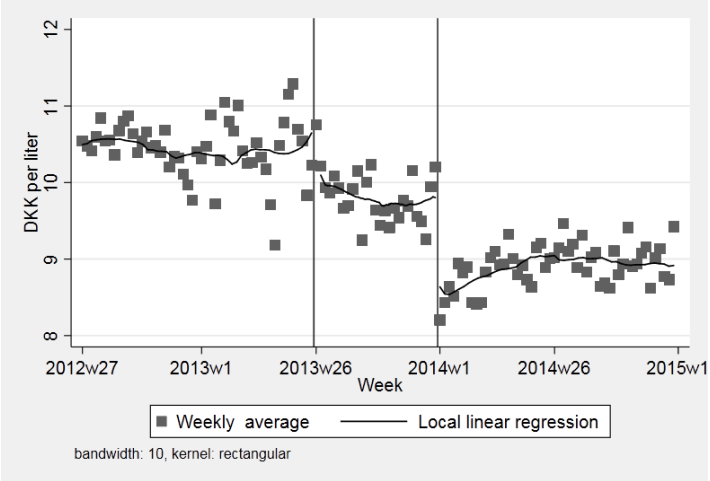
C Soft Drink Tax

C.1 Pass-through of soft drink tax to prices

Figure C.1: Average price residuals over time (Graph from Schmacker and Smed (2019))



(a) Tax increase



(b) Tax repeal

Notes: Graph shows soft drink prices around the tax increase in January 2012 and the tax cuts in July 2013 and January 2014. The graph plots residuals that are added to the sample mean after regressing prices on product fixed effects. Dots represent weekly averages and the lines local polynomials (triangular weights and 16 weeks bandwidth). The vertical lines indicate the timing of tax changes.

Table C.1: Soft drink purchases in response to placebo tax changes by self-control

	(1) Quantity	(2) Quantity	(3) Quantity	(4) Quantity
Tax Placebo	-3.314	1.428	0.870	-2.683
	(6.069)	(6.006)	(6.015)	(5.774)
High self-control × Tax Placebo	-0.193	0.076	6.217	5.313
	(8.107)	(8.100)	(8.116)	(8.024)
Households	1171	1171	1260	1260
Household Months	20674	20674	21622	21622
Placebo	January 2010	January 2010	January 2011	January 2011
Controls	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: Table shows OLS regression results with standard errors clustered on household level. The dependent variable is monthly quantity in centiliter per household member. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C.2 Robustness of soft drink tax estimations

Table C.2: Soft drink purchases in response to soft drink tax changes controlling for income and education

	(1)	(2)	(3)	(4)	(5)	(6)
		Extensive	Intensive		Extensive	Intensive
	Quantity	Margin	Margin	Quantity	Margin	Margin
Panel A: Tax Hike						
Tax Hike	-2.137	-0.013	0.014	-0.713	-0.020	0.012
	(10.629)	(0.015)	(0.059)	(9.438)	(0.013)	(0.054)
Interactions with Tax hike						
High self-control	-25.081*	-0.048**	-0.137*	-25.918**	-0.030*	-0.105
	(13.058)	(0.020)	(0.077)	(12.392)	(0.017)	(0.074)
High Income	-0.600	-0.009	-0.031			
	(14.557)	(0.021)	(0.087)			
High self-control × High income	8.170	0.034	0.111			
	(18.305)	(0.028)	(0.116)			
High education				-3.465	0.009	-0.052
				(13.012)	(0.021)	(0.081)
High self-control × High education				11.929	-0.002	0.094
				(16.700)	(0.027)	(0.117)
Panel B: Tax Repeal						
Tax Repeal	30.456***	0.039**	0.110*	39.494***	0.059***	0.111**
	(11.268)	(0.015)	(0.056)	(9.641)	(0.013)	(0.046)
Interactions with Tax repeal						
High self-control	0.050	0.010	0.012	-16.417	-0.022	0.019
	(13.026)	(0.021)	(0.075)	(12.000)	(0.017)	(0.063)
High Income	2.826	0.013	0.081			
	(14.326)	(0.020)	(0.073)			
High self-control × High income	-6.955	-0.016	-0.058			
	(17.772)	(0.027)	(0.101)			
High education				-20.416	-0.036	0.116
				(14.251)	(0.022)	(0.078)
High self-control × High education				31.851*	0.059**	-0.101
				(17.923)	(0.028)	(0.105)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Table shows OLS regression results with standard errors clustered on household level. In columns (1) and (4) the dependent variable is monthly quantity in centiliter per household member. In columns (2) and (5) it is purchase incidence in a given month. In columns (3) and (6) it is log-transformed quantity. In Panel A, we run the estimations with 1,278 households (22,197 household months) and for the intensive margin estimations with 1,104 households (7,466 household months). In Panel B, we use 1,278 households (22,747 households months) and for the intensive margin estimations with 1,122 households (7,782 household months). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.3: Soft drink purchases in response to soft drink tax changes controlling for tastes and knowledge

	(1)	(2)	(3)	(4)	(5)	(6)
		Extensive	Intensive		Extensive	Intensive
	Quantity	Margin	Margin	Quantity	Margin	Margin
Panel A: Tax Hike						
Tax Hike	-7.406	-0.011	-0.078	-0.844	-0.015	-0.008
	(10.614)	(0.014)	(0.064)	(7.848)	(0.011)	(0.049)
Interactions with Tax hike						
High self-control	-20.837*	-0.049***	-0.039	-20.808**	-0.030**	-0.049
	(12.142)	(0.017)	(0.078)	(9.501)	(0.015)	(0.060)
Unhealthy taste	11.563	-0.004	0.140*			
	(13.407)	(0.020)	(0.081)			
High self-control × Unhealthy taste	3.628	0.046	-0.007			
	(17.467)	(0.028)	(0.106)			
Lacks knowledge				-2.934	0.008	0.027
				(14.955)	(0.024)	(0.088)
High self-control × Lacks knowledge				-11.094	-0.021	-0.129
				(21.548)	(0.037)	(0.158)
Panel B: Tax Repeal						
Tax Repeal	38.873***	0.046***	0.167***	31.241***	0.039***	0.147***
	(11.005)	(0.015)	(0.057)	(8.869)	(0.013)	(0.044)
Interactions with Tax repeal						
High self-control	-8.093	-0.001	0.008	-3.169	0.014	-0.014
	(12.895)	(0.018)	(0.070)	(10.433)	(0.015)	(0.056)
Unhealthy taste	-15.041	0.003	-0.054			
	(14.391)	(0.021)	(0.074)			
High self-control × Unhealthy taste	7.356	0.009	-0.044			
	(17.733)	(0.029)	(0.103)			
Lacks knowledge				-0.787	0.041	-0.039
				(14.789)	(0.025)	(0.092)
High self-control × Lacks knowledge				1.285	-0.071*	0.107
				(20.489)	(0.039)	(0.139)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Table shows OLS regression results with standard errors clustered on household level. In columns (1) and (4) the dependent variable is monthly quantity in centiliter per household member. In columns (2) and (5) it is purchase incidence in a given month. In columns (3) and (6) it is log-transformed quantity. "Unhealthy taste" identifies consumers that agree to the statement "I believe I would make healthier food choices if unhealthy food was less tasty", "Lacks knowledge" identifies consumers who agree to the statement "I believe I would make healthier food choices if I had more information on how to eat healthy". In Panel A, we run the estimations with 1,197 households (20,887 household months) and for the intensive margin estimations with 1,033 households (6,956 household months). In Panel B, we use 1,197 households (21,389 households months) and for the intensive margin estimations with 1,050 households (7,291 household months). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.4: Soft drink purchases in response to soft drink tax changes, only single households

	(1)	(2)	(3)
		Extensive	Intensive
	Quantity	Margin	Margin
Panel A: Tax Hike			
Tax Hike	7.997	0.003	0.044
	(11.441)	(0.016)	(0.069)
High self-control × Tax Hike	-36.567**	-0.051**	-0.112
	(14.804)	(0.021)	(0.085)
Panel B: Tax Repeal			
Tax Repeal	39.102***	0.041**	0.104*
	(14.230)	(0.018)	(0.062)
High self-control × Tax Repeal	-10.256	0.003	0.027
	(15.831)	(0.023)	(0.084)
Sample	Single HH	Single HH	Single HH
Controls	Yes	Yes	Yes
Household FE	Yes	Yes	Yes

Notes: Table shows OLS regression results with standard errors clustered on household level. In columns (1)the dependent variable is monthly quantity in centiliter per household member. In columns (2) it is purchase incidence in a given month. In columns (3) it is log-transformed quantity. In Panel A, we run the estimations with 467 households (7,893 household months) and for the intensive margin estimations with 391 households (2,466 household months). In Panel B, we use 467 households (8,064 households months) and for the intensive margin estimations with 394 households (2,523 household months). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.5: Soft drink purchases in response to soft drink tax by self-control (sample split by quartiles)

	(1) Overall	(2) Ext. Margin	(3) Int. Margin
Panel A: Tax Hike			
Tax Hike	6.060	-0.011	0.048
	(10.040)	(0.014)	(0.056)
Interactions with Tax Hike			
Medium low self-control	-15.812	-0.010	-0.109
	(12.898)	(0.019)	(0.077)
Medium high self-control	-21.595*	-0.027	-0.059
	(12.514)	(0.019)	(0.073)
High self-control	-36.275***	-0.043**	-0.195***
	(11.892)	(0.018)	(0.073)
Panel B: Tax Repeal			
Tax repeal	42.986***	0.048***	0.206***
	(11.261)	(0.015)	(0.053)
Interactions with Tax Repeal			
Medium low self-control	-22.349	-0.004	-0.123*
	(13.927)	(0.020)	(0.072)
Medium high self-control	-16.593	0.003	-0.113*
	(13.211)	(0.019)	(0.068)
High self-control	-13.082	-0.003	-0.028
	(13.435)	(0.019)	(0.074)
Controls	Yes	Yes	Yes
Household FE	Yes	Yes	Yes

Notes: Table shows OLS regression results with standard errors clustered on household level. In Panel A, we run the estimations with 1,278 households (22,197 household months) and for the intensive margin estimations with 1,104 households (7,466 household months). In Panel B, we use 1,278 households (22,747 households months) and for the intensive margin estimations with 1,122 households (7,782 household months). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.6: Soft drink purchases in response to soft drink tax by access to German border

	(1) Quantity	(2) Extensive Margin	(3) Intensive Margin
Panel A: Tax Hike			
Tax Hike	1.422	-0.003	-0.002
	(10.445)	(0.015)	(0.065)
Interactions with Tax hike			
High self-control	-28.427**	-0.054***	-0.076
	(12.928)	(0.020)	(0.078)
No Toll	-5.651	-0.023	-0.000
	(13.239)	(0.020)	(0.078)
High self-control × No Toll	12.824	0.041	0.003
	(16.616)	(0.026)	(0.105)
Panel B: Tax Repeal			
Tax Repeal	28.108**	0.022	0.135**
	(12.482)	(0.017)	(0.056)
Interactions with Tax repeal			
High self-control	5.180	0.031	0.018
	(14.229)	(0.021)	(0.071)
No Toll	6.345	0.040*	0.028
	(14.592)	(0.021)	(0.073)
High self-control × No Toll	-15.402	-0.050*	-0.061
	(18.124)	(0.028)	(0.100)
Controls	Yes	Yes	Yes
Household FE	Yes	Yes	Yes

Notes: Table shows OLS regression results with standard errors clustered on household level. In columns (1) the dependent variable is monthly quantity in centiliter per household member. In columns (2) it is purchase incidence in a given month. In columns (3) it is log-transformed quantity. In Panel A, we run the estimations with 1,277 households (22,177 household months) and for the intensive margin estimations with 1,103 households (7,465 household months). In Panel B, we use 1,278 households (22,747 households months) and for the intensive margin estimations with 1,122 households (7,782 household months). While 730 households live in the "No Toll" region, 547 live in the "Toll" region. If a household has moved between "Toll" and "No toll", we use the region where they reported the most purchases. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

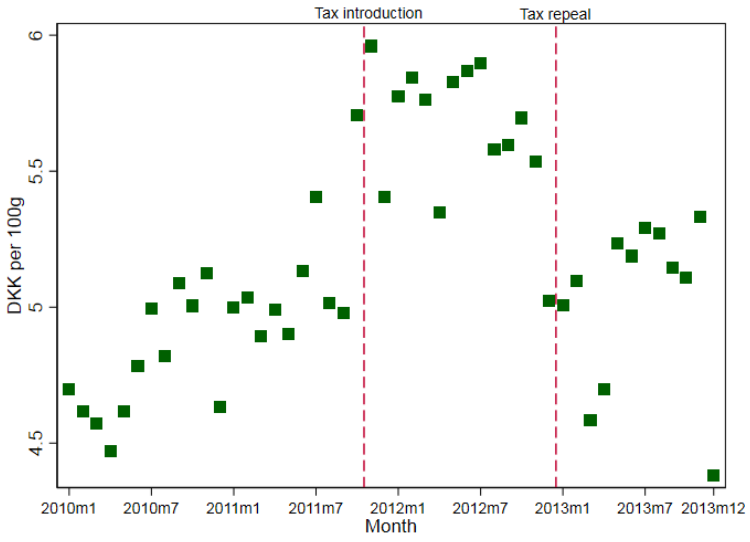
D Fat tax

D.1 Pass-through of fat taxes to butter prices

In this section, we aim to show that the fat tax indeed had an effect on the price of butter. Figure D.1 illustrates the development of prices around the fat tax introduction and repeal. The graph plots residuals after controlling for product fixed effects in order to control for potentially changing purchasing patterns. It is clearly shown that during the time window when the fat tax was enacted, prices for butter were higher than before and after.

In Table D.1 we quantify the extent of the price changes by regressing absolute and log-transformed prices on a tax dummy while controlling for product fixed effects. Since we use a bandwidth of one year around the tax changes, the regression amounts to comparing the average prices one year before the tax change to one year after the tax change. We observe that prices per 100g of butter have increased by DKK 0.761 after the tax introduction and have decreased by DKK 0.611 after the tax repeal. Hence, the magnitude of price changes is indeed very similar for the tax introduction and the repeal.

Figure D.1: Average price residuals (controlling for product fixed effects) over time added to the sample mean



Notes: Graph shows butter prices around the tax increase in January 2012 and the tax cuts in July 2013 and January 2014. The graph plots residuals that are added to the sample mean after regressing prices on product fixed effects. Dots represent monthly averages. The vertical lines indicate the timing of tax changes.

Table D.1: Butter prices in response to tax changes

	Tax introduction		Tax repeal	
	(1)	(2)	(3)	(4)
	Absolute price	Log price	Absolute price	Log price
Tax change	0.761***	0.151***	-0.611***	-0.124***
	(0.042)	(0.010)	(0.051)	(0.009)
Constant	4.905***	1.546***	5.758***	1.710***
	(0.022)	(0.005)	(0.026)	(0.005)
EAN fixed effects	Yes	Yes	Yes	Yes
n	52198	52198	59123	59123

Standard errors clustered on EAN level in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

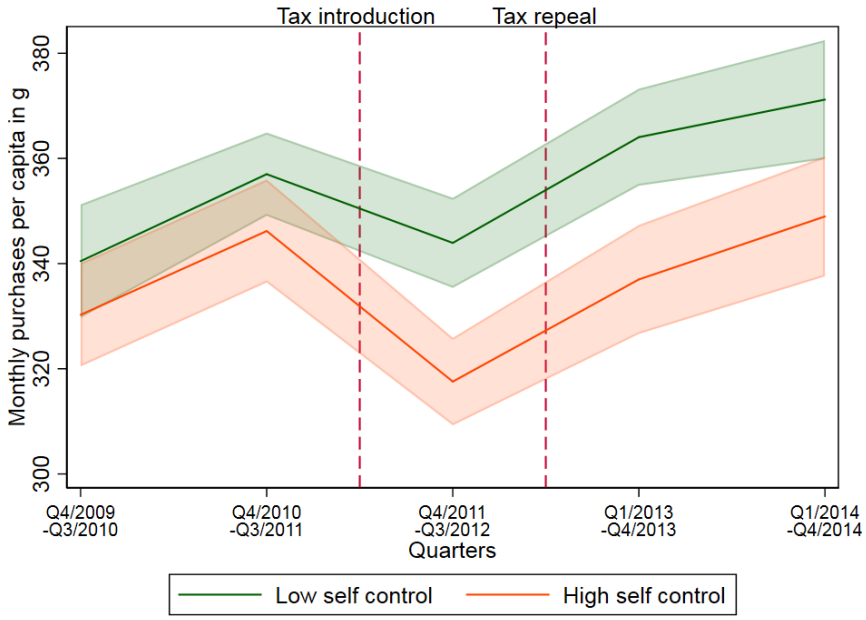
D.2 Robustness of fat tax responsiveness to sample window

Table D.2: Butter purchases in response to placebo tax changes by self-control

	(1) Quantity	(2) Quantity	(3) Quantity	(4) Quantity
Tax Placebo	16.743***	16.169***	-2.208	-3.170
	(5.969)	(5.908)	(6.040)	(6.031)
High self-control × Tax Placebo	-0.011	-0.255	1.846	2.813
	(8.250)	(8.202)	(8.000)	(7.951)
Households	1284	1284	1217	1217
Household Months	26139	26139	25355	25355
Placebo	January 2010	January 2010	October 2010	October 2010
Controls	No	Yes	No	Yes
Household FE	Yes	Yes	Yes	Yes

Notes: Table shows OLS regression results with standard errors clustered on household level. The dependent variable is monthly quantity in gram per household member. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure D.2: Predicted values of monthly butter purchase quantity by self-control



Notes: Graph shows predicted values after controlling for household fixed effects and the control variables specified in the methods section. Household quantities are individualized by dividing the observed household quantity by the number of household members (children aged 0 to 6 enter as 0.5 household members). The shaded areas represent 95% confidence intervals. The vertical lines indicate the timing of tax changes.

D.3 Robustness of fat tax estimations

Table D.3: Butter purchases in response to fat tax changes controlling for education

	(1) Quantity	(2) Extensive Margin	(3) Intensive Margin
Panel A: Tax introduction			
Tax introduction	-7.851	-0.015	-0.020
	(7.924)	(0.010)	(0.018)
Interactions with Tax introduction			
High self-control	-24.008**	-0.033**	-0.017
	(11.058)	(0.014)	(0.025)
High Income			
High self-control × High income			
High education	-9.217	-0.009	-0.014
	(12.376)	(0.016)	(0.029)
High self-control × High education	19.480	0.025	0.025
	(17.276)	(0.023)	(0.040)
Panel B: Tax Repeal			
Tax Repeal	15.202*	0.025**	0.031
	(8.571)	(0.010)	(0.020)
Interactions with Tax repeal			
High self-control	-8.504	-0.018	-0.009
	(11.790)	(0.014)	(0.028)
High Income			
High self-control × High income			
High education	-13.290	-0.022	-0.011
	(13.680)	(0.016)	(0.031)
High self-control × High education	14.863	0.047**	-0.007
	(18.408)	(0.022)	(0.044)
Controls	Yes	Yes	Yes
Household FE	Yes	Yes	Yes

Notes: Table shows OLS regression results with standard errors clustered on household level. In columns (1) the dependent variable is monthly quantity in gram per household member. In columns (2) it is purchase incidence in a given month. In columns (3) it is log-transformed quantity. In Panel A, we run the estimations with 1,324 households (27,192 household months) and for the intensive margin estimations with 1,291 households (17,056 household months). In Panel B, we use 1,323 households (27,507 households months) and for the intensive margin estimations with 1,298 households (17,460 household months). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table D.4: Butter purchases in response to fat tax changes using the subsample of low and high income households

	(1)	(2)	(3)	(4)	(5)	(6)
		Extensive	Intensive		Extensive	Intensive
	Quantity	Margin	Margin	Quantity	Margin	Margin
Panel A: Tax Introduction						
Tax Introduction	-12.755	-0.016	-0.032	8.020	-0.008	0.004
	(9.801)	(0.012)	(0.021)	(8.614)	(0.012)	(0.020)
High self-control × Tax	-5.068	-0.009	0.009	-28.953**	-0.034**	-0.022
	(13.957)	(0.016)	(0.030)	(11.707)	(0.016)	(0.027)
Households	739	739	706	815	815	794
n	12591	12591	7778	14601	14601	9278
Panel B: Tax Repeal						
Tax Repeal	18.219	0.041***	0.017	4.668	0.006	0.028
	(12.771)	(0.015)	(0.031)	(8.946)	(0.012)	(0.021)
High self-control × No Tax	-13.004	-0.019	-0.036	8.018	0.013	0.011
	(13.786)	(0.016)	(0.034)	(12.148)	(0.015)	(0.030)
Households	730	730	712	782	782	765
n	13087	13087	8217	14420	14420	9243
Income	Low	Low	Low	High	High	High
Controls	No	No	No	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Table shows OLS regression results with standard errors clustered on household level. The estimations are performed separately on the sample of low and high income households. Low income indicates that the household is below the median of equivalized annual income (i.e. DKK 265,000) and high income that the household is above the median. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table D.5: Butter purchases in response to fat tax changes controlling for tastes and knowledge

	(1)	(2)	(3)	(4)	(5)	(6)
		Extensive	Intensive		Extensive	Intensive
	Quantity	Margin	Margin	Quantity	Margin	Margin
Panel A: Tax Hike						
Tax Hike	-2.005	-0.007	-0.003	-9.469	-0.022**	-0.004
	(8.517)	(0.011)	(0.019)	(6.784)	(0.009)	(0.015)
Interactions with Tax hike						
High self-control	-22.875**	-0.030**	-0.034	-17.139*	-0.017	-0.032
	(11.498)	(0.015)	(0.026)	(9.370)	(0.012)	(0.021)
Unhealthy taste	-22.545*	-0.021	-0.054*			
	(11.948)	(0.016)	(0.028)			
High self-control × Unhealthy taste	17.582	0.016	0.060			
	(17.461)	(0.023)	(0.041)			
Lacks knowledge				-18.580	0.022	-0.129***
				(14.680)	(0.021)	(0.037)
High self-control × Lacks knowledge				19.031	-0.017	0.143**
				(24.507)	(0.030)	(0.057)
Panel B: Tax Repeal						
Tax Repeal	7.767	0.026**	0.008	12.167*	0.022**	0.028
	(9.355)	(0.011)	(0.023)	(7.331)	(0.009)	(0.018)
Interactions with Tax repeal						
High self-control	2.074	-0.010	0.021	-3.269	-0.004	-0.009
	(11.819)	(0.014)	(0.028)	(9.543)	(0.011)	(0.023)
Unhealthy taste	6.160	-0.014	0.038			
	(12.378)	(0.015)	(0.029)			
High self-control × Unhealthy taste	-15.572	0.019	-0.096**			
	(17.218)	(0.022)	(0.043)			
Lacks knowledge				-6.742	-0.014	-0.011
				(15.963)	(0.020)	(0.038)
High self-control × Lacks knowledge				-13.550	0.014	-0.076
				(23.328)	(0.030)	(0.056)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Table shows OLS regression results with standard errors clustered on household level. In columns (1) and (4) the dependent variable is monthly quantity in gram per household member. In columns (2) and (5) it is purchase incidence in a given month. In columns (3) and (6) it is log-transformed quantity. "Unhealthy taste" identifies consumers that agree to the statement "I believe I would make healthier food choices if uhealthy food was less tasty", "Lacks knowledge" identifies consumers who agree to the statement "I believe I would make healthier food choices if I had more information on how to eat healthy". In Panel A, we run the estimations with 1,241 households (25,602 household months) and for the intensive margin estimations with 1,211 households (16,019 household months). In Panel B, we use 1,241 households (25,914 households months) and for the intensive margin estimations with 1,220 households (16,418 household months). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

E Complete estimation tables

Table E.1: Soft drink purchases in response to soft drink tax hike by self-control

	(1)	(2)	(3)	(4)	(5)	(6)
		Extensive	Intensive		Extensive	Intensive
	Quantity	Margin	Margin	Quantity	Margin	Margin
Interaction of tax and self-control (Reference: Low self-control)						
Tax Hike	0.319	-0.014	0.022	-1.912	-0.016*	-0.002
	(6.543)	(0.010)	(0.040)	(6.559)	(0.010)	(0.041)
High SC × Tax Hike	-21.663***	-0.032**	-0.086	-21.097***	-0.030**	-0.075
	(8.198)	(0.013)	(0.054)	(8.134)	(0.013)	(0.052)
Equivalized HH income in DKK (Reference: <175K)						
175-250 DKK				16.556	0.028	0.023
				(15.061)	(0.021)	(0.078)
250-325 DKK				13.345	0.007	0.101
				(15.550)	(0.024)	(0.093)
325-400 DKK				13.420	0.001	0.053
				(17.779)	(0.029)	(0.116)
>500 DKK				12.521	-0.018	0.106
				(22.425)	(0.035)	(0.178)
Labor market status (Reference: Not employed)						
Full time				10.433	0.014	0.080
				(13.467)	(0.026)	(0.090)
Part time				31.778**	0.046**	0.152**
				(14.277)	(0.022)	(0.076)
Quarter Dummies (Reference: 1st Quarter)						
2nd Quarter				33.907***	0.049***	0.129**
				(7.880)	(0.014)	(0.053)
3rd Quarter				30.764***	0.043**	0.112
				(10.465)	(0.018)	(0.071)
4th Quarter				10.632*	-0.000	0.071
				(6.187)	(0.011)	(0.047)
Number of Kids (0-6)				-73.308***	-0.085	-0.276*
				(25.293)	(0.065)	(0.164)
Number of Kids (7-14)				-33.188***	-0.008	-0.284***
				(9.141)	(0.024)	(0.036)
Number of Kids (15-20)				-27.673	-0.025	-0.274
				(20.154)	(0.021)	(0.167)
Temperature				-0.771	-0.000	-0.005
				(0.717)	(0.001)	(0.005)
Constant	130.428***	0.351***	5.414***	102.136***	0.309***	5.359***
	(2.042)	(0.003)	(0.013)	(16.466)	(0.025)	(0.099)
Adj. R2	0.412	0.304	0.400	0.414	0.307	0.404
Households	1278	1278	1104	1278	1278	1104
n	22197	22197	7466	22197	22197	7466

Notes: Table shows OLS regression results with standard errors clustered on household level. ^{b} indicates that standard errors are bootstrapped with 400 replications. $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table E.2: Soft drink purchases in response to soft drink tax repeal by self-control

	(1)	(2)	(3)	(4)	(5)	(6)
		Extensive	Intensive		Extensive	Intensive
	Quantity	Margin	Margin	Quantity	Margin	Margin
Interaction of tax and self-control (Reference: Low self-control)						
Tax Repeal	28.512***	0.041***	0.127***	31.827***	0.046***	0.151***
	(6.967)	(0.010)	(0.036)	(7.351)	(0.011)	(0.039)
High SC × Tax Repeal	-3.667	0.001	-0.013	-3.613	0.002	-0.015
	(8.817)	(0.014)	(0.050)	(8.814)	(0.014)	(0.050)
Equivalized HH income in DKK (Reference: <175K)						
175-250 DKK				13.744	0.041**	0.122
				(10.516)	(0.020)	(0.082)
250-325 DKK				0.248	0.022	0.101
				(14.571)	(0.029)	(0.105)
325-400 DKK				15.547	-0.007	0.204*
				(16.058)	(0.035)	(0.115)
>500 DKK				19.576	-0.010	0.126
				(25.757)	(0.045)	(0.156)
Labor market status (Reference: Not employed)						
Full time				-4.105	0.022	-0.082
				(13.473)	(0.030)	(0.110)
Part time				11.221*	0.023*	0.081
				(6.785)	(0.013)	(0.049)
Quarter Dummies (Reference: 1st Quarter)						
2nd Quarter				31.387***	0.039***	0.161***
				(7.885)	(0.013)	(0.050)
3rd Quarter				41.412***	0.061***	0.209***
				(10.485)	(0.017)	(0.071)
4th Quarter				9.923	0.006	0.093**
				(6.834)	(0.012)	(0.047)
Number of Kids (0-6)				-14.869	0.008	-0.184
				(21.006)	(0.051)	(0.162)
Number of Kids (7-14)				-28.951	0.021	-0.203
				(20.351)	(0.044)	(0.150)
Number of Kids (15-20)				-17.614	0.028	-0.175
				(18.735)	(0.041)	(0.146)
Temperature				-0.712	-0.001	-0.007
				(0.679)	(0.001)	(0.005)
Constant	119.302***	0.322***	5.370***	96.388***	0.266***	5.274***
	(2.179)	(0.003)	(0.013)	(12.387)	(0.025)	(0.106)
Adj. R2	0.412	0.300	0.424	0.414	0.302	0.426
Households	1278	1278	1122	1278	1278	1122
n	22747	22747	7782	22747	22747	7782

Notes: Table shows OLS regression results with standard errors clustered on household level. ^{b} indicates that standard errors are bootstrapped with 400 replications. $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table E.3: Butter purchases in response to fat tax introduction by self-control

	(1)	(2)	(3)	(4)	(5)	(6)
		Extensive	Intensive		Extensive	Intensive
	Quantity	Margin	Margin	Quantity	Margin	Margin
Interaction of tax and self-control (Reference: Low self-control)						
Tax Introduction	-11.926**	-0.018**	-0.023*	-11.224*	-0.018**	-0.026*
	(5.908)	(0.008)	(0.014)	(5.974)	(0.008)	(0.014)
High SC × Tax Intro.	-15.692*	-0.022**	-0.007	-16.440**	-0.022**	-0.008
	(8.416)	(0.011)	(0.019)	(8.380)	(0.011)	(0.019)
Equivalized HH income in DKK (Reference: <175K)						
175-250 DKK				25.717**	0.018	0.061*
				(12.649)	(0.015)	(0.032)
250-325 DKK				29.178*	0.029	0.042
				(15.031)	(0.019)	(0.040)
325-400 DKK				55.229***	0.030	0.092**
				(17.658)	(0.023)	(0.047)
>500 DKK				39.027**	0.031	0.051
				(18.800)	(0.026)	(0.056)
Labor market status (Reference: Not employed)						
Full time				11.149	0.003	0.009
				(12.696)	(0.018)	(0.040)
Part time				-10.567	0.008	-0.045
				(12.260)	(0.016)	(0.032)
Quarter Dummies (Reference: 1st Quarter)						
2nd Quarter				20.119***	0.026***	0.010
				(5.412)	(0.007)	(0.013)
3rd Quarter				42.608***	0.046***	0.037***
				(5.267)	(0.007)	(0.013)
4th Quarter				61.383***	0.056***	0.097***
				(6.028)	(0.007)	(0.013)
Number of Kids (0-6)				-70.836***	-0.040	-0.329***
				(18.565)	(0.043)	(0.079)
Number of Kids (7-14)				-25.842**	-0.016	-0.181***
				(10.898)	(0.022)	(0.035)
Number of Kids (15-20)				-42.327*	-0.017	-0.229***
				(23.945)	(0.014)	(0.049)
Constant	349.137***	0.642***	6.002***	300.673***	0.591***	6.010***
	(2.136)	(0.003)	(0.005)	(14.135)	(0.019)	(0.040)
Adj. R2	0.384	0.275	0.481	0.387	0.277	0.485
Households	1324	1324	1291	1324	1324	1291
n	27192	27192	17056	27192	27192	17056

Notes: Table shows OLS regression results with standard errors clustered on household level. ^{b} indicates that standard errors are bootstrapped with 400 replications. $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table E.4: Butter purchases in response to fat tax repeal by self-control

	(1)	(2)	(3)	(4)	(5)	(6)
		Extensive	Intensive		Extensive	Intensive
	Quantity	Margin	Margin	Quantity	Margin	Margin
Interaction of tax and self-control (Reference: Low self-control)						
Tax Repeal	12.913**	0.018**	0.027*	10.208	0.017**	0.027*
	(5.996)	(0.007)	(0.014)	(6.562)	(0.008)	(0.016)
High SC × Tax Repeal	-0.183	0.002	-0.008	-2.291	0.002	-0.013
	(8.467)	(0.010)	(0.021)	(8.516)	(0.010)	(0.021)
Equivalized HH income in DKK (Reference: <175K)						
175-250 DKK				17.008	-0.015	0.045
				(15.686)	(0.015)	(0.037)
250-325 DKK				19.140	-0.005	0.037
				(18.439)	(0.019)	(0.046)
325-400 DKK				34.319	0.009	0.058
				(22.088)	(0.025)	(0.058)
>500 DKK				23.555	0.011	0.072
				(23.764)	(0.031)	(0.062)
Labor market status (Reference: Not employed)						
Full time				-15.677	0.002	-0.026
				(12.565)	(0.018)	(0.040)
Part time				-4.661	-0.003	0.012
				(8.514)	(0.010)	(0.020)
Quarter Dummies (Reference: 1st Quarter)						
2nd Quarter				-12.448**	0.002	-0.054***
				(5.647)	(0.007)	(0.013)
3rd Quarter				5.548	0.019***	-0.034***
				(5.477)	(0.007)	(0.013)
4th Quarter				71.547***	0.074***	0.090***
				(6.264)	(0.007)	(0.013)
Number of Kids (0-6)				-67.879***	0.025	-0.299***
				(19.330)	(0.030)	(0.089)
Number of Kids (7-14)				-78.071***	0.029	-0.288***
				(20.746)	(0.029)	(0.080)
Number of Kids (15-20)				-76.105***	0.016	-0.297***
				(19.532)	(0.029)	(0.067)
Constant	335.547***	0.625***	5.970***	329.519***	0.595***	6.024***
	(2.115)	(0.003)	(0.005)	(15.764)	(0.020)	(0.047)
Adj. R2	0.382	0.274	0.470	0.388	0.278	0.476
Households	1323	1323	1298	1323	1323	1298
n	27507	27507	17460	27507	27507	17460

Notes: Table shows OLS regression results with standard errors clustered on household level. ^{b} indicates that standard errors are bootstrapped with 400 replications. $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$