Institute for Fiscal Studies

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Working paper
21/21

The impact of a tax on added sugar and salt

Economic and Social Research Council

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July 12, 2021

Abstract

Keywords: sugar tax, salt tax
JEL classification: H23, H31, H32
Acknowledgements: Griffith gratefully acknowledge financial support from the Economic and Social Research Council (ESRC) under the Centre for the Microeconomic Analysis of Public Policy (CPP), grant number ES/M010147/1. Data supplied by Kantar FMCG Purchase Panel. The use of Kantar FMCG Purchase Panel data in this work does not imply the endorsement of Kantar FMCG Purchase Panel in relation to the interpretation or analysis of the data. All errors and omissions remain the responsibility of the authors.

*Griffith: IFS and University of Manchester; Jenneson: The University of Leeds; James: DEFRA; Taylor: Food Foundation.

1 Introduction

Sugary drinks taxes have been implemented around the world,[1] and governments around the world are considering extending these taxes to address concerns about rising obesity.

We demonstrate the range of impacts a tax on added sugar and salt could have on purchases of food at home and out of the home in the UK. The impact will depend on how firms and consumers respond. There is considerable uncertainty about each of these. Therefore we take a very robust approach and consider scenarios that cover the full range of realistic possible levels of response – from very responsive firms and consumers to non-responsive firms and consumers, and everything in between. Fully responsive firms would reformulate products to reduce sugar and salt (we assume the maximum reformulation would be to targets set by Public Health England, PHE). Fully responsive consumers would substitute away from products in proportion to the increase in price, and not increase purchases of added sugar or salt on other products.

In the remainder of this paper we describe the data in more detail (section 2), show the impact of taxes on prices (section 3), the impact on sugar and salt purchases (section 4), including by age, and show the implied health benefits from the Department of Health and Social Care calorie model and analysis by researchers at the The London School of Hygiene and Tropical Medicine (LSHTM) (section 5).

Appendices show details on PHE reformulation targets (Appendix A), the results using the larger sample of data on home purchases (Appendix B), and we describe the methods and calculations used (Appendix C) .

2 Data

We use the Kantar Fast Moving Consumer Goods (FMCG) Purchase Panel (Take Home) 2019 and Kantar Out of Home Purchase Panel 2016-2019. The Kantar purchase panel data covers food purchased and brought into the home and has demographic and purchase data for over 30,000 households in the UK and price and nutritional information for over 100,000 products. The Out of Home data has demographic and purchase information on over 10,000 individuals aged 13 and older from the Kan-

[1] See for example Global Food Research Program at University of North Carolina, and Griffith et al. (2017).

tar Worldpanel households. The Out of Home data does not include nutritional information, we match this in at the category level.
We exclude the following food categories from our analysis:

- sugar
- artificial sweeteners
- table salt
- alcoholic drinks

In all data there are sometimes extreme observations. Here this could for example be a household that purchased an extraordinary amount of food that was not representative of their usual purchases. When looking at means these extreme observations can distort the numbers. Because of this we drop the largest 1% of purchases of added sugar and salt.

Added sugar

We consider a tax that is applied to added sugar. The Kantar data records total sugar as reported on the back of package label. We use estimates of the % of sugars that are added sugar from the nutritional conversion factors provided by DEFRA; these are recorded at the level of around 500 food groups (maffcodes) and are used in combination with the Living Cost and Food Survey (previously Expenditure and Food Survey or National Food Survey).
For at home purchases we apply this % to the amount of total sugar recorded in the Kantar data to estimate the amount of added sugar, see description in Table 2.1. For the out of home data there are some products where we do not have quantities or nutrients (for example meals out). We impute the quantity of added sugar and salt in each product using information from the Living Costs and Food Survey (LCFS), assuming that the relationship between expenditure in quantity is the same in the Kantar data and the LCFS when comparing similar food categories. The lower panel in Table 2.1 describes sugar and added sugar for the out of home data.

Table 2.1: *Sugar and added sugar by category*

Category			% from this category				
	Mean sugar intensity g per 100g	% of sugar that is added sugar	sugar	added sugar	calories	salt	expend-iture
Food at home							
Fruit	12	4.7	15.8	0.3	0.6	4.7	8.3
Vegetables	3	0.0	6.0	0.0	2.7	6.0	9.5
Grains	2	2.0	0.0	0.0	0.1	0.2	0.2
Bread	4	2.7	3.8	0.1	13.4	12.7	4.9
Breakfast cereals	16	72.2	3.9	5.6	1.9	4.9	2.1
Morning goods	13	60.1	1.4	1.6	1.7	1.5	0.8
Dairy and eggs	3	0.2	10.6	0.0	5.5	7.2	5.1
Yoghurt	10	52.3	3.6	3.6	1.0	1.6	2.5
Cheese fats	1	0.0	0.3	0.0	10.4	11.7	6.1
Red meat	1	25.0	0.4	0.2	15.3	6.2	10.5
Poultry and fish	1	46.4	0.2	0.2	5.1	4.0	7.9
Condiments and deli	9	72.5	3.6	5.1	14.0	3.0	3.9
Savoury snacks	3	1.9	0.5	0.0	4.2	3.6	2.9
Ready meals	2	25.5	3.0	2.4	14.0	10.0	11.9
Fruit juice	8	100.0	3.7	7.1	0.1	0.8	1.2
Milk drinks	24	58.1	1.2	1.5	0.4	0.5	0.6
Soft drinks	4	66.3	4.4	6.9	1.2	1.2	7.0
Sweet spreads	51	81.1	3.3	6.2	0.3	1.2	0.6
Biscuits	27	85.0	8.3	14.7	4.1	6.9	3.6
Confectionery	54	96.1	12.1	22.8	1.0	4.8	4.5
Desserts	28	80.8	13.7	21.7	2.9	7.2	5.9
Food out of home							
Soft drink	9	83.6	32.6	39.3	0.8	5.3	10.1
Hot beverages	2	10.3	3.1	2.9	0.6	1.0	20.0
Sugar confectionery	50	84.6	6.9	8.3	0.3	1.5	0.6
Chocolate confectionery	55	87.6	14.7	16.0	1.0	5.4	1.1
Cakes and desserts	21	69.6	23.7	24.9	8.4	15.0	5.0
Savoury snacks	3	12.5	1.8	1.6	7.2	7.1	3.6
Sandwiches	2	3.5	2.1	0.1	22.9	12.8	8.9
Fruit and nuts	10	1.7	1.1	0.1	0.2	0.5	0.9
Vegetables	3	0.0	0.0	0.0	0.0	0.0	0.0
Meals	3	16.2	13.6	6.7	57.9	50.8	49.4
Other	7	29.6	0.4	0.3	0.8	0.7	0.5

Notes: The first column shows the mean sugar intensity across products in that category. The second column show the mean percentage that is added sugar. The final five columns show the share of total sugar, added sugar, calories, salt and expenditure that are from each category. In the third to seventh columns the rows in each panel sum to 100%.

Consumption versus purchases

We calculate the change in purchased amounts. To calculate health impacts we require consumed amounts. We assume that all food and drink that is purchased is consumed. Using data from 2008, DEFRA estimated that around 15% of food and drink that is purchased by UK households is not consumed (Defra, 2010. Household Food and Drink Waste linked to Food and Drink Purchases). This varied substantially by product category and by nutrient. Evidence shows that the share of food that is purchased that is consumed in the UK has been increasing over recent years (WRAP, 2020). In the absence of reliable and up-to-date estimates we do not make any adjustment for waste; we assume food waste to be zero.

3 Prices

Table 3.1 shows estimated price increases. See Appendix C for details of how these are calculated. If firms fully pass the tax on to prices and they do not reformulate, an added sugar tax of £3 per kilo would lead to price increases for foods purchased for consumption at home of around 4.1%, this could be reduced to 3.2% if firms fully reformulated to PHE targets. The equivalent price rises for food purchased for consumption outside of the home are 1.1% and 0.7%.

A salt tax of £6 per kilo would lead to price increases for foods purchased for consumption at home of around 0.9%, this could be reduced to 0.7% if firms fully reformulated to PHE targets. The equivalent price rises for food purchased for consumption outside of the home are 0.24% and 0.2%.

If implemented together these could lead to price increase for foods purchased for consumption at home of between 4.0% to 5.0%, and for food out of between 0.9% and 1.4%.

Table 3.1: *% increase in prices, fixed basket price index*

Reformulation	Added sugar tax		Salt tax		Added sugar and salt tax	
	Home	Out	Home	Out	Home	Out
none (0%)	4.09	1.12	0.88	0.24	4.98	1.36
10%	4.01	1.08	0.87	0.24	4.87	1.31
20%	3.92	1.04	0.86	0.23	4.77	1.27
30%	3.83	1.00	0.84	0.23	4.67	1.23
40%	3.74	0.96	0.83	0.23	4.57	1.18
50%	3.65	0.92	0.82	0.22	4.47	1.14
60%	3.56	0.88	0.80	0.22	4.36	1.10
70%	3.47	0.84	0.79	0.21	4.26	1.05
80%	3.38	0.80	0.78	0.21	4.16	1.01
90%	3.30	0.76	0.76	0.21	4.06	0.97
full (100%)	3.21	0.72	0.75	0.20	3.96	0.92

Notes: The reported price change is the change in the cost of the observed pre-tax basket of products assuming that the increased cost of the tax is fully pass on to prices; see Section C. As with other fixed basket (Laspeyres) price indices, such as the CPI, these overestimate the price change that people will experience because people will substitute to alternative, cheaper, products.

Table 3.2: *% increase in prices, fixed basket price index, by equivalised income quartiles*

	Equivalised household income quartile			
Reformulation	1=lowest income	2	3	4=highest income
none	5.71	5.24	4.87	4.26
	5.60	5.14	4.77	4.18
	5.48	5.03	4.67	4.09
	5.36	4.92	4.57	4.00
	5.25	4.81	4.47	3.91
	5.13	4.71	4.37	3.82
	5.02	4.60	4.27	3.74
	4.90	4.49	4.17	3.65
	4.79	4.38	4.07	3.56
	4.67	4.28	3.97	3.47
full	4.55	4.17	3.87	3.38

Notes: See notes to Table 3.1.

If we apply these overall price increases to average household spending on food and drink from the Office for National Statistics (ONS (2021b)) this could result in in-

creases to expenditure of between 16-20 pence per person per day, depending on how much companies reformulate.[2]

Table 3.1 shows the overall price increases from the taxes for different levels of reformulation. Table 3.3 shows price changes by food category if there is no reformulation, and Table 3.4 shows price changes by food category if there is full reformulation.

[2]The average household is made up of 2.4 people, ONS (2021a)

Table 3.3: *% increase in prices by category, no reformulation*

Category	Added sugar tax	Salt tax	Added sugar and salt tax	Expenditure share
Food at home				
Fruit	0.14	0.07	0.21	8.27
Vegetables	0.00	0.26	0.26	9.52
Grains	0.02	0.37	0.39	0.19
Bread	0.11	2.48	2.59	4.93
Breakfast cereals	11.15	0.81	11.97	2.09
Morning goods	8.38	1.89	10.28	0.81
Dairy and eggs	0.00	0.99	0.99	5.10
Yoghurt	5.99	0.37	6.36	2.54
Cheese fats	0.00	1.54	1.54	6.12
Red meat	0.07	1.33	1.40	10.52
Poultry and fish	0.10	0.59	0.69	7.86
Condiments and deli	5.55	3.29	8.84	3.86
Savoury snacks	0.03	1.31	1.33	2.93
Ready meals	0.86	1.07	1.93	11.89
Fruit juice	25.58	0.11	25.69	1.16
Milk drinks	10.14	0.67	10.81	0.60
Soft drinks	4.16	0.15	4.32	6.98
Sweet spreads	42.83	0.39	43.21	0.60
Biscuits	17.20	1.04	18.24	3.58
Confectionery	21.24	0.21	21.45	4.51
Desserts	15.35	0.44	15.79	5.93
Total	4.09	0.88	4.98	100.0
Food out of home				
Soft drink	4.32	0.02	4.34	10.05
Hot beverages	0.16	0.01	0.17	20.03
Sugar confectionery	16.09	0.11	16.20	0.57
Chocolate confectionery	15.69	0.22	15.91	1.13
Cakes and desserts	5.55	0.41	5.96	4.95
Savoury snacks	0.47	0.48	0.95	3.63
Sandwiches	0.01	0.62	0.63	8.89
Fruit and nuts	0.11	0.04	0.15	0.86
Vegetables	0.00	0.02	0.02	0.01
Meals	0.15	0.28	0.43	49.38
Other	0.63	0.40	1.04	0.50
Total	1.12	0.24	1.36	100.0

Notes: The reported price change is the change in the cost of the observed pre-tax basket of prices assuming the increased cost of the tax is fully pass on to prices and no reformulation, see Section C.

Table 3.4: *% increase in prices by category, full reformulation*

Category	Added sugar tax	Salt tax	Added sugar and salt tax	Expenditure share
Food at home				
Fruit	0.14	0.06	0.20	8.27
Vegetables	0.00	0.20	0.20	9.52
Grains	0.02	0.32	0.33	0.19
Bread	0.11	2.38	2.49	4.93
Breakfast cereals	6.82	0.79	7.61	2.09
Morning goods	5.42	1.77	7.19	0.81
Dairy and eggs	0.00	0.99	0.99	5.10
Yoghurt	5.32	0.37	5.69	2.54
Cheese fats	0.00	1.41	1.41	6.12
Red meat	0.07	1.06	1.14	10.52
Poultry and fish	0.10	0.49	0.59	7.86
Condiments and deli	5.43	1.75	7.18	3.86
Savoury snacks	0.03	1.19	1.21	2.93
Ready meals	0.86	1.00	1.86	11.89
Fruit juice	13.90	0.11	14.01	1.16
Milk drinks	5.20	0.39	5.59	0.60
Soft drinks	3.01	0.15	3.16	6.98
Sweet spreads	35.23	0.38	35.62	0.60
Biscuits	14.78	0.96	15.74	3.58
Confectionery	16.67	0.21	16.88	4.51
Desserts	12.07	0.40	12.47	5.93
Total	3.21	0.75	3.96	100.0
Food out of home				
Soft drink	2.01	0.02	2.03	10.05
Hot beverages	0.07	0.01	0.08	20.03
Sugar confectionery	11.63	0.11	11.74	0.57
Chocolate confectionery	12.27	0.22	12.49	1.13
Cakes and desserts	4.33	0.36	4.69	4.95
Savoury snacks	0.22	0.43	0.66	3.63
Sandwiches	0.01	0.62	0.63	8.89
Fruit and nuts	0.11	0.04	0.15	0.86
Vegetables	0.00	0.02	0.02	0.01
Meals	0.14	0.21	0.35	49.38
Other	0.54	0.28	0.82	0.50
Total	0.72	0.20	0.92	100.0

Notes: The reported price change is the change in the cost of the observed pre-tax basket of prices assuming the increased cost of the tax is fully pass on to prices and full reformulation to PHE targets, see Section C.

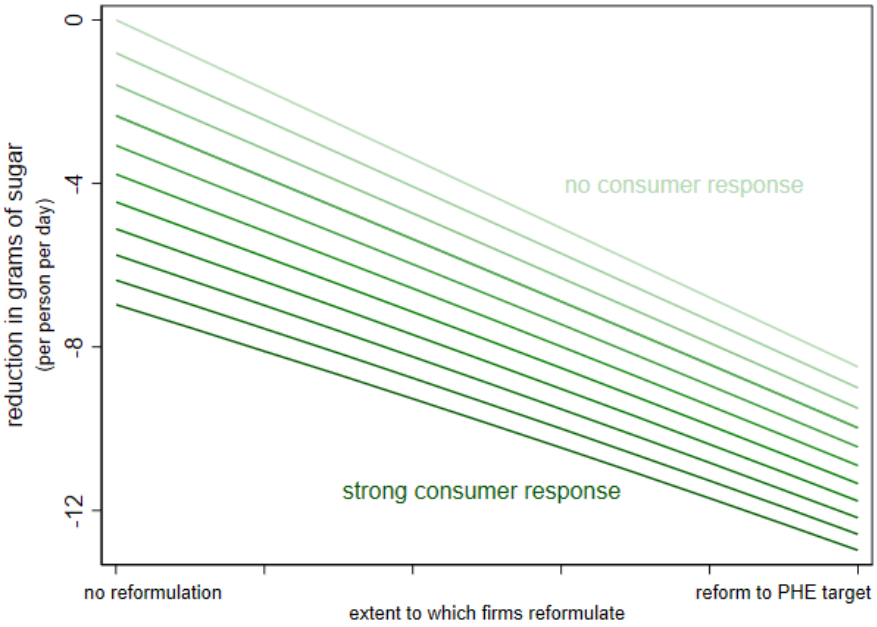
4 Impact on purchases of added sugar and salt

Figure 5.1 shows the range of potential impacts of implementing an added sugar and salt tax simultaneously. The vertical axis shows the reduction in grams of added sugar (a) and salt (b); these are reported as the change, so lower numbers indicate larger reductions. The horizontal axis shows the extent of reformulation; points to the far left show the reduction if firms do no reformulation; points to the far right show the reduction if firms fully reformulate to PHE's reduction targets; points in between show situations between these two extremes. The different lines show the reduction for different levels of consumer responsiveness. Table 4.1 shows the same information.

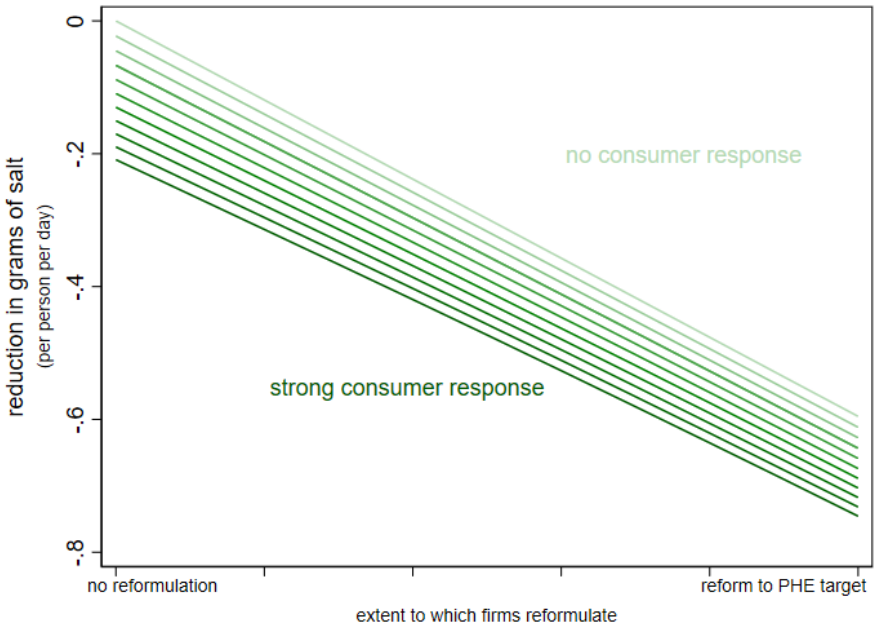
If consumers are fully responsive, the impact of an added sugar and salt tax would be to reduce added sugar from between 7.0 to 13.0 grams per person per day and salt by between 0.2 to 0.7 grams per person per day, whatever firms do. If firms fully reformulate then the impact will be to reduce sugar between 8.5 to 13.0 and salt between 0.6 to 0.7 grams per person per day, whatever consumers do. The reduction will be more than 3.0 gram of sugar per person per day and more than 1.0 gram of salt per person per day unless consumers *and* firms are both very unresponsive (consumers and firm respond by less than 40% of the price change/reformulation).

Figure 4.1: *Impact of an added sugar and salt tax*

(a) added sugar



(b) salt



Notes: Mean reduction in grams of (a) added sugar, and (b) salt per person per day from an added sugar tax of £6 per kilo and a salt tax of £6 per kilo. Includes reduction from at home and out of home; mean over 9,000 individuals aged 13+ observed in both.

Table 4.1: *Added sugar and salt tax*

reduction in added sugar (g per person per day)												
	Firm reformulation:											
	none		⟶			increasing to			⟶			full
Consumer response:												
none	-0.0	-0.8	-1.7	-2.5	-2.5	-3.4	-4.2	-5.1	-5.9	-6.8	-7.6	-8.5
	-0.8	-1.6	-2.4	-3.3	-3.3	-4.1	-4.9	-5.7	-6.5	-7.4	-8.2	-9.0
	-1.6	-2.4	-3.2	-3.9	-3.9	-4.7	-5.5	-6.3	-7.1	-7.9	-8.7	-9.5
	-2.3	-3.1	-3.9	-4.6	-4.6	-5.4	-6.1	-6.9	-7.7	-8.4	-9.2	-10.0
	-3.1	-3.8	-4.5	-5.2	-5.2	-6.0	-6.7	-7.4	-8.2	-8.9	-9.7	-10.4
	-3.8	-4.5	-5.2	-5.9	-5.9	-6.6	-7.3	-8.0	-8.7	-9.4	-10.2	-10.9
	-4.5	-5.1	-5.8	-6.5	-6.5	-7.1	-7.8	-8.5	-9.2	-9.9	-10.6	-11.3
	-5.1	-5.8	-6.4	-7.0	-7.0	-7.7	-8.4	-9.0	-9.7	-10.4	-11.1	-11.8
	-5.7	-6.4	-7.0	-7.6	-7.6	-8.2	-8.9	-9.5	-10.2	-10.8	-11.5	-12.2
	-6.4	-7.0	-7.6	-8.2	-8.2	-8.8	-9.4	-10.0	-10.6	-11.3	-11.9	-12.6
full	-7.0	-7.5	-8.1	-8.7	-8.7	-9.3	-9.9	-10.5	-11.1	-11.7	-12.3	-13.0
reduction in salt (g per person per day)												
	Firm reformuation:											
	none		⟶			increasing to			⟶			full
Consumer: response:												
none	-0.0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3	-0.4	-0.4	-0.5	-0.5	-0.6
	-0.0	-0.1	-0.1	-0.2	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5	-0.6	-0.6
	-0.0	-0.1	-0.2	-0.2	-0.2	-0.3	-0.3	-0.4	-0.5	-0.5	-0.6	-0.6
	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3	-0.4	-0.4	-0.5	-0.5	-0.6	-0.6
	-0.1	-0.1	-0.2	-0.3	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5	-0.6	-0.7
	-0.1	-0.2	-0.2	-0.3	-0.3	-0.3	-0.4	-0.4	-0.5	-0.6	-0.6	-0.7
	-0.1	-0.2	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5	-0.6	-0.6	-0.7
	-0.2	-0.2	-0.3	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5	-0.6	-0.6	-0.7
	-0.2	-0.2	-0.3	-0.3	-0.3	-0.4	-0.4	-0.5	-0.6	-0.6	-0.7	-0.7
	-0.2	-0.2	-0.3	-0.3	-0.3	-0.4	-0.5	-0.5	-0.6	-0.6	-0.7	-0.7
full	-0.2	-0.3	-0.3	-0.4	-0.4	-0.4	-0.5	-0.5	-0.6	-0.6	-0.7	-0.7

Notes: Mean reduction in grams of (a) added sugar, and (b) salt per person per day from an added sugar tax of £3 per kilo and a salt tax of £6 per kilo. Includes reduction from at home and out of home; mean over 9,000 individuals aged 13+ observed in both.

5 Health impacts

To estimate the public health impacts of sugar reduction we used the Department of Health and Social Care (DHSC) calorie model (version 3.1)[3] We model benefits over a period of 25 years. The use of the DHSC model does not imply that DHSC endorse the methodology used to calculate the calorie reductions.
The London School of Hygiene and Tropical Medicine (LSHTM) carried out modelling of the impact of reduction in salt intake on the UK population for us.
We consider four possible scenarios to demonstrate the range of possible effects (see Appendix C for details of calculations):

1. a modest response by industry (firms reformulate to 30% of PHE targets), and a modest response by consumers (they substitute away from products by one-third of the price increase)

2. firms fully reformulate to PHE targets, and consumers:

   (a) do not respond to price increases at all,

   (b) respond moderately (they substitute away from products by 70% of the price increase),

   (c) they fully respond (they substitute away from products by the same amount as the price increase).

These are shown in Table 5.1 and Figure 5.1.

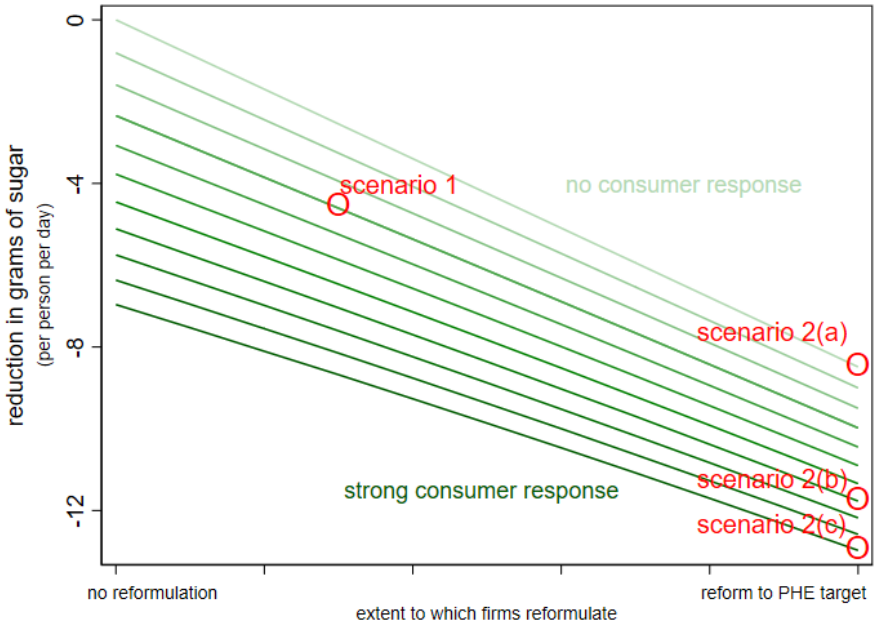
Table 5.1: *Reformulation and elasticities of different scenarios*

Scenario	Reformulation	Price responsiveness
1	30%	0.3
2(a)	100%	0
2(b)	100%	0.7
2(c)	100%	1

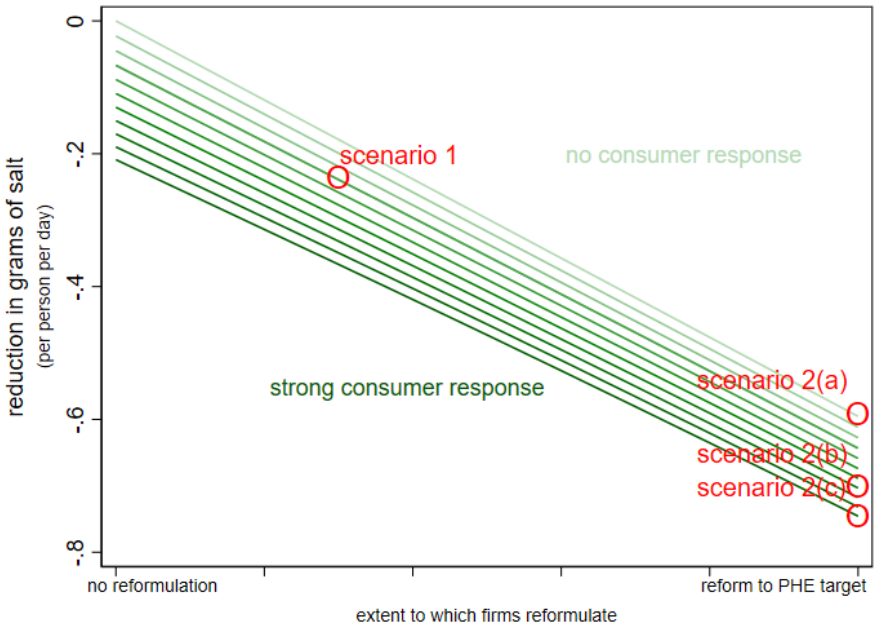
[3]https://www.gov.uk/government/publications/department-of-health-and-social-care-dhsc-calorie-model

Figure 5.1: *Impact of an added sugar and salt tax*

(a) added sugar



(b) salt



Notes: Mean reduction in grams of (a) added sugar, and (b) salt per person per day from an added sugar tax of £3 per kilo and a salt tax of £6 per kilo. Includes reduction from at home and out of home; mean over 9,000 individuals aged 13+ observed in both.

The degree of responsiveness of consumers can be interpreted as the own-price elasticity of demand for products with added sugar - that is it expresses the percentage change in quantity that we would expect from a percentage change in the price of all products that contain added sugar (incorporating any patterns of substitution within this set of products). As far as we know there are no estimates of this elasticity available in the literature. The paper that comes closest is Harding and Lovenheim (2017), who estimate a model of demand for a very large set of grocery products in the US, and find that products that are higher in sugar are more price elastic. They simulate a tax of 20% on sugar and find that it reduces sugar by 16.4% (Table 7 Panel B); this implies an elasticity of price responsiveness of around 0.8 in terms of Table 5.1. They also simulate a salt tax of 20% and find a 10% reduction in salt, implying a price responsiveness of around 0.5 in terms of Table 5.1.

Other relevant papers include evidence on responsiveness to the Soft Drinks Industry Levy (Scarborough et al., 2020) and food taxes in Hungary (Organisation, 2015) and Mexico(Taillie et al., 2017), and on soft drinks taxes around the world (Griffith et al. (2019), Bonilla-Chacin et al. (2016), Dubois et al. (2020), Andreyeva et al. (2010), and Faulkner et al. (2011)).

5.1 Estimating individual level from household level purchases

Purchases for food at are made at a household level. The DHSC and LSHTM model are at the individual level. In Figure 5.1 and Table 4.1 we simply divide by the number of people in the household and show the impacts averaged over people of all ages. In this section we show the impacts by age. To convert these to the individual level we apportion the food in the household to individuals in proportion to government recommended kcal levels,[4] shown in Table 5.2.[5]

[4]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/618167/government_dietary_recommendations.pdf

[5]For example, if a household consisted of a 52 year-old women, a 52 year-old man and a 12 year-old girl then the shares would be 30% for the women = (1900/(1900+2550+1845), 41% for the man = (2550/(1900+2550+1845) and and 29% for the child =(1845/(1900+2550+1845).

Table 5.2: *Recommended calories*

Age	Female	Male
0-1	698	745
1-3	1165	1230
4-6	1545	1715
7-10	1740	1970
11-14	1845	2220
15-18	2110	2755
19-50	1940	2550
51-59	1900	2550
60-64	1900	2380
65-74	1900	2330
75+	1810	2100

We convert the predicted sugar reductions into calorie reductions, by multiplying the sugar reduction in grams by 3.75 (the energy value ascribed to 1g of sugar; PHE (2021)); these are used as the input in the DHSC calorie model.

Table 5.3: *Scenario 1: reduction in sugar , salt and calories*

	Added sugar		**Salt**		**Calories**	
dhscAge	Mean	Sd	Mean	Sd	Mean	Sd
Female 0-4	-1.8	1.3	-0.1	0.1	-6.6	4.9
Male 0-4	-1.9	1.5	-0.1	0.1	-7.2	5.6
Female 5-12	-3.0	2.0	-0.1	0.1	-11.1	7.6
Male 5-12	-3.4	2.3	-0.2	0.1	-12.8	8.5
Female 13-18	-4.4	2.7	-0.2	0.1	-16.4	10.2
Male 13-18	-5.4	3.2	-0.2	0.2	-20.1	12.0
Female 19-64	-4.3	3.0	-0.2	0.1	-16.0	11.1
Male 19-64	-5.1	3.5	-0.3	0.2	-19.1	13.1
Female 65+	-6.2	4.0	-0.3	0.2	-23.4	15.2
Male 65+	-6.8	4.5	-0.4	0.2	-25.3	16.7

Notes: Reformulation of 30% of target, consumers respond by 30% of price increase. Mean reduction in grams of added sugar and salt per person per day from an added sugar tax of £3 per kilo and salt tax of £6 per kilo. Calories are 3.75 times grams reduction in added sugar. For ages less than 13 at home food only.

Table 5.4: *Scenario 2(a): reduction in sugar , salt and calories*

	Added sugar		**Salt**		**Calories**	
dhscAge	Mean	Sd	Mean	Sd	Mean	Sd
Female 0-4	-3.0	2.3	-0.2	0.1	-11.2	8.7
Male 0-4	-3.3	2.6	-0.2	0.2	-12.3	9.9
Female 5-12	-5.0	3.6	-0.3	0.2	-18.9	13.3
Male 5-12	-5.9	4.0	-0.3	0.2	-22.0	15.2
Female 13-18	-8.0	5.3	-0.4	0.3	-29.9	19.9
Male 13-18	-9.3	5.3	-0.5	0.3	-34.9	19.9
Female 19-64	-8.0	5.8	-0.5	0.4	-30.1	21.9
Male 19-64	-9.3	6.8	-0.7	0.5	-35.0	25.6
Female 65+	-11.2	7.3	-0.9	0.6	-42.1	27.4
Male 65+	-11.9	8.2	-1.0	0.6	-44.7	30.7

Notes: Reformulation of 100% target, no response by consumers. Mean reduction in grams of added sugar and salt per person per day from an added sugar tax of £3 per kilo and salt tax of £6 per kilo. Calories are 3.75 times grams reduction in added sugar. For ages less than 13 at home food only.

Table 5.5: *Scenario 2(b): reduction in sugar , salt and calories*

	Added sugar		**Salt**		**Calories**	
dhscAge	Mean	Sd	Mean	Sd	Mean	Sd
Female 0-4	-4.3	3.2	-0.2	0.2	-16.3	11.9
Male 0-4	-4.8	3.6	-0.3	0.2	-17.9	13.5
Female 5-12	-7.3	4.9	-0.4	0.2	-27.4	18.4
Male 5-12	-8.5	5.6	-0.4	0.3	-31.8	20.8
Female 13-18	-11.1	7.0	-0.5	0.3	-41.7	26.1
Male 13-18	-13.4	7.9	-0.7	0.4	-50.4	29.5
Female 19-64	-10.9	7.5	-0.6	0.4	-41.1	28.3
Male 19-64	-13.0	8.9	-0.8	0.6	-48.6	33.2
Female 65+	-15.8	10.0	-1.0	0.6	-59.2	37.5
Male 65+	-17.0	11.1	-1.2	0.7	-63.9	41.8

Notes: Reformulation of 100% target, consumers respond by 70% of price increase. Mean reduction in grams of added sugar and salt per person per day from an added sugar tax of £3 per kilo and salt tax of £6 per kilo. Calories are 3.75 times grams reduction in added sugar. For ages less than 13 at home food only.

Table 5.6: *Scenario 2(c): reduction in sugar , salt and calories*

	Added sugar		**Salt**		**Calories**	
lshtmAge	Mean	Sd	Mean	Sd	Mean	Sd
Male 0-17	-7.2	5.3	-0.4	0.2	-27.0	19.8
Female 0-17	-8.2	6.0	-0.4	0.3	-30.9	22.6
Male 18+	-12.6	8.7	-0.7	0.5	-47.2	32.6
Female 18+	-15.0	10.2	-0.9	0.6	-56.3	38.4
dhscAge	Mean	Sd	Mean	Sd	Mean	Sd
Female 0-4	-4.8	3.5	-0.3	0.2	-18.1	13.2
Male 0-4	-5.3	4.0	-0.3	0.2	-20.0	14.9
Female 5-12	-8.1	5.4	-0.4	0.2	-30.5	20.3
Male 5-12	-9.5	6.1	-0.5	0.3	-35.5	23.1
Female 13-18	-12.3	7.6	-0.5	0.3	-46.1	28.6
Male 13-18	-15.0	8.9	-0.7	0.5	-56.1	33.3
Female 19-64	-12.0	8.2	-0.7	0.4	-45.1	30.9
Male 19-64	-14.3	9.7	-0.8	0.6	-53.6	36.2
Female 65+	-17.5	11.1	-1.1	0.6	-65.5	41.5
Male 65+	-18.9	12.3	-1.2	0.7	-70.9	46.2

Notes: Reformulation of 100% target, consumers respond by 100% of price increase. Mean reduction in grams of added sugar and salt per person per day from an added sugar tax of £3 per kilo and salt tax of £6 per kilo. Calories are 3.75 times grams reduction in added sugar. For ages less than 13 at home food only.

5.2 Health impacts of a sugar tax

The DHSC calorie model provides an estimate of health-related economic benefits of the scenario discounted[6] to estimate the present value of these future benefits, as consistent with the HMT green book.[7]

The estimate comprises:

- Health benefits, the monetised increase in quality adjusted life years (QALYs)
- NHS costs, the reduction in NHS treatment costs for obesity-related conditions
- Economic output, the increase in economic output due to a larger and healthier workforce

[6]The general discount rate of 1.5% is applied to the Economic Output and Social Care Costs with the health discount rate of 3.5% applied to the Health Benefits and NHS costs.

[7]Discount rates and the monetised value of a QALY are given in the HMT Green Book, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/685903/The_Green_Book.pdf

- Social Care costs, the reduction in Social Care costs

The 25-year total health related economic benefit, the four component benefits, and the QALY gain, are given in Table 5.7. The results are for England only. [8]

Table 5.7: *Health related economic benefits from calorie reductions resulting from a sugar tax*

	Scenario:			
	1	2(a)	2(b)	2(c)
QALY count in 1000s (not discounted)	344	631	873	962
Economic Output (£m)	1,912	3,520	4,852	5,337
NHS costs (£m)	1,363	2,500	3,462	3,814
QALY (£m)	16,388	29,984	41,530	45,739
Social care costs (£m)	1,644	2,976	4,084	4,482
Total (£m)	21,307	38,981	53,928	59,372

Notes: A QALY is valued at £60,000 as detailed in HMT Green Book. Monetised benefits are rounded to the nearest million and QALY counts to the nearest 1000. NHS, social care and economic benefits are based on 2019 prices.

This DHSC calorie model does not include all obesity related conditions, for example, it does not include the savings from reduced incidences of musculoskeletal conditions, and so we expect these benefits to be an underestimate. The conditions included are:

- Coronary heart disease (CHD)
- Stroke
- Diabetes
- Breast Cancer
- Colorectal Cancer
- Liver Disease

[8]The model disease prevalence and mortality are calculated from English data, with the model cohorts based on the Health Survey for England data. Therefore, all results relate to the English public health situation, population, demographics and weight distribution. The results can be uprated to the UK by assuming the population of England is 85% that of the UK.

The model reflects the health benefits of lower weight due to reduced calorie intake; it does not include wider health benefits due to nutritional or other lifestyle changes. The model calculates average national benefits, it does not distinguish by region or demographics.

5.3 Health impacts of a salt tax

Health impacts were estimated by LSHTM using a life table model that applies changes in disease risk factors to current tables of life expectancy in the UK at each age.

For salt reductions, relative risks for coronary heart disease and stroke according to different levels of salt consumption were derived from a paper modelling health gains by salt reduction in Europe Hendriksen et al. (2015) and relative risks for stomach cancer were taken from the Global Burden of Disease study Afshin et al (2019). Where relative risks differed by age, they were weighted these according to the age distribution of the UK population in 2013.

Table 5.8 shows the estimates from the LSHTM modelling exercise. Outputs from the life table models were average changes in life expectancy for each individual in the UK associated with each of the dietary changes and years of life gained over 25 years. Years of life gained were converted into QALYs to produce an estimate of the economic savings (PHE, 2018). This does not take account for years of life lost to disability, additional economic output, NHS savings or social care savings.

Table 5.8: *Health related economic benefits resulting from salt reductions resulting from a salt tax*

	Scenario:			
	1	2(a)	2(b)	2(c)
Change in life expectancy from salt reduction (months)	0.6	1.5	1.8	1.8
QALY count in 1000s (not discounted)	537	1,233	1,403	1,474
QALY (£m)	22,697	52,136	59,291	62,286

Notes: For whole of the UK, QALY valued at £60,000.

6 Discussion

Some of the major strengths of the analysis presented here are that:

- we have detailed purchased data for a large nationally representative sample with detailed information on the products they purchase, so that what individual households choose to purchase is the key driver of the results.
- the data are relatively recent (2019) and represent a whole year (so seasonal variation on dietary habits does not affect the results).
- back of pack nutrition information gives an accurate account of nutrients within products, accounting for differences by brand/flavour variant etc.
- we are cautious in the way we use the data, and thus our estimates are likely underestimates of the true impact. For example, we have removed the largest 1% of purchases of added sugar and salt to reduce the likelihood of extreme observations skewing the data.

Some of the major limitations of this analysis are that:

- we only consider the calorie reduction from consuming less sugar, however, if people stop buying a product and do not replace it with another, there will be a greater calorie reduction as the fat/protein/carbohydrates they don't eat will contribute to reduced calories.
- we do not account for any change in behaviour by manufacturers or retailers, other than reformulation. For example, changes in promotions/marketing, changes to pack size or changes to the store environment etc. These could either amplify or mitigate the impacts of the tax.
- we use the same conversion factor to estimate added sugars (from total sugars) in both pre- and post-reformulation scenarios. The tax on added sugars could lead to greater reductions in added sugar than in total sugars. The data measures purchases and might under or over-estimate consumption.
- we do not account for the interaction of the sugar or salt tax with VAT. The price of goods that are subject to VAT could increase by more than more than just the tax.

Appendices

A Reformulation targets

We use the 2020 sugar targets (PHE, 2017) and 2024 salt reduction targets (PHE, 2020) set by Public Health England to represent the maximum level of reformulation that could be expected within each product category. PHE sugar targets are for total sugars, which are reported on the product back of pack nutrition label. The targets take into account the average amount of added sugar in a product category, and thus represent reformulation targets through the removal of added sugar. The PHE salt targets account for the fact that salt is essential for some products e.g. processed meat.

We mapped categories of products in the Kantar data to the categories that PHE used to express salt and sugar reduction targets. The sugar reduction target was taken as the 20% reduction target for each category (g sugar/100g product) which was set to be achieved by 2020 (PHE (2017)). The salt reduction target was taken as the 2024 maximum target for each category (g salt/100g product). Where no maximum target was given, we used the sales-weighted average target for either the product or range. Some categories did not map directly to a PHE salt or sugar reduction target category. Where they contained only small amounts of added salt or sugar (e.g. fruit, vegetables, cooking oils, herbs and spices), the target fields were left blank (N/A), and we assumed that no reformulation would occur. Where a categories contain added sugar or salt we mapped to the closest alternative target category. A full list of the mappings we used for categories that did not have a PHE target are shown in Tables A.1 and A.2. PHE salt and sugar targets and descriptive statistics by category are shown in Tables A.3 and A.4 for at home and out of home respectively.

The Kantar Food out of home data reports expenditure at the individual transaction level. For some products quantity purchased is available, but not for all products (for example meals). Nutrient information is also not included in the data. We match OOH products at the sub-category level to MAFFcodes (used by the Living Costs and Food Survey, LCFS), which express nutrients per gram of product. Where quantities are not available, we impute them using expenditure per kg on that category in the LCFS.

Table A.1: *Sugar target category mapping decisions for sub-categories without a PHE sugar target*

Kantar category(ies) description	PHE sugar target category
Rice, noodles, pasta	N/A
Fish, meat	N/A
Fruit, veg, nuts	N/A
Cheese	N/A
Cooking fats	N/A
Herbs and spices	N/A
Frozen yogurt, yogurt drinks	Yogurt
Cake coverings, icing	Sweet sauces/dessert toppings
Jam, syrups	Fruit spreads
Soft drinks	4.9g (just below SDIL cut-off)
Food drinks (e.g. hot chocolate powders)	4.9g (just below SDIL cut-off)
Condiments, cooking sauces, dips	Sweet sauces/dessert toppings
Ready meals, soups, pizza, baked beans etc	Morning goods
Savoury snacks e.g. crisps and crackers	Sweet biscuits
Savoury pastries	Morning goods
Bread	Morning goods

Table A.2: *Salt target category mapping decisions for sub-categories without a PHE salt target*

Kantar category(ies) description	PHE sugar target category
Fruit, veg	N/A
Cooking oils	N/A
Yogurts/fromage frais	N/A
Soft drinks	N/A
Confectionary	N/A
Sweet spreads	N/A
Soft rind cheese (brie and camembert)	Cheese targets mean
Fish	Meal centres
Pizza bases	Bread
Custard, mousse, jelly, rice pudding, crème caramel	Other puddings
Fresh meat	Cooked meat
Mustard	Brown sauce
Olives	Canned vegetables
Unmapped condiments	Table sauces targets mean
Dips	Table sauces targets mean
Sandwich spreads/fillers	Sandwiches
Pickles e.g. onions/beetroot/gherkins	Canned tuna
Antipasti	Canned vegetables

Table A.3: *Reformulation targets by category, food at home*

Category	Target	Expenditure weighted intensity (g per100g)	% products above target	% purchases from this category		% purchases above target	
	sugar	sugar	sugar	sugar	added sugar	sugar	added sugar
Fruit		12.37	0.0	15.8	0.3	0.0	0.0
Vegetables		2.64	0.0	6.1	0.0	0.0	0.0
Grains		1.74	0.0	0.0	0.0	0.0	0.0
Bread	10.0	4.07	19.7	3.8	0.1	33.8	43.8
Breakfast cereals	12.3	15.72	66.8	3.9	5.6	88.5	89.1
Morning goods	10.0	13.56	90.2	1.4	1.6	93.9	93.9
Dairy and eggs	38.7	3.59	0.0	10.5	0.0	0.0	0.0
Yoghurt	11.0	9.60	44.5	3.6	3.6	57.4	57.0
Cheese fats		0.85	0.0	0.3	0.0	0.0	0.0
Red meat	10.0	0.59	0.0	0.4	0.2	0.0	0.0
Poultry and fish		0.41	0.0	0.2	0.2	0.0	0.0
Condiments and deli	38.0	8.84	2.8	3.6	5.1	10.3	10.2
Savoury snacks	26.2	3.11	1.0	0.5	0.0	1.2	0.0
Ready meals	10.0	2.50	1.0	3.0	2.4	4.1	1.0
Fruit juice	4.9	8.54	74.1	3.7	7.1	92.7	92.7
Milk drinks	10.6	22.45	71.8	1.2	1.5	73.7	82.7
Soft drinks	4.9	5.21	20.1	4.4	6.9	48.5	59.7
Sweet spreads	29.3	50.81	70.2	3.3	6.2	60.6	58.9
Biscuits	27.1	27.15	49.4	8.3	14.7	68.9	69.6
Confectionery	45.8	52.54	80.5	12.1	22.8	92.6	93.4
Desserts	23.7	26.89	58.9	13.8	21.7	60.8	63.3
	salt	salt	salt	salt		salt	
Fruit	1.2	0.06	3.3	0.6		39.4	
Vegetables	0.6	0.12	13.6	2.7		32.8	
Grains	0.4	0.23	6.3	0.1		42.1	
Bread	0.8	0.74	22.9	13.4		18.8	
Breakfast cereals	0.9	0.43	6.7	1.9		24.7	
Morning goods	1.0	0.82	10.9	1.7		39.1	
Dairy and eggs	1.2	0.15	0.0	5.5		0.0	
Yoghurt		0.15	0.0	1.0		0.0	
Cheese fats	1.6	1.38	27.2	10.4		38.5	
Red meat	1.4	1.35	53.9	15.3		71.1	
Poultry and fish	0.8	0.68	39.0	5.0		55.8	
Condiments and deli	1.5	3.62	32.5	14.0		71.0	
Savoury snacks	1.5	1.54	47.9	4.2		52.5	
Ready meals	0.9	0.72	21.7	14.1		34.0	
Fruit juice		0.02	0.0	0.1		0.0	
Milk drinks	0.1	0.57	24.6	0.4		48.0	
Soft drinks		0.10	0.0	1.2		0.0	
Sweet spreads	1.2	0.24	1.6	0.3		8.5	
Biscuits	1.1	0.76	17.0	4.1		36.7	
Confectionery	1.2	0.27	2.0	1.0		7.1	
Desserts	0.5	0.33	12.5	2.9		26.9	

Table A.4: *Reformulation targets by category, food out*

Category	Target	Expenditure weighted intensity (g per100g)	% products above target	% purchases from this category		% purchases above target	
	sugar	sugar	sugar	sugar	added sugar	sugar	added sugar
Soft drink	5.0	9.41	75.4	32.6	39.3	99.6	100.0
Hot beverages	4.9	1.60	11.2	3.1	2.9	74.7	100.0
Sugar confectionery	48.4	50.27	82.6	6.9	8.3	89.4	94.6
Chocolate confectionery	43.7	54.11	83.7	14.7	16.0	82.8	83.1
Cakes and desserts	21.0	21.34	55.6	23.7	24.9	59.9	63.2
Savoury snacks	22.8	3.69	2.0	1.8	1.6	61.9	90.8
Sandwiches	10.0	1.82	0.0	2.1	0.1	0.0	0.0
Fruit and nuts		9.34	0.0	1.1	0.1	0.0	0.0
Vegetables		2.87	0.0	0.0	0.0	0.0	0.0
Meals	15.7	2.45	1.4	13.6	6.7	33.5	73.5
Other	14.9	6.37	18.9	0.4	0.3	39.8	46.3
	salt	salt	salt	salt		salt	
Soft drink		0.02	0.0	0.8		0.0	
Hot beverages		0.03	0.0	0.6		0.0	
Sugar confectionery		0.17	0.0	0.3		0.0	
Chocolate confectionery		0.33	0.0	1.0		0.0	
Cakes and desserts	0.7	0.63	43.6	8.4		51.9	
Savoury snacks	1.4	1.25	37.5	7.2		52.9	
Sandwiches		1.71	0.0	22.9		0.0	
Fruit and nuts		0.12	0.0	0.2		0.0	
Vegetables		0.07	0.0	0.0		0.0	
Meals	0.9	0.86	37.1	57.9		78.6	
Other	1.2	1.08	22.1	0.8		51.8	

B Purchases for home consumption only

We consider the robustness of our results to using only the at home data, where we observe more individuals

Table B.1 shows the number of individuals we observe in the at home data and the matched at home and out of home data. We observe many more people in the at home sample, and in the out of home data we do not observe anyone under the age of 13.

Table B.1: *Number of individuals*

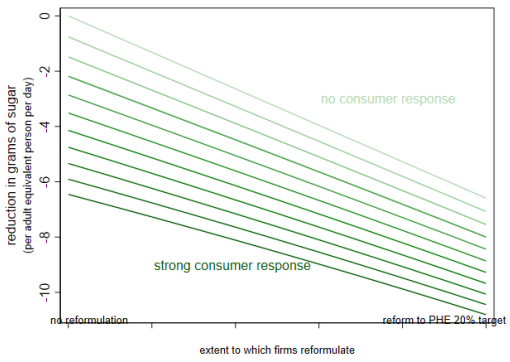
Age	**home**	**out of home and matched**
Female 0-4	2,436	0
Male 0-4	2,549	0
Female 5-10	3,663	0
Male 5-10	3,828	0
Female 11-18	4,357	244
Male 11-18	4,491	210
Female 19-64	25,843	5,246
Male 19-64	23,040	3,151
Female 65+	6,217	580
Male 65+	6,014	558
Total	82,438	9,989

Notes: For the matched sample the youngest age is 13.

These are the results using only the at home data but using information on all 30,000 households.

Figure B.1: *Added sugar and salt tax*

(a) added sugar



(b) salt

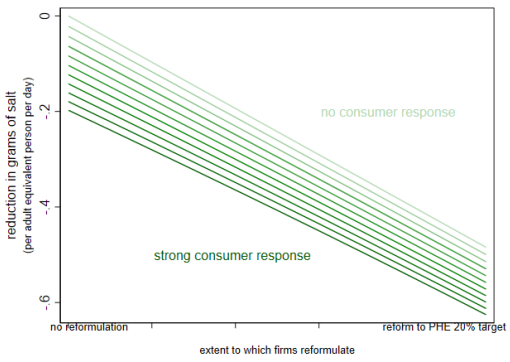


Table B.2: *Added sugar and Salt tax: reduction in added sugar and salt (g per adult equivalent per day)*

reduction in added sugar (g per person per day)												
	Firm reformulation:											
	none			⟶			increasing to			⟶		full
Consumer response:												
none	-0.0	-0.7	-1.3	-2.0	-2.0	-2.6	-3.3	-4.0	-4.6	-5.3	-5.9	-6.6
	-0.8	-1.4	-2.0	-2.6	-2.6	-3.3	-3.9	-4.5	-5.2	-5.8	-6.4	-7.1
	-1.5	-2.1	-2.7	-3.3	-3.3	-3.9	-4.5	-5.1	-5.7	-6.3	-6.9	-7.5
	-2.2	-2.8	-3.3	-3.9	-3.9	-4.5	-5.1	-5.6	-6.2	-6.8	-7.4	-8.0
	-2.9	-3.4	-4.0	-4.5	-4.5	-5.1	-5.6	-6.2	-6.7	-7.3	-7.9	-8.4
	-3.5	-4.0	-4.6	-5.1	-5.1	-5.6	-6.1	-6.7	-7.2	-7.8	-8.3	-8.9
	-4.1	-4.6	-5.1	-5.6	-5.6	-6.1	-6.6	-7.2	-7.7	-8.2	-8.7	-9.3
	-4.7	-5.2	-5.7	-6.2	-6.2	-6.7	-7.1	-7.6	-8.1	-8.6	-9.2	-9.7
	-5.3	-5.8	-6.2	-6.7	-6.7	-7.2	-7.6	-8.1	-8.6	-9.1	-9.6	-10.1
	-5.9	-6.3	-6.8	-7.2	-7.2	-7.6	-8.1	-8.5	-9.0	-9.5	-10.0	-10.4
full	-6.5	-6.9	-7.3	-7.7	-7.7	-8.1	-8.5	-9.0	-9.4	-9.9	-10.3	-10.8
reduction in salt (g per person per day)												
	Firm reformulation:											
	none			⟶			increasing to			⟶		full
Consumer response:												
none	-0.0	-0.0	-0.1	-0.1	-0.1	-0.2	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5
	-0.0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5
	-0.0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5
	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5
	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5	-0.5
	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5	-0.6
	-0.1	-0.2	-0.2	-0.3	-0.3	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5	-0.6
	-0.1	-0.2	-0.2	-0.3	-0.3	-0.3	-0.4	-0.4	-0.4	-0.5	-0.5	-0.6
	-0.2	-0.2	-0.2	-0.3	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5	-0.6	-0.6
	-0.2	-0.2	-0.3	-0.3	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5	-0.6	-0.6
full	-0.2	-0.2	-0.3	-0.3	-0.3	-0.4	-0.4	-0.4	-0.5	-0.5	-0.6	-0.6

Table B.3 shows the change for individuals separating out the change in at home and out of the home purchases.

Table B.3: *Added sugar and salt tax, full consumer response, full reformulation*

	all		matched					
	home		both		home		out	
reduction in added sugar (g per person per day)								
dhscAge	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd
Female 0-4	-4.8	3.5						
Male 0-4	-5.3	4.0						
Female 5-12	-8.1	5.4						
Male 5-12	-9.5	6.1						
Female 13-18	-10.1	6.5	-12.3	7.6	-10.6	6.8	-1.7	2.8
Male 13-18	-12.8	7.9	-15.0	8.9	-13.5	8.7	-1.5	2.0
Female 19-64	-10.1	7.8	-12.0	8.2	-10.0	7.3	-2.0	2.9
Male 19-64	-12.5	9.1	-14.3	9.7	-12.3	8.8	-2.0	3.5
Female 65+	-15.4	10.0	-17.5	11.1	-15.2	10.7	-2.3	3.0
Male 65+	-16.8	10.4	-18.9	12.3	-16.5	10.9	-2.4	4.0
Total	-11.3	8.6	-13.5	9.4	-11.5	8.5	-2.0	3.2
reduction in salt (g per person per day)								
dhscAge	Mean	Sd	Mean	Sd	Mean	Sd	Mean	Sd
Female 0-4	-0.3	0.2						
Male 0-4	-0.3	0.2						
Female 5-12	-0.4	0.2						
Male 5-12	-0.5	0.3						
Female 13-18	-0.5	0.3	-0.5	0.3	-0.5	0.3	-0.0	0.1
Male 13-18	-0.7	0.4	-0.7	0.5	-0.7	0.4	-0.0	0.1
Female 19-64	-0.6	0.4	-0.7	0.4	-0.6	0.4	-0.1	0.2
Male 19-64	-0.8	0.5	-0.8	0.6	-0.7	0.5	-0.1	0.2
Female 65+	-0.9	0.5	-1.1	0.6	-0.9	0.5	-0.2	0.3
Male 65+	-1.0	0.6	-1.2	0.7	-1.0	0.6	-0.2	0.4
Total	-0.7	0.5	-0.8	0.5	-0.7	0.5	-0.1	0.2

Notes: Mean reduction in grams of added sugar per person per day from an added sugar tax of £3 per kilo. For the matched sample and out the youngest age is 13.

C Calculations

Price change

The Consumer Price Index (CPI) is an index of the prices of a "typical" basket of goods times weight for each good in the basket. The basket changes slowly (every year) to reflect changes in spending patterns, based on spending patterns in LCFS.

CPI is measured using :

$$\Delta p = \frac{\sum_j p_j^t q_j^0}{\sum_j p_j^0 q_j^0} \tag{C.1}$$

where 0 is the base period, t is the current period, p are prices, q are quantity weights.

Technical details on calculations

Notation:

- i: households
- j: products
- t: transactions (i.e. an observations of a household purchasing a product on a specific date and location)
- p_j: pre-tax price of product j (the one recorded in the Kantar data). This is the mean price across all transactions in the Kantar data and includes VAT and any price discounts (sales). We add the added sugar and salt taxes to the VAT inclusive price (in reality it will likely be levied prior to VAT)
- s_j: pre-tax grams of added sugar or salt in product j
- s_j^*: post-tax grams of added sugar or salt in product j, reflecting reformulation
- t: tax rate per g of added sugar or salt
- p_j^*: the after tax price with full pass-through is:

$$p_j^* = p_j + t * s_j^*$$

- q_j: pre-tax quantity of product j purchased
- q_j^*: post-tax quantity of product j purchased We consider the following tax rates:
  - **added sugar**, a tax of £3/kg of added sugar, or $t = 0.3$, which is approximately the level of the SDIL.[9]

[9] 24p per litre if 8g per 100 ml, is 80g per litre, is around 0.3p per g of added sugar

– **salt** a tax of £6/kg of salt, or $t = 0.6$, this would increase the price of the cheapest wholemeal loaf by 12% (4p) which we judge to be politically feasible while still providing a clear incentive to reformulate.

The % change in price of each product is,

$$\%\Delta p_j = \frac{(p_j^* - p_j)}{p_j}$$

and the (transaction weighted) mean change in price is

$$\%\Delta p = \frac{1}{N_j}\frac{1}{N_p}\sum_j \sum_p \%\Delta p_j p$$

where p indicates purchases or transactions
The % change in added sugar (equivalent for salt) is

$$\%\Delta s = \frac{\sum_j \left(q_j^* s_j^* - q_j s_j\right)}{\sum_j q_j s_j}$$

where

- the new quantity depends on how responsive consumers are to the price change and what they substitute towards, substitution away from products is captured by β (the own-price elasticity of all products with added sugar)

$$q_j^* = \left(\frac{1}{1 + \%\Delta p_j}\right)^{\beta} q_j$$

- where the manufacturer reformulates

$$s_j^* = max(\bar{s}_j^{PHE}, s_j)$$

where $\bar{s}_j^{PHE}$ is the PHE target, which we take as a technologically feasible maximum for that product category. This is in terms of total sugars. We assume the share of added sugars remains the same.

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