

Do sin taxes work?

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joint work with

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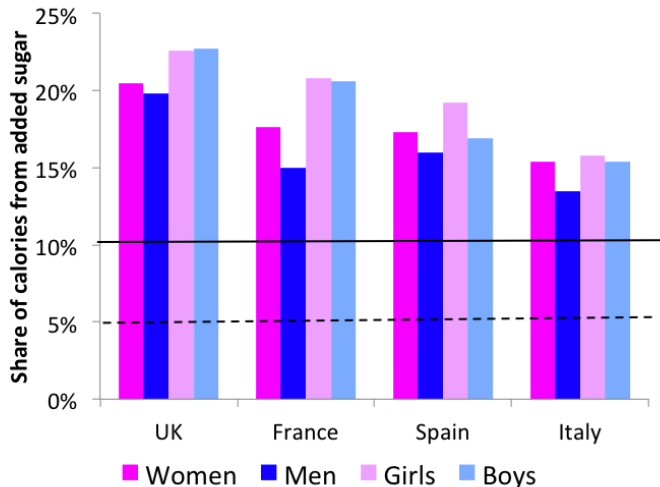
Corrective Taxes

- ▶ Corrective taxes have long been seen as a tool to improve social welfare when consumption imposes costs on others
 - ▶ externalities (Pigou, 1920)
 - ▶ taxes on fuel, alcohol, tobacco, gambling are examples
- ▶ More recently have been advocated to reduce consumption that imposes costs on your future self
 - ▶ **“internalities”**
 - ▶ Gruber and Koszegi, 2004; ODonoghue and Rabin, 2006; Haavio and Kotakorpi, 2011; Allcott, Mullainathan and Taubinsky, 2014, ...
- ▶ Soda (soft drinks, fizzy drinks) taxes are a leading example

Excess consumption of sugar

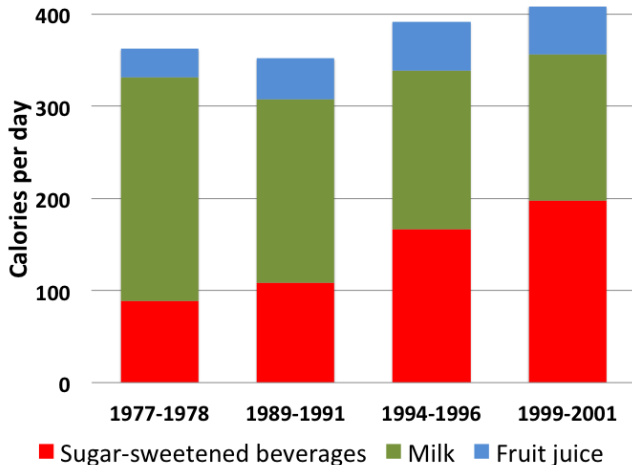
- ▶ Considerable evidence of very high consumption of sugar
 - ▶ in US over 65% of population and in UK over 70% consume more than recommended max of 10% total calories from added sugar
 - ▶ even higher amongst children
- ▶ Growing evidence that
 - ▶ leads to type 2 diabetes, heart disease, cancers, obesity, etc...
 - ▶ is associated with decreased bone density and other signs of malnutrition and poor mental health, particularly in children
 - ▶ likely be a driver of poor performance and long term economic and social outcomes in children, particularly from low socio-economic status households

Sugar consumption is above recommended levels in most countries, especially high for children



Source: Azais-Braesco, Sluik, Maillot, Kok and Moreno (2017)

Children have shifted from milk to soda, US

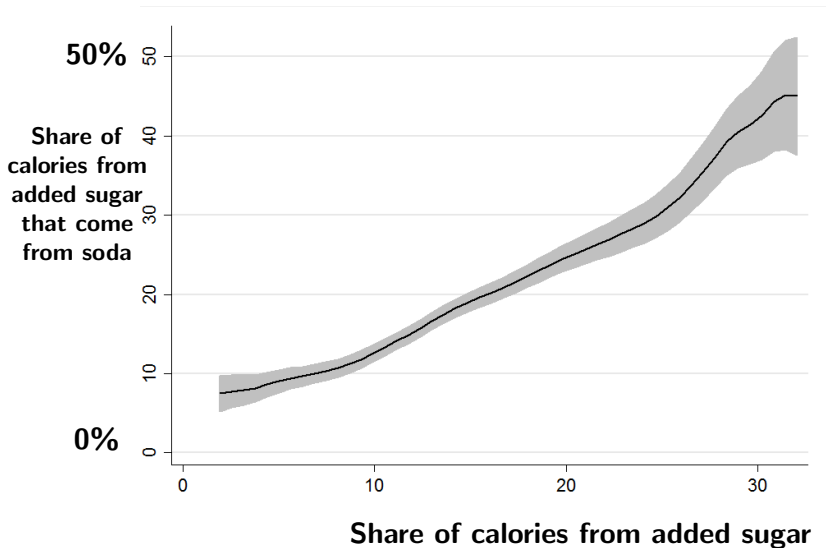


Source: Nielsen and Popkin (2004), calories from drinks children ages 2-18

Soda taxes

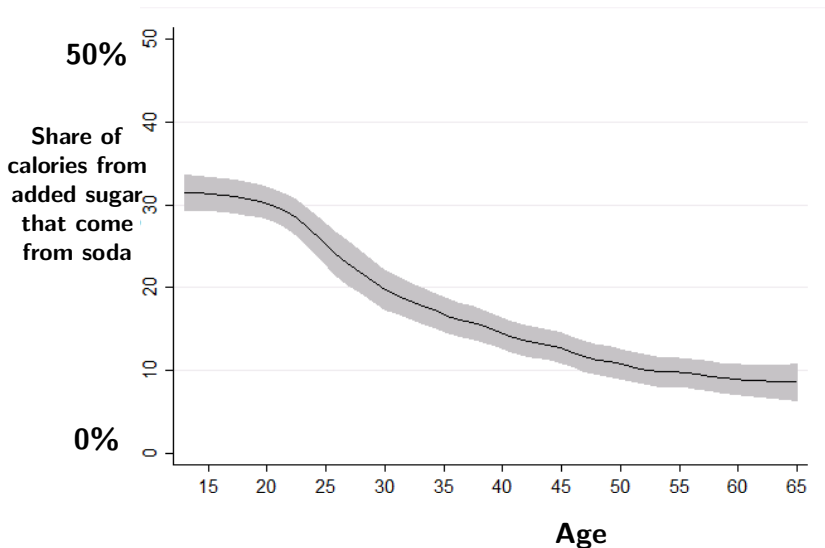
- ▶ World Health Organisation (WHO) has urged countries to tax sugary drinks to reduce sugar consumption, especially in children
- ▶ Taxes on soda or sugar in soda have been introduced in
 - ▶ France in 2012, Mexico in 2013, UK in 2016
 - ▶ Albany, Berkeley, Oakland, and San Francisco
 - ▶ Boulder, Philadelphia, Chicago (Cook County)
- ▶ Why target soda?
 - ▶ Soda represents a substantial share of sugar consumption
 - ▶ Soda consumption is higher for those consuming a lot of sugar
 - ▶ particularly children and young adults
 - ▶ Soda has no redeeming nutritional characteristics

Soda is a large % of calories from added sugar, UK



Source: NDNS

And more so for younger consumers, **UK**



Source: *NDNS*

Corrective Taxes

- ▶ There is a sharp divide between
 - ▶ libertarian view, which suggests that where harm only accrues to the individuals themselves (in contrast to externalities which involve third-parties) there is no rationale of government intervention
 - ▶ paternalistic view, often taken in the public health literature, which considers that (most) health risks should be reduced, even where individuals are taking choices with complete information
- ▶ What are the efficiency and equity implications of taxes with the objective to reduce externalities from sugar?
- ▶ How can we evaluate these?

Soda Taxes

- ▶ Soda taxes largely aim to correct for externalities
 - ▶ people make errors, we might be able to design policies to help them make better choices (e.g. O'Donoghue and Rabin, 2003, 2006)
 - ▶ poverty is correlated with optimisation errors (possibly causally related)
 - ▶ tax might serve as a commitment device that benefits those at risk of making errors (Gruber and Koszegi, 2004)
 - ▶ but only if they respond to tax, if have inelastic demand they might both pay the tax and bear the internal costs in future
- ▶ In order to evaluate the efficiency and equity implications of recently introduced soda taxes we need to
 - ▶ have estimate of shape of demand for soda products, and other sugary products
 - ▶ and how this correlates with marginal externalities

Dubois, Griffith and O'Connell

- ▶ Estimate demand (discrete choice) for drinks “on-the go”
 - ▶ less well studied than the “at home” market
 - ▶ optimisation errors may be worse in this context (temptation)
 - ▶ accounts for around half of soda consumption
- ▶ We exploit longitudinal data to estimate individual specific demands
 - ▶ allows us to relate individual responsiveness to characteristics that proxy for marginal harm
 - ▶ we find that high sugar consumers have inelastic demand for sugary soda, although younger consumers are more price elastic
- ▶ To help organise thoughts first consider the effects of a soda tax using a simple welfare criterion

A tax on sugar in soda

- ▶ consumers: $i \in \{1, \dots, N\}$, with income y_i
- ▶ food and drink products:
 - ▶ sodas: $j \in \{1, \dots, j'\} = \Omega_w$
 - ▶ other products that contain sugar: $j \in \{j' + 1, \dots, J\} = \Omega_{nw}$
- ▶ $\mathbf{p} = (p_1, \dots, p_J)'$: post tax prices
- ▶ z_j : sugar in each product
- ▶ τ : tax rate on the sugar in soda
- ▶ $v_i(\mathbf{p}, y_i)$: indirect decision utility, demands are:

$$q_{ij}(\mathbf{p}, y_i) = -\frac{\partial v_i / \partial p_j}{\partial v_i / \partial y_i}$$

A tax on sugar in soda

- ▶ Total sugar in a consumer's diet

$$\mathcal{S}_i(\mathbf{p}, y_i) = \sum_{j \in \Omega} q_{ij}(\mathbf{p}, y_i) z_j$$

- ▶ includes sugar from soda (w) and non-soda (nw)

$$\mathcal{S}_i(\mathbf{p}, y_i) = \mathcal{S}_i^w(\mathbf{p}, y_i) + \mathcal{S}_i^{nw}(\mathbf{p}, y_i)$$

- ▶ $v_i(\mathbf{p}, y_i)$ governs choice, but not necessarily long term welfare
 - ▶ sugar consumption may give rise to future costs, both to the consumer (internalities) and to others (externalities), that consumers do not take account of at the point of consumption
 - ▶ $\phi_i(\mathcal{S}_i(\mathbf{p}, y_i))$: the internality (+ externality) from sugar consumption
 - ▶ consumers ignore this when making choices

A tax on sugar in soda

- ▶ Policy maker chooses a tax on sugar in soda (τ) to maximise a utilitarian social welfare function,

$$W = \sum_i [v_i(\mathbf{p}, y_i + r_i) - \phi_i(S_i(\mathbf{p}, y_i + r_i))]$$

- ▶ where $[v_i(\cdot) - \phi_i(\cdot)]$ is consumer's long run welfare
- ▶ r_i is any rebate to consumer i
- ▶ \tilde{p}_j denotes the pre-tax price
 - ▶ for soda products ($j \in \Omega_w$), $p_j = \tilde{p}_j + \tau z_j$
 - ▶ for non-soda products ($j \in \Omega_{nw}$) $p_j = \tilde{p}_j$

A tax on sugar in soda

- ▶ Effect of a marginal change in the soda tax:

$$\frac{dW}{d\tau} = \underbrace{\sum_i (\phi'_i - \tau \bar{\lambda}) |S'_i{}^w|}_{\text{direct efficiency}} - \underbrace{\sum_i \phi'_i S'_i{}^{nw}}_{\text{indirect efficiency}} - \underbrace{\sum_i (\lambda_i - \bar{\lambda}) S'_i{}^w}_{\text{redistribution}}$$

- ▶ ϕ'_i is the marginal internality (+externality) of consumer i
- ▶ S'_i impact of marginal change in tax rate on consumer's sugar demand
- ▶ λ_i is the marginal (decision) utility of income of consumer i
 - ▶ $\bar{\lambda} = \sum_i \beta_i \lambda_i$ is weighted average marginal utilities

A tax on sugar in soda

- ▶ Effect of a marginal change in the soda tax:

$$\frac{dW}{d\tau} = \underbrace{\sum_i (\phi'_i - \tau \bar{\lambda}) |S'_i{}^w|}_{\text{direct efficiency}} - \underbrace{\sum_i \phi'_i S'_i{}^{nw}}_{\text{indirect efficiency}} - \underbrace{\sum_i (\lambda_i - \bar{\lambda}) S'_i{}^w}_{\text{redistribution}}$$

- ▶ For consumers with a marginal internality above the tax rate
 - ▶ this term is positive, reduction in sugar leads to a welfare gain
 - ▶ the size of the gain is proportional to how responsive the consumer's demand for sugar in soda is to the tax
 - ▶ higher correlation between ϕ'_i and $|S'_i{}^w|$ the more effective the tax
- ▶ For consumers with marginal internality below tax rate
 - ▶ this term is negative

A tax on sugar in soda

- ▶ Effect of a marginal change in the soda tax:

$$\frac{dW}{d\tau} = \underbrace{\sum_i (\phi'_i - \tau \bar{\lambda}) |S'_i{}^w|}_{\text{direct efficiency}} - \underbrace{\sum_i \phi'_i S'_i{}^{nw}}_{\text{indirect efficiency}} - \underbrace{\sum_i (\lambda_i - \bar{\lambda}) S_i{}^w}_{\text{redistribution}}$$

- ▶ if taxing the sugar in soda increases demand for untaxed sugar ($S'_i{}^{nw} > 0$), this will have a negative welfare effect
 - ▶ the stronger the correlation between ϕ'_i and $S'_i{}^{nw}$
 - ▶ i.e. the more strongly consumers with large marginal internalities switch to other forms of sugar (fruit juice, chocolate milk, chocolate ...)
 - ▶ the larger will be this inefficiency cost from only taxing a subset of sugar

A tax on sugar in soda

- ▶ Effect of a marginal change in the soda tax:

$$\frac{dW}{d\tau} = \underbrace{\sum_i (\phi'_i - \tau \bar{\lambda}) |S_i'^w|}_{\text{direct efficiency}} - \underbrace{\sum_i \phi'_i S_i'^{nw}}_{\text{indirect efficiency}} - \underbrace{\sum_i (\lambda_i - \bar{\lambda}) S_i'^w}_{\text{redistribution}}$$

- ▶ if consumers with high marginal utility of income have high demands for sugary soda then this term will have a negative effect and the tax will be regressive

Empirical assessment of the effects of tax on soda

- ▶ Estimate demand for drinks “on-the-go” to obtain estimates of
 - ▶ substitution away from the sugar in soda (S_i^w) in response to tax
 - ▶ how strongly switch to alternatives (S_i^{nw}) in response to tax
- ▶ Correlate these with
 - ▶ marginal utility of income (λ_i)
 - ▶ marginal internalities (ϕ_i') – unobserved (unobservable?)
 - ▶ marginal internalities may vary across people for two reason:
 - ▶ (a) the function may be convex in sugar, so two similar people, one with low and one with high sugar consumption, may create significantly different marginal internalities
 - ▶ (b) for a fixed amount of sugar, some people may have larger internalities associated with sugar (e.g. children)

Demand model overview

- ▶ Model demand for drinks on-the-go
 - ▶ discrete choice model, choice of drink conditional on buying a drink
 - ▶ individual chooses one of several options
 - ▶ one of several soda products, some with sugar some diet
 - ▶ non-soda drinks with sugar
 - ▶ non-soda drinks without sugar (mainly water)
 - ▶ upper stage model of choice to buy a drink, chocolate bar, or other (non-sugary) snack
- ▶ Estimate individual specific demands
 - ▶ exploiting long panel, allow preferences for price, sugar and soda to be individual specific
 - ▶ other preferences vary by demographic group (gender-age)

Data

- ▶ “On-the-go” purchase decision
 - ▶ 5,373 individuals, aged 13+
 - ▶ June 2010-October 2012
 - ▶ individuals make on average 81 drinks purchases
 - ▶ all food and drinks purchases made by the individual “on-the-go”
 - ▶ participants use mobile phones to record purchases
 - ▶ all grocery purchases made by the household
 - ▶ scanned in the home
 - ▶ collected by market-research firm Kantar

Individual specific vs. random coefficient logit

- ▶ Preference heterogeneity
 - ▶ standard empirical approach (random coefficients logit) requires distribution assumptions, allows us to recover distribution of preferences by estimating a small number of parameters
 - ▶ we estimated individual specific coefficients, we don't need to specify the functional form of preference distribution
- ▶ Most importantly, we recover consumer specific parameters and therefore can relate them to other information about consumers
 - ▶ we can correlate slopes of demand (S_i^w , S_i^{nw}) with income, share of calories from added sugar, age and other proxies for marginal internalities or propensity to make optimisation errors
 - ▶ this is key if we want to understand who is affected by the tax and how well targeted it is

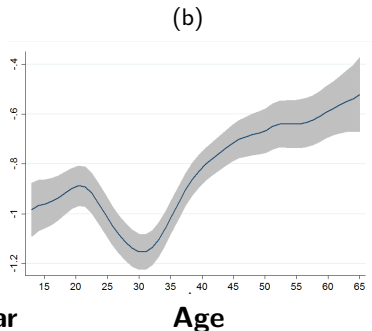
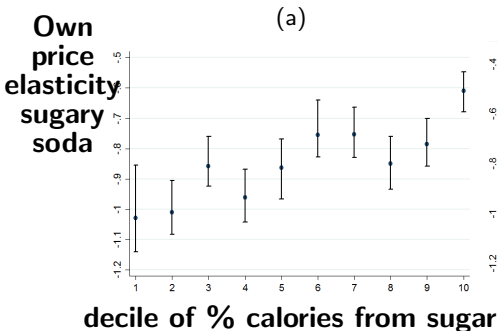
Econometric Issues

- ▶ Identifying the effect of price
 - ▶ we exploit
 - ▶ individuals shopping in multiple outlets, we assume that outlet choice is independent of demand shock and use cross-outlet variation in relative prices of different drinks
 - ▶ we assume unobserved effects are common across products within the same brand, we use differential time series variation in product price *within* brands, assume that is driven by costs (factors other than shocks to demands)
- ▶ Incidental parameters problem
 - ▶ Our estimator will be asymptotically biased (Arellano and Hahn, 2007)
 - ▶ even if both $N \rightarrow \infty$ and $T \rightarrow \infty$, if N and T grow at the same rate ($\frac{N}{T} \rightarrow \rho$ where ρ is a non zero constant)
 - ▶ we use the split sample jackknife bias correction procedure suggested in Dhaene and Jochmans (2015)
 - ▶ we show that our results are robust to this concern

Correlation between ϕ'_i and $S'_i{}^w$

$$\frac{dW}{d\tau} = \sum_i (\phi'_i - \tau \bar{\lambda}) |S'_i{}^w| - \sum_i \phi'_i S'_i{}^{nw} - \sum_i (\lambda_i - \bar{\lambda}) S_i{}^w$$

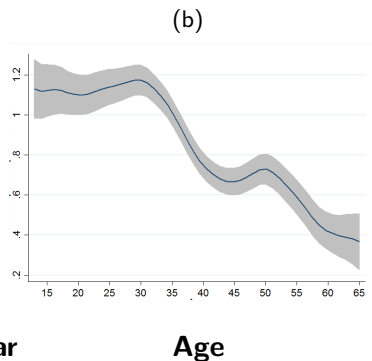
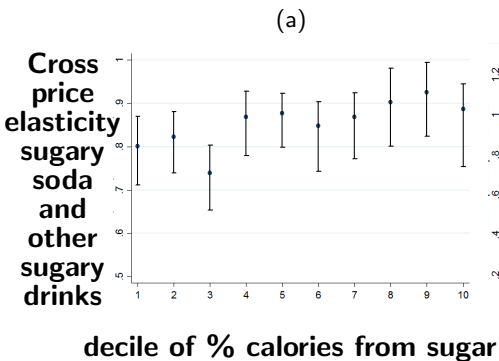
- ▶ (a) high sugar consumers are less responsive to price of sugary soda
 - ▶ suggests tax will not be effective
- ▶ (b) younger consumers are more responsive to price of sugary soda
 - ▶ suggests tax will be effective



Correlation between ϕ'_i and $S'_i{}^{nw}$

$$\frac{dW}{d\tau} = \sum_i (\phi'_i - \tau \bar{\lambda}) |S'_i{}^w| - \sum_i \phi'_i S'_i{}^{nw} - \sum_i (\lambda_i - \bar{\lambda}) S_i^w$$

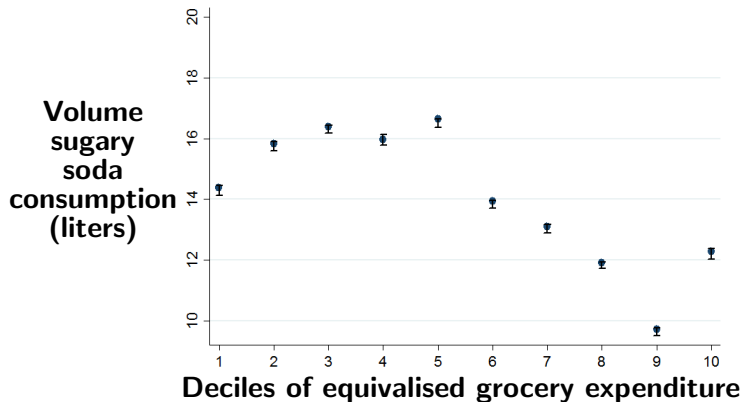
- ▶ (a) high sugar and (b) younger consumers are both more willing to substitute to other sugary drinks when price of sugary soda rises
 - ▶ suggests tax will not be effective



The impact of a tax on soda

$$\frac{dW}{d\tau} = \sum_i (\phi'_i - \tau \bar{\lambda}) |S'_i{}^w| - \sum_i \phi'_i S'_i{}^{nw} - \sum_i (\lambda_i - \bar{\lambda}) S_i{}^w$$

- ▶ Households with lower equivalised total annual grocery expenditure purchase more sugary soda



Simulate the effects of a sugary soda tax

- ▶ **sugary soda tax:**

- ▶ 11p tax per can (335ml or 12oz) on only sugary soda (similar to UK, Berkeley, Chicago)
- ▶ average price increase of around 12% on affected products
- ▶ we assume pass-through is 100%

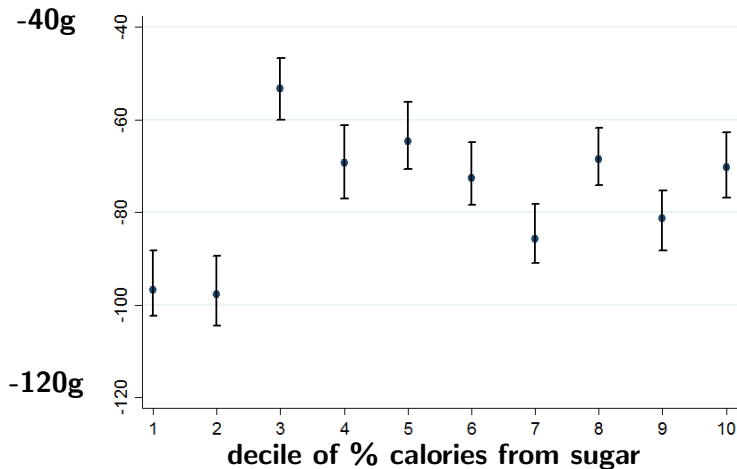
Average effect of tax

	Change following sugary soda tax
% reduction sugar from soda	-5.8% [-6.2, -5.3]
% reduction sugar from all drinks	-4.7% [-4.9, -4.3]

- ▶ reduction of sugar from soda = 84g sugar, around 340 calories, equivalent of 2.5 cans of Coke
- ▶ reduction of sugar from all drinks = 76g sugar, around 300 calories, equivalent of 2 cans Coke

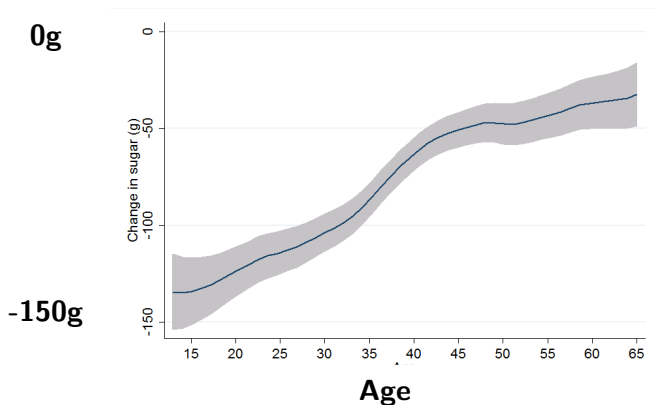
Change in sugar from sugary soda tax

- ▶ high added sugar consumers reduce sugar consumption from soda by less in response to the tax



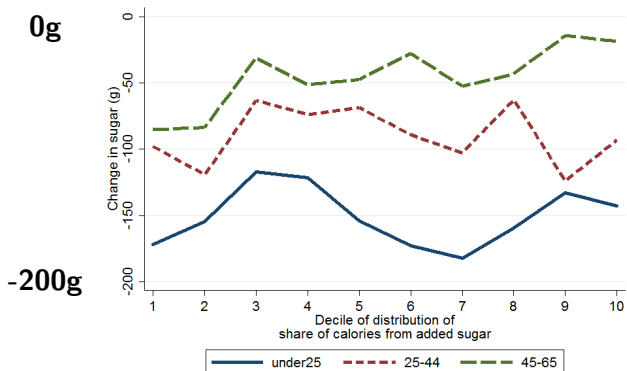
Change in sugar from sugary soda tax

- ▶ younger consumers reduce sugar consumption from soda by more in response to the tax
 - ▶ 150g sugar, around 600 calories, more than 4 cans of Coke



Change in sugar from sugary soda tax

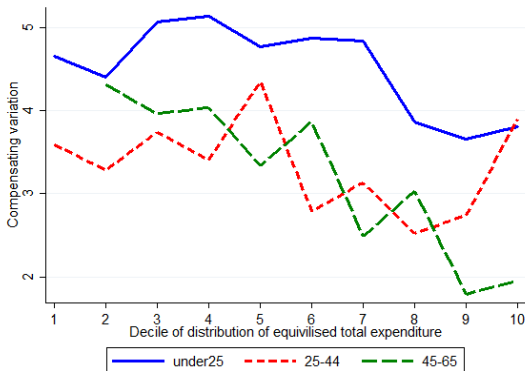
- ▶ younger consumers reduce sugar consumption from soda by more than older consumers across the distribution of total calories from added sugar



decile of % calories from sugar

Compensating variation from a sugary soda tax

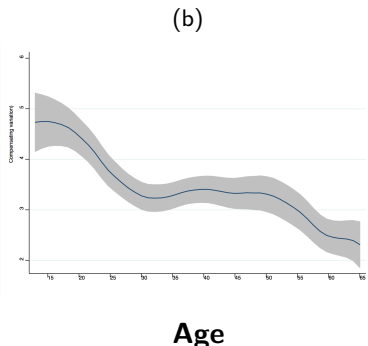
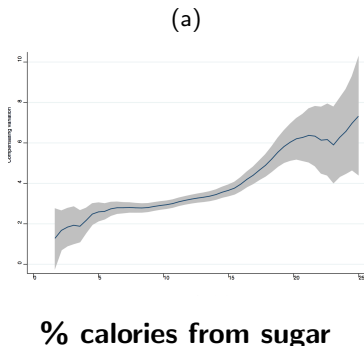
- ▶ Individuals in households with lower equivalised total annual grocery expenditure (poorer) and younger consumers are hit harder by the tax (have higher compensating variation)



decile of equivalised total grocery expenditure

Compensating variation from a sugary soda tax

- ▶ (a) compensating variation is higher for high sugar consumers (who did not reduce sugar consumption by much)
- ▶ (b) compensating variation is higher for younger consumers (who did reduce sugar consumption)

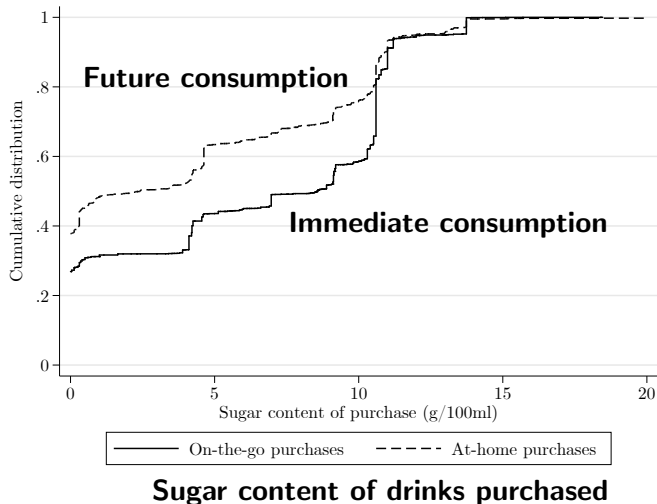


What is the extent of internalities?

- ▶ In order to put together all the pieces we need to also know more about the extent to which decisions over consumption of sugar and soda are sub-optimal from an individual perspective? do individuals:
 - ▶ suffer from temptation and a lack of self-control
 - ▶ lack information on nutritional characteristics and their long term consequences
 - ▶ lack the cognitive ability or will to evaluate information
 - ▶ have habits or suffer from addiction to sugar
 - ▶ ...
- ▶ Cherchye, De Rock, Griffith, O'Connell, Smith and Vermeulen
"A new year, a new you? Temptation and self-control in food purchases"
- ▶ Griffith, O'Connell and Smith "Temptation and Sugar Consumption"
- ▶ Dubois, Griffith and Nevo
"Habit Formation in Sugar Consumption: Evidence from Consumer Migration"

Self-control problems?

Individual's purchase more sugar when for immediate consumption than for future



Griffith, O'Connell and Smith

Summary

- ▶ A tax on sugary soda reduces mean sugar consumption
 - ▶ there is weaker switching away from sugar from those with high added sugar in their diets *relative to* those with lower added sugar
 - ▶ high sugar consumers have both stronger preferences for sugar in drinks and are less price sensitive, leading them to be less willing to switch away from sugary soda when facing higher prices
 - ▶ young consumers with high sugar consumption do respond
 - ▶ they are more price sensitive
 - ▶ compensating variation is high, but they also (probably) benefit from lower internalities (lower future costs)
 - ▶ older consumers with high overall sugar consumption are worse off
- ▶ We needed the flexible heterogeneity from the individual specific coefficient logit to learn this

Policy Implications

- ▶ There are winners and losers from the soda tax
 - ▶ older and poorer high-added sugar consumers lose
 - ▶ younger and richer consumers benefit
- ▶ Need to look also at complementary policies
 - ▶ redistributive concerns, what is done with tax revenue
 - ▶ restrictions on advertising
 - ▶ reformulation and regulations on sugar content of products
 - ▶ education, etc.