Industry levy versus banning promotion on soft drinks in Scotland: A distributional analysis

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ABSTRACT

In 2018, Public Health England and the UK House of Parliament introduced a soft drinks industry levy to reduce the amount of sugar in sugar-sweetened beverages (SSBs). In addition to the positive results coming from the levy, in January 2019 the UK Government opened a consultation to consider regulating the use of price promotions on foods high in fat, sugar, and salt content. The levy and the banning of promotions could have similar effects (i.e., to potentially increase the product price); however, there is no study comparing their ex-ante effectiveness in reducing sugar consumption and even less their distributional impact. The purpose of the present study is to compare the effect and distributional impact of the measures. To achieve this, we estimated an EASI demand model using scanner panel data for Scotland for the period 2013 to 2017 (i.e., before the introduction of the levy). The results from the present study show that banning promotions on soft drinks would be more effective in reducing energy and sugar purchases than the soft drinks levy. The effectiveness of either policy varies by income, life stage, location, and degree of deprivation in Scotland. This argues for targeted policies instead of the usual 'one-size-fits-all' government policy. Specifically, banning promotions could reduce the annual quantity of beverage purchases by 35.8 per cent whereas the soft drinks levy results in only a 1.36 per cent reduction in annual beverage purchases Also, banning promotions reduces annual sugar purchases by 9 per cent compared to 3.9 per cent for the soft drinks levy. Translating this into changes in intake show that the average person will lose 0.85 kg and 0.36 kg per annum for the ban on promotions or soft drinks levy, respectively. The marginal changes in body weight suggest that other avenues such as a tax on and/or restricting promotions on dietary fat should be explored to achieve a larger impact.

1. Introduction

Consumption of sugar-sweetened beverages (SSBs) predisposes consumers to weight gain and risk of dental caries, adiposity, and type 2 diabetes (Hu, 2013; Mishra and Mishra, 2011). For instance, soft drink intake is strongly associated with increased energy intake and body weight (Vartanian et al., 2007).

As a result, the UK Scientific Advisory Committee on Nutrition recommends minimal or reduced intakes of SSBs (Briggs et al., 2017). Following their recommendation, in March 2016, Public Health England and the UK House of Parliament Health Committee advised the UK Government to introduce a tax on SSBs, which became known as the soft drinks industry levy. The levy came into effect in 2018. The levy was imposed on industries manufacturing or importing sugar-sweetened beverages in three tiers: soft drinks with a sugar content of less than 5 g/100 ml – no tax; drinks with sugar content 5-8 g/100 ml – basic level tax; more than 8 g/100 ml – higher-level tax) (Pell et al., 2019). All kinds of alcoholic drinks, milk-based drinks, and fruit juices were exempted from the tax irrespective of their sugar composition. In addition, small producers were excluded from the levy[1]

Industries responded to the tax through reformulation to reduce the sugar content of SSBs (Bandy et al., 2020). In addition, to minimize sugar intake, industries encouraged buyers to buy reformulated drinks (lower in sugar content) through advertisement (Briggs et al., 2017). Even though the UK government did not want the tax to be passed on to buyers through an increase in the retail price of SSBs, this was not

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[1] Briggs et al., 2017 showed that small producers contribute a negligible amount of 0.6% to the total UK SSB sales. As a result, we did not adjust the data to account for these producers.

guaranteed. For instance, Scarborough et al. (2020a) show that some manufacturers and importers passed on some amount of the soft drinks levy to consumers as higher prices.

Ludbrook (2019) highlighted that taxes, subsidies, and price-based interventions are economic instruments that can help promote healthier food and drink choices. Similarly, a policy study by Hagenaars, Jeurissen, and Klazinga (2017) concluded that taxation is effective in reducing the consumption of energy-dense products. For instance, to deal with the rising prevalence of obesity, Hungary raised taxes on sugar-sweetened beverages (SSB), energy drinks, confectionaries, chocolate, and salty snacks in 2011 (Escobar et al., 2013); Finland, in 2011, raised taxes on SSB, ice-creams, chocolates, and confectionery; and France, in 2012, raised taxes on SSB and energy drinks (Berardi et al., 2016). Denmark introduced taxes on saturated fat (nutrient tax) in October 2011 but this change was later abolished (in 2012; Jensen et al., 2016; Smed, 2012).

The impact of the UK soft drinks industry levy was always going to vary depending on the measures adopted by the soft drink industry. For instance, a reformulation by Sprite and Lipton Iced Tea led to a reduction in sugar concentration by 30% in 2015 (Mason, 2015). Similarly, in 2015, the British Soft Drinks Association projected to reduce sugar and caloric concentration by 20% by 2020 (British Soft Drinks Association (BSDA), 2016). A recent study by Pell et al. (2021) shows that soft drinks sugar purchases in the UK had reduced by (30 g.) 10 per cent per household per week one year after the implementation of the levy.

Even though price-based interventions on unhealthy foods have been beneficial in western Europe and North America (see Escobar et al., 2013; Hagenaars et al., 2017; Jensen et al., 2016), some stakeholders and lobby groups are campaigning for mandatory restriction on price promotions of unhealthy foods and beverages (Huse et al., 2020). Price promotions are temporary price reductions and bundle deals used by retailers and/or manufacturers to increase sales (Chandon, 1995). According to Backholer, Sacks, and Cameron (2019) buyers are more responsive to price promotions on unhealthy foods and beverages than healthy foods. Price promotions, therefore, present an untapped policy to influence diet and reduce obesity among the population (Zorbas et al., 2019).

Following the increasing prevalence of obesity in the UK, the UK and Scottish governments have proposed policy reforms through restrictions on price promotions on unhealthy foods and beverages (APS Group Scotland, 2018; Obesity Action Scotland, 2019; Pomeranz, 2014). According to Huse et al. restricting promotions on SSBs presents a cost-effective option for reducing daily energy intake by 12.52 kJ and mean body weight by 0.11 kg. However, the extent of cost-effectiveness depends strongly on how buyers and the SSB industry respond (Huse et al., 2020).

To the best of our knowledge, no study has compared the potential effectiveness of mandatory promotion restriction versus taxing soft drinks based on their sugar content after the implementation of the industry levy. Recent studies have adopted the approach of either estimating the effectiveness of SSB taxes (Berardi et al., 2016; Colchero et al., 2016; Jensen et al., 2016; Smed, 2012), e.g. the soft drinks levy on the sugar content of soft drinks and health (Briggs et al., 2017; Scarborough et al., 2020b), or evaluating the effectiveness of promotion restriction (Huse et al., 2020) in different countries. The later study assessed the potential effectiveness of mandatory restrictions on promotions for SSBs in Australia using consumption data from Australia and SSB sales data from the UK. They applied a multi-state, multiple-cohort Markov model to estimate the impact on obesity and cost impact. They concluded that mandatory restriction of price promotions on SSBs is likely to be more cost-effective. Mexico implemented a 1 peso per litre excise tax on SSBs in January 2014. Colchero et al. (2016) estimated the changes in beverage purchases for 2014 and 2015. They concluded that purchases of SSBs reduced by 5.5 percent in 2014 and 9.7 per cent in 2015. Even though these two studies suggest that SSB taxes and mandatory promotion restrictions are effective in reducing the

consumption of SSBs, they are geographically and methodologically incomparable. There is therefore a need to empirically estimate which of the two policies is more effective in reducing dietary sugar and energy intake. We have used an Exact Affine Stone Index (EASI) demand model to estimate and compare the potential effectiveness of the two policies. The tax level imposed on soft drinks was based on their average sugar content. A similar taxation strategy has been suggested by Dimbleby for sugar (£3/kg) and salt (£6/kg) content of processed foods sold in supermarkets, restaurants, and catering, sparing only small companies such as takeaways (Quinn, 2021). We estimated an average sugar content of about 78 g per litre for soft drinks. This suggests that the average soft drink will now attract a tax rate corresponding to mid-sugar content drinks – 18 pence/litre. To assess the implications of restricting promotions on soft drinks, we have set the promotional index of soft drinks in the EASI demand model to zero and calculated the net effect on both demand and nutrient purchases.

The contributions of this paper are as follows: Unlike previous studies evaluating the health effect of the UK soft drinks levy (Bandy et al., 2020; Briggs et al., 2017), a major contribution of this paper is the ex-ante evaluation of the soft drinks industry levy in Scotland using home scan data following the implementation of the tax. Unlike Briggs et al. the tax rate is based on the actual sugar content of soft drinks bought in 2018. Second, this is the first paper to modify the EASI demand model to incorporate promotional indices estimated following Drèze et al. (2004) and Revoredo-Giha et al. (2018). Unlike Huse et al. (2020) or Scarborough et al. (2020), this paper compares the effectiveness of the industry levy to restricting promotions on sugar consumption and body weight. In addition, the EASI demand model is modified to incorporate unobserved household heterogeneity in our policy simulation. Finally, the results are presented for different demographic groups in Scotland to bring to light the distributional impact of the measures.

The remainder of the article is structured as follows: Section 2 describes the data used in this study. Section 3 discusses the empirical model applied to our data and the simulation scenarios. Section 4 shows the main results and brief discussions. The paper ends with conclusions.

2. Data and empirical model

The econometric dataset used for the analysis was constructed from the Kantar Worldpanel database from 2013 to 2017 i.e., before the introduction of the soft drinks industry levy. Kantar Worldpanel collects data from a representative panel of households across Great Britain; however, this study was focused on Scotland. The dataset contains food purchases intended for home consumption from a range of retail shops including traditional grocery stores, super- and hyper- markets, and convenience shops. All food products were identified by their universal product code (UPC). Households were made to scan the UPC of each product purchased, type of promotion[2] and promotional prices, date of purchase, retail store, location, and the quantity of each product purchased. Retail promotions usually last a week and run from Thursday of one week to Wednesday of the following week. We identified all households who made use of temporary price discounts during their shopping trip in the week. At the end of each week, participating households transmit their purchase data electronically to Kantar Worldpanel.

A panel of 2,568 unique households who were present in the dataset for more than 40 weeks were used for the analysis. Household-specific information that was included in the dataset was age, gender, social class, location, Scottish index of multiple deprivation (SIMD), number of children, number of adults, and life stage.

Based on the UK 'Eat Well' guidelines, beverages were aggregated

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[2] Includes temporary price reductions, multi-buy offers and buy-one-get-one free offers.

into five categories: mineral water, soft drinks, juices, other drinks, and drinks with health claims. All other groceries purchased by the household were aggregated into a numeraire category[3]. This allows us to model the complete basket of foods purchased by each consumer in the panel.

To estimate the product group prices and promotional indices, this study follows the approach of Drèze et al. (2004). The approach requires group price to be computed using a weighted average of the prices of the individual products in each group. The advantage of using this method to compute the category price is that category price during a given trip by a given household would reflect the price of all products the household might buy. However, using a weighted average to construct price indices comes with its challenges. For instance, what items to include and what the weighting scheme should be (Drèze et al., 2004; Revoredo-Giha et al., 2018). This study followed the approach proposed by Manchanda, Ansari, and Gupta (1999) and Krishnamurthi and Raj (1988) to deal with these challenges. Unlike Manchanda et al. (1999) and Krishnamurthi and Raj (1988) who used only multi-buys, we considered all types of price promotions for our analysis. Thus, the overall price for a category in our data was estimated as the weighted average of product prices in effect that year where the weights[4] are the share of each product bought by the household in that year.

The mathematical formula for computing the group expenditure, weighted prices, and promotion variables is below (number):

Group expenditure of each household Y_{jt}^i, was estimated as:

$$Y_{jt}^h = \sum_{s=1}^{S} p_{st} \cdot q_{st}^h \tag{1}$$

Group price of each household P_{jt}^i, was estimated as:

$$P_{jt}^h = \sum_{s=1}^{S} p_{st} \cdot w_s^h \tag{2}$$

Finally, the group promotional index for each household, Pr_{jt}^h was also estimated using:

$$Pr_{jt}^h = \sum_{s=1}^{S} pr_{st} \cdot w_s^h \tag{3}$$

where:

Pr_{jt}^h is 1 if product s was on promotion during trip t; 0 otherwise.

p_{st} is the price of product s during time t.

q_{st}^h is the quantity of product s bought by household h at time t.

s = number of individual products in category j.

t = time period from 1…T

The weights associated with product s in household h, w_s^h was calculated as follow:

$$\frac{\sum_{t=1}^{T} p_{st} \cdot q_{st}^h}{\sum_{t=1}^{T} \sum_{k=1}^{S} p_{kt} \cdot q_{kt}^h} \tag{4}$$

Since not all households purchased all five beverages, missing prices were replaced with the mean prices from adjacent regions.

The summary of the data is presented in Table 1. Drinks with health claims are the most consumed beverage followed by soft drinks. All other types of drinks that were not in any of the four categories were summed into other drinks representing 0.26 per cent of drinks bought between 2013 and 2017. Non-consuming households were 16 per cent, 3.3 per cent, 23.2 per cent, 24.1 per cent and 2.5 per cent for mineral water, soft drinks, juices, other drinks and drinks with healthy claims, respectively. In terms of promotions, drinks with health claims had the

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[3] The numeraire category included all other food products.
[4] Weight given to each item is the share of expenditure of that item over the whole span of the study for the given individual.

Table 1
Mean budget shares, prices, and promotional indices of purchases from 2013 to 2017.

Food products	Shares (%)	Prices	Promotional index	Non-consuming households (%)
Mineral water	0.38	0.57	1.28	16.00
Soft drinks	1.22	1.39	2.32	3.30
Juices	0.34	0.92	1.29	23.20
Other drinks	0.26	1.55	1.16	24.10
Drinks with health claims	1.84	1.28	3.61	2.50

Source: Own *computation based on Kantar Worldpanel data, 2021*.

highest promotional index followed by soft drinks. Among the five beverages, mineral water had the lowest average price per litre whilst the 'other drinks' category had the highest average price.

Table 2 presents the household's sociodemographic characteristics. Sociodemographic data that were considered in the analysis included the life stage of respondents, SIMD, income levels, gender, age, number of children, and number of adults in the household. Gender, age, number of children, and number of adults were included in the model as explanatory variables.

The majority of the respondents (67.5 per cent) lived in urban areas whilst the remaining 32.5 per cent lived in remote small towns, accessible small towns, and accessible rural areas. The Scottish 2017 census data show that 71 per cent of households live in urban areas (The Scottish Government, 2018). The SIMD is the Scottish Government's standard approach to identify areas of multiple deprivation in Scotland. This considers the extent to which residents in an area are deprived of income, employment, education, health, access to services, level crime rate, and housing. Table 2 shows that 16.5 per cent of respondents are in the first quintile, 21.5 per cent are in the second quintile, 20.5 per cent are in the third quintile, 21.04 per cent are in the fourth quintile and 18.4 per cent are in the fifth quintile. The distribution is quite similar to that found in Scotland in 2017 (see The Scottish Government, 2018).

Table 2
Average household characteristics.

Demographics	Distribution (%)	Std. dev.	95% confidence interval	
Life stage				
Pre-family	13.62	0.004	0.129	0.144
Young family	11.65	0.004	0.110	0.123
Middle family	7.93	0.003	0.073	0.085
Older family	8.92	0.003	0.083	0.095
45 + no children	57.87	0.004	0.110	0.123
Scottish Deprivation Multiple Index				
SIMD quintile 1	16.50	0.004	0.157	0.173
SIMD quintile 2	21.46	0.005	0.206	0.223
SIMD quintile 3	20.53	0.004	0.197	0.214
SIMD quintile 4	21.04	0.004	0.202	0.219
SIMD quintile 5	18.40	0.004	0.176	0.192
N/A	2.08	0.002	0.018	0.024
Location				
Large Urban Areas	28.27	0.005	0.273	0.292
Other Urban Areas	39.20	0.005	0.381	0.403
Accessible Small Towns	8.93	0.003	0.083	0.096
Remote Small Towns	3.42	0.002	0.030	0.038
Accessible Rural Areas	13.81	0.004	0.131	0.146
Remote Rural Areas	6.36	0.003	0.058	0.069
Income Groups				
£0 - £29,999	58.49	0.003	0.083	0.095
£30,000 - £39,999	17.55	0.005	0.234	0.252
£40,000 - £49,999	11.89	0.005	0.231	0.250
£50,000 - £59,999	6.22	0.004	0.164	0.180
£60,000 - over	5.85	0.004	0.109	0.123
Gender (=1 if male)	27.48	0.005	0.265	0.284
Average age	51.13	0.150	50.840	51.427
Average number of children	0.48	0.009	0.465	0.502
Average number of adults	2.08	0.022	2.033	2.120

About 2 per cent of the respondents did not belong to any of the five quintiles. By life stage[5], consumers were identified as belonging to one of the following: pre-family (13.6 per cent), young family (11.7 per cent), middle and older family (16.9 per cent), and family without children (11.7 per cent). According to income groups, the majority of the respondents (58.4 per cent) earned less than £29,999. However, only about 12.07 per cent of the respondents earned more than £50,000. This figure is slightly lower than the 2017 Scottish census data, which shows that 63 per cent of households earn below £30,000 (The Scottish Government, 2018).

The data contain nutritional information on all products purchased by UPC. Nutritional information contained in the dataset includes carbohydrates, proteins, total fats, saturated fats, sugar, fibre, and sodium. The impact of eliminating all forms of promotion versus Soft Drinks Industry levy were assessed from the energy and nutritional context.

Table 3 presents the mean quantities of nutrients and energy contained in the drinks. Soft drinks contain the lowest amounts of protein and fat per 100 ml. However, they have the highest amount of carbohydrates. The 'other drinks' category has the highest amount of sugar followed by soft drinks. Soft drinks are of public interest as they contain a relatively high amount of calories and sugar but the lowest amount of protein. This explains the large number of policies directed at soft drinks worldwide. Despite the low nutritional composition of soft drinks, Table 1 shows that it is the second most important beverage in the basket of consumers.

3. Empirical methodology: EASI demand model

3.1. Theoretical framework

Temporary price reductions are widely used by retailers to induce shoppers to visit the promoting store and purchase promoted and non-promoted products. Inman and Winer (1999) suggest that about 60 per cent of household supermarket purchases are due to in-store decisions. Temporary price reductions, therefore, have a positive effect on total household shopping expenditure during a shopping trip. Richards and Padilla (2009) studied the effect of price promotions on the demand for fast foods. They used Canadian panel data for their analysis. They find that price promotions increase the demand for fast foods and have a similar effect on restaurant market shares.

Most research work has been done on the impact of promotions on retail sales, specifically on intra-category and inter-category demand (Gupta, 1988; Leeflang and Parreño-Selva, 2012; Nijs et al., 2001; Sun

et al., 2003). These studies focus on maximizing retail sales using price promotions ignoring the potential effects of promotions on health. For instance, Gupta (1988) was interested in the promotional effect on sales due to brand switching, purchase time acceleration, and stockpiling. Leeflang and Parreño-Selva (2012) focused on the inter-category effect of promotions. We deviate from these previous studies by adopting a consumer demand approach where the consumer allocates expenditures between a numéraire good and five beverage groups. The demand model adopted here is an extension of the EASI demand model that allows us to model the effect of banning promotions on energy and nutrient purchases.

To be able to incorporate the effect of eliminating promotions on soft drinks on net energy and nutrient intake, we modified the EASI demand systems to incorporate promotional indices. We expected that promotion for soft drinks at any given shopping occasion would have a positive impact on the expenditure share of soft drinks but a negative impact on the share of the remaining beverages. As such, eliminating promotions on soft drinks should decline the expenditure share of soft drinks. However, the impact on the remaining drinks would depend on the level of substitution between soft drinks and the other drinks. The promotional indices are incorporated in the model as observed household heterogeneity.

3.2. Estimating elasticities

The demand model used comprised of the budget shares of household, h, on category is given by

$$W_h^* = \sum_{r=0}^{5} b_r y_h^r + A\ln P_h + Cz_n + DPr_h + u_h \tag{10}$$

where the index h corresponds to a household; W_h^*, is a j vector of latent budget shares; y^h is the log total real expenditure, log prices $\ln P$ is the j vector of commodity price indices in (2); Pr is a vector of promotional indices faced by household h; z is a an n vector of sociodemographic characteristics; u_h is the error term which captures unobserved household heterogeneity. A, C, D and b_r are matrices and vectors of parameters to be estimated. We followed the approach proposed by Zhen et al. (2013) by estimating a Tobit[6] form of the EASI demand model where the latent budget share W_h^* is related to observed budget share w_h according to $w_h \equiv \max(0, W_h^*)$. The w_h is calculated as the category expenditure divided by the annual expenditure.

The real food expenditure y^h as deflated by the Stone index is given by:

$$y^h = \ln\left(x^h\right) - \mathring{p}_h^{\mathring{A}} w_h \tag{11}$$

where x^h is the total nominal expenditure.

The real food expenditure (y^h) makes the budget share equation to be linear[7] in parameters. For the demand model to be consistent with theory the budget share equations w_h are required to satisfy the properties of adding up and homogeneity through:

$$1_j^{\cdot}A = 1_j^{\cdot}B = 0_j;$$

and

Table 3
Caloric and nutritional contents of beverages consumed in Scotland

All the sample	Mineral water	Soft drinks	Juices	Other drinks	Drinks with health claims
Energy(kcal)	28.77	341.01	367.17	369.55	32.44
Protein(g)	0.89	0.08	3.45	6.34	0.22
Carbohydrate (g)	4.36	83.15	82.55	76.45	4.92
Sugar(g)	4.06	78.54	80.39	70.07	4.36
Fat(g)	0.50	0.03	0.38	2.55	0.07
Saturates(g)	0.07	0.01	0.06	1.45	0.04
Fibre(g)	0.16	0.21	2.06	2.65	0.19
Sodium(g)	0.00	0.04	0.37	0.21	0.11

Source: Own *computation based on Kantar Worldpanel data.*

[5] Life stage was categorised by GB Kantar FMCG as pre-family (main shopper under 45 years, no children), young family (youngest child 0–4 years), middle family (youngest child 5–9 years), older family (youngest child 10+ years), and older dependents (main shopper 45+ years, no children, 3+ adults).

[6] Zhen et al. (2013) suggest that this approach circumvents the empirical difficulties of imposing nonnegativity restrictions under the Kuhn-Tucker framework when estimating demand model with high proportion of non-consuming households.
[7] Lewbel and Pendakur (2009) compared the actual model with the linear approximate model and show that there are not major differences between the parameters from both models.

$$1'_j b_0 = 1, 1'_j b_r = 0 \forall_r \neq 0 \tag{12}$$

Finally, Slutsky symmetry is ensured by the symmetry of the $J \times J$ matrices of A.

There are two sources of endogeneity. First, the presence of budget shares in the stone index makes this index to be endogenous, however, according to Lewbel and Pendakur (2009), this type of endogeneity is numerically unimportant. The second source of endogeneity is that the real food expenditure y^h is a function of the endogenous food group expenditure (x^h). We have controlled for this form of endogeneity following the approach proposed by Lewbel and Pendakur (2009) by using the real food expenditure $\overline{y}^h$ (estimated by replacing the budget shares w_j, with the mean budget shares $\overline{w}_j$) to instrument for food groups expenditure (x^h).

$$\overline{y}^h = ln(x^h) - \sum_{k=1}^{J} ln(P_{kj})\overline{w}_j \tag{13}$$

Demand analyses considered five different household groups: (1) the entire sample; (2) SIMD; (3) Rural-urban classification (4) household income ranges and (5) life stage group. The final model was estimated using iterative 3-Stage least Squares to account for endogeneity.

Expenditure elasticities, Hicksian and Marshallian price elasticities, as well as promotional elasticities, were derived from (10) following Castellón, Boonsaeng, and Carpio, (2015) and Lewbel and Pendakur (2009). The compensated Hicksian price elasticity of demand for good k with respect to the price of the good j was derived by

$$\in = \overline{w}^{-1}(B) + \Omega\overline{w} - I \tag{14}$$

where $\in$ is an $n \times n$ matrix of compensated demand elasticities, $\overline{w}$ is an identity matrix where the ones have been replaced by the group budget shares, Ω is an $n \times n$ matrix of ones and I is an identity matrix.

The vector of expenditure elasticities ϑ were subsequently derived by

$$\vartheta = (\overline{w})^{-1}(I + Ap\hat{A})^{-1}A + 1_n \tag{15}$$

where ϑ is the $J X 1$ vector of estimated expenditure elasticities, A is the expenditure semi-elasticity coefficients which is $\sum_{r=0}^{5} A_r y^r$, p is a vector of mean prices and 1_j is a $J \times 1$ vector of ones.

The matrix of uncompensated Marshallian elasticities, ε, were derived from the Slutsky equation given by

$$\varepsilon = \in - \overline{w}\vartheta \tag{16}$$

The matrix of promotional elasticities, θ were derived using

$$\theta = \overline{w}^{-1}(D) * \overline{Pr} \tag{17}$$

where D is $j \times j$ matrix of promotional coefficients, and $\overline{Pr}$ is an identity matrix where the ones have been replaced by the mean promotional indices, and $\overline{w}$ is an identity matrix where the ones have been replaced by the group budget shares.

3.3. Simulations

The present paper aimed to evaluate the effectiveness of eliminating promotions on soft drinks and compare the results to a tax imposition on soft drinks based on the UK's soft drinks industry levy assuming a pass-through effect of 50 per cent[8]. The price impact of the soft drinks levy is dependent on how the industry implements it. Firms are expected to 1)

reformulate to reduce sugar concentration; 2) raise the prices that consumers pay for; and/or 3) initiate activities to reduce the market share of high and mid-sugar soft drinks (Briggs et al., 2017). Using data following the implementation of the soft drinks levy, we estimated the average sugar content in soft drinks (see Table 3) and this suggested that the average soft drink will attract a tax of mid-sugar soft drink levy. According to the Office for Budget Responsibility, the levy will be 18 pence per litre on mid-sugar soft drinks and 24 pence per litre high-sugar soft drinks. According to Briggs et al. (2017), if all the taxes are passed to the consumer this will cause a price increase of about 75 per cent for the concentrated high-sugar soft drinks and 31 per cent for the regular high-sugar soft drinks. Since the tax was to be imposed on the firm and not the consumer, we assumed a pass-through of only 50 per cent of the tax to consumers corresponding to 9 pence per litre. The impacts were quantified in terms of changes in weekly energy and nutritional purchases from beverages.

The change in the quantities, total expenditure, and expenditure shares consumed after the tax imposition were estimated as:

$$\Delta Q_i = \sum_{j}^{m} \in_{ij} . \frac{\Delta P_i}{P_i} . Q_i \tag{5}$$

$$\Delta E_i = \Delta Q_i * P_i \tag{6}$$

$$\Delta W_i = \Delta E_i / E_i \tag{7}$$

where $\frac{\Delta Q_i}{Q_i}$ and $\frac{\Delta P_i}{P_i}$ represent the percentage change in quantities and price of the i-th beverage, $\in_{ij}$ are the price elasticities, ΔE_i is the change in expenditure after the tax, and ΔW_i is the change in budget shares after the tax.

Finally, the post-tax changes in energy and nutrient were estimated as the difference in the nutrient purchase with and without the tax:

$$\Delta N_i = \Delta Q_i . \aleph \tag{8}$$

ΔN_i is the change in nutrient for the i-th beverage and $\aleph$ is the nutritional coefficient for the i-th beverage.

In contrast to the soft drinks industry levy, the study proposes the elimination of promotions[9] (excluding temporary price reductions) on soft drinks sold in retail shops in Scotland. The impact of the proposed policy was estimated on weekly energy and nutrient purchases from beverages. To estimate the impact of eliminating promotions, we started by setting advertising promotions on soft drinks to zero (i.e. $Pr = 0$). Assuming that prices and expenditure are constant, changes in calories and nutrient i, for food group g can be estimated as

$$\Delta N_{ig} = \left[\frac{\left(-\sum_{j=1}^{J} D_{gj} . \overline{Pr_j} \right)\overline{X}}{\overline{P}_g} \right] \aleph_{ig} \tag{9}$$

where $\overline{X}$ is the average total weekly expenditure, $\overline{P}_g$ is the average price of category g, $\overline{Pr_j}$ is the average promotional index, and $\aleph_{ig}$ is the nutrient i coefficient of food group g. $\sum_{j=1}^{J} D_{gj} . \overline{Pr_j}$ is the change in budget shares, $\left(-\sum_{j=1}^{J} D_{gj} . \overline{Pr_j} \right)\overline{X}$ is the change in expenditure and the change in quantity is measured by $\frac{\left(-\sum_{j=1}^{J} D_{gj} . \overline{Pr_j} \right)\overline{X}}{\overline{P}_g}$.

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[8] Changes in consumption are linear suggesting that at 100 per cent pass-through rate changes in consumption will only double. An estimate by Scarborough et al. (2020b) suggest that prices of high levy category drinks increased by £0.075 suggesting a pass-through rate of 31 per cent. We chose a higher figure due to differences in estimation procedure and data aggregation.

[9] Note this does not mean that prices cannot change, only that they cannot be promoted/advertised.

4. Results

4.1. Price, expenditure, and promotional elasticities

Table 4 presents the price and expenditure elasticities of the average[10] sample. All own-price elasticities and expenditure elasticities and most cross-price elasticities are significant at the 5 per cent significance level. Among the five beverage categories, mineral water, other drinks, and drinks with health claims are price elastic whilst soft drinks and juices are price inelastic. The elasticities of soft drinks and juices confirm results by Revoredo-Giha et al. (2018), however, the estimate for soft drinks differs from results found in Mexico (Colchero et al., 2015) and Chile (Guerrero-López et al., 2017). Scottish consumers are less responsive to price changes in soft drinks compared to consumers in Mexico and Chile. Price elasticity for mineral water tallies with the result found in Mexico (Colchero et al., 2015). All expenditure elasticities are elastic, suggesting that consumers consider these beverages as luxury goods. This makes our expenditure elasticities for soft drinks and juice higher than that found by Revoredo-Giha et al. (2018). The variation in the results could be attributed to differences in the data aggregation and the duration considered.

Table 5 presents the promotional elasticities for the average sample. All own price promotional elasticities are positive and significant at a 5 per cent level. Among the beverages, 'other drinks' are the most responsive to promotions whilst mineral water is the least responsive to promotions. The cross-promotional elasticities for soft drinks show that an increase in promotions for mineral water, juices, and drinks with health claims will reduce demand for soft drinks. On the contrary, an increase in promotions for 'other drinks' will increase the demand for soft drinks.

4.2. The distributional effect of a ban on promotions versus soft drinks levy on beverage demand

4.2.1. Average sample

Table 6 compares the effectiveness of banning promotions on soft drinks compared to imposing a tax according to the soft drinks levy on net demand for beverages. Three main demand variables were considered: changes in expenditure shares, changes in total expenditures, and changes in quantities of beverages consumed per person per year. The results indicate that the former is more effective than the latter. For instance, the net expenditure share allocated to beverages reduces by 24.2 per cent when promotions are banned compared to 2.25 per cent when soft drinks are taxed.

4.2.2. Scottish index of multiple deprivation

Table 7 compares the changes in demand across different households based on their SIMD. Overall, the results suggest that the ban on promotions will be more effective than imposing then implementing the soft drinks levy. However, the impact of both policies varies by SIMD. For the ban on promotions, households in the least deprived areas (SIMD 5) will reduce their expenditure by 28 per cent whilst households in the most deprived areas will reduce their expenditure shares by 17 per cent; about 11 per cent lower. This suggest that persons living in highly deprived areas are less responsive to the ban on promotion. For instance, Turrell et al. (2002) found that consumers from socioeconomically disadvantaged backgrounds are less like to purchase healthy foods i.e. low in sugar, salt, and fat. The high reduction in quantity for persons living in the least deprived areas confirms findings by Nakamura et al., (2015) that higher socioeconomic groups are more responsive to promotions in general on any food category. For the soft drinks levy, the highest

reduction in expenditure shares is 2.4 per cent for households in the least deprived areas (SIMD 5) and the lowest reduction is 1.7 per cent for those living in less deprived areas (SIMD 4). In summary, the results suggest that government policies do not have the same effects across different household types.

4.2.3. Households based on their location

Like previous tables, in Table 8, banning promotion is more effective than the soft drinks levy. For the ban on promotions, households living in large urban areas reduce their expenditures more than those living in other urban areas (difference of 9 per cent). For households in small towns, those living in remote small towns reduce expenditure more than those in accessible small towns (a difference of 5.5 per cent). The largest variations were estimated for households in rural areas, where those living in accessible rural areas reduced their expenditure shares more than those in remote rural areas (a difference of 12.5 per cent). In general, the expenditure shares of rural dwellers will be more affected than urban dwellers. For the soft drinks levy, households living in other urban areas reduce their expenditure more than those in large urban areas (0.34 per cent difference). For small towns, households living in accessible small towns reduce their expenditure shares more than those in remote small towns (a difference of 0.47 per cent). For rural areas, households in accessible rural areas reduce their expenditure shares by 0.15 per cent more than those in remote rural areas. Overall, the levy is more effective on urban dwellers than those in small towns.

4.2.4. Life stage

Table 9 compares the effectiveness of banning promotions versus the soft drinks levy across households based on their life stage. Banning promotions reduces expenditure shares of households aged 45 and without children (28 per cent) more than any other household group. Households with the least reductions in expenditures are those considered as middle families (16 per cent). In terms of quantity, the highest reduction was estimated for the pre-family group (45 kg.) whilst the lowest reduction was estimated for the middle family group. The huge reduction in the quantities by the pre-family group following the ban on promotions confirms findings by Freeman et al., (2016) that young adults are the target populations for energy-dense, nutrient-poor and beverage marketing. For the soft drinks levy, households in the young family group have the highest reduction in expenditure shares (2.9 per cent) whilst those in the middle family group have the least reductions in expenditure shares. In summary, middle family groups are the least responsive to both policies.

4.2.5. Income groups

Table 10 compares the effectiveness of banning promotions versus the soft drinks levy based on income levels. For the ban on promotions, a household with an annual income of £40,000 - £49,999 have the highest reduction in expenditure shares whilst those earning £50,000 - £59,999 have the lowest reduction in expenditure shares (a difference of 13.1 per cent). However, in terms of changes in quantities, households with an annual income of £60,000 and more have the highest reduction in net quantities whilst those £50,000 - £59,999 had the lowest reduction. For the soft drinks levy, households earning £40,000 - £49,999 annually had the highest reduction in expenditure shares whilst those earning £60,000 – over had the lowest reduction. Changes in net quantities of beverages consumed follow the same pattern.

4.3. The distributional effect of a ban on promotions versus soft drinks levy on change in sugar consumption, energy, and body weight

We have used results from a study by Apovian (2004) to simulate the implication of changes in sugar consumption on body weights.

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[10] Price, promotional and expenditure elasticities for the distributional analysis are available upon request. They have been omitted due to space limitations.

Table 4
Mean uncompensated price and expenditure elasticities.

Product	Mineral water	Soft drinks	Juices	Other drinks	Drinks with health claims	Others	Expenditure
Mineral Water	−1.491	0.019	−0.171	0.150	0.010	0.010	−0.002
	(0.0376)	(0.0107)	(0.0364)	(0.0343)	(0.0071)	(0.0003)	(0.043)
Soft drinks	0.054	−0.938	0.054	0.060	0.020	0.023	−0.015
	(0.0344)	(0.0260)	0.0406	(0.0367)	(0.0132)	(0.0005)	(0.029)
Juices	−0.153	0.016	−0.984	0.100	−0.037	−0.037	−0.003
	(0.0322)	(0.0112)	(0.0703)	(0.0511)	(0.0073)	(0.0004)	(0.050)
Other drinks	0.098	0.013	0.075	−1.437	0.008	0.009	−0.003
	(0.0230)	(0.0077)	(0.0387)	(0.0562)	(0.0049)	(0.0003)	(0.045)
Drinks with health claims	0.045	0.038	−0.198	0.065	−1.085	−1.081	−0.018
	(0.0342)	(0.0200)	(0.0395)	(0.0355)	(0.01990	(0.0005)	(0.023)
Others	−1.190	−1.367	−1.094	−1.227	−1.326	−1.297	−1.946
	(0.0003)	(0.0005)	(0.0004)	(0.0003)	(0.0005)	(0.0436)	(0.001)

*Standard errors are in parenthesis.
Source: Own *computation based on Kantar Worldpanel data.*

Table 5
Mean promotional elasticities.

Products	Mineral water	Soft drinks	Juices	Other drinks	Drinks with health claims	Numeraire
Mineral Water	0.314	−0.017	−0.019	−0.004	−0.032	−0.435
	(0.007)	(0.005)	(0.007)	(0.007)	(0.004)	(0.000)
Soft drinks	−0.003	0.468	−0.006	0.002	−0.123	−0.335
	(0.005)	(0.004)	(0.006)	(0.005)	(0.003)	(0.0001)
Juices	−0.043	−0.150	0.487	0.000	−0.181	−0.472
	(0.008)	(0.006)	(0.009)	(0.008)	(0.005)	(0.0001)
Other drinks	0.075	0.184	−0.035	0.669	0.253	−1.560
	(0.012)	(0.008)	(0.013)	(0.011)	(0.006)	(0.0002)
Drinks with health claims	−0.002	−0.029	−0.005	−0.003	0.370	−0.169
	(0.004)	(0.003)	(0.004)	(0.004)	(0.002)	(0.0001)
Numeraire	0.000	−0.002	0.000	0.000	−0.005	0.006
	(0.014)	(0.010)	(0.016)	(0.014)	(0.008)	(0.0002)

*Standard errors are in parenthesis.
Source: Own computation based on Kantar Worldpanel data.

Table 6
Compares changes in demand for the average household.

	Net change in demand (per person per year)	
Demand variables	Banning promotions	Soft drinks levy
Δ in share	−24.15%	−2.25%
Δ in expenditure	−27.32%	−2.21%
Δ in quantity	−35.80%	−1.36%

Source: Own computation based on Kantar Worldpanel data.

Table 7
Compares changes in demand for households based on their SIMD.

SIMD	Demand variable	Net change in demand (per person per year)	
		Banning promotions	Soft drinks levy
1	Δ in share	−16.89%	−2.31%
	Δ in expenditure	−19.94%	−2.19%
	Δ in quantity	−27.13%	−1.44%
2	Δ in share	−27.50%	−2.50%
	Δ in expenditure	−30.24%	−2.40%
	Δ in quantity	−39.57%	−1.55%
3	Δ in share	−23.58%	−2.25%
	Δ in expenditure	−25.73%	−2.32%
	Δ in quantity	−36.57%	−1.39%
4	Δ in share	−27.14%	−1.74%
	Δ in expenditure	−30.02%	−1.73%
	Δ in quantity	−38.35%	−0.93%
5	Δ in share	−28.02%	−2.44%
	Δ in expenditure	−32.35%	−2.43%
	Δ in quantity	−40.08%	−1.55%

Source: Own computation based on Kantar Worldpanel data.

Table 8
Compares changes in demand for households based on their location.

Location	Demand variables	Net change in demand(per person per year)	
		Banning promotions	Soft drinks levy
Large urban areas	Δ in share	−28.54%	−2.06%
	Δ in expenditure	−31.07%	−2.00%
	Δ in quantity	−45.65%	−1.23%
Other urban areas	Δ in share	−19.42%	−2.40%
	Δ in expenditure	−22.68%	−2.30%
	Δ in quantity	−29.45%	−1.49%
Accessible small towns	Δ in share	−20.21%	−1.92%
	Δ in expenditure	−22.53%	−1.86%
	Δ in quantity	−26.08%	−1.16%
Remote small towns	Δ in share	−25.77%	−1.45%
	Δ in expenditure	−26.97%	−1.66%
	Δ in quantity	−39.51%	−0.94%
Accessible rural	Δ in share	−34.57%	−2.32%
	Δ in expenditure	−39.23%	−2.41%
	Δ in quantity	−51.14%	−1.29%
Remote rural	Δ in share	−22.01%	−2.17%
	Δ in expenditure	−25.53%	−2.15%
	Δ in quantity	−27.47%	−1.38%

Source: Own computation based on Kantar Worldpanel data.

According to the study, one can of sugar-sweetened soda drink contains 150 kcal and 40–50 g.[11] of sugar. Therefore, if a person consumes one can of sugar-sweetened soda drink (equivalent to 40–50 g.) each day for a year he will increase his body weight by 6.75 kg. Under this assumption, we estimated the impact of both the ban on promotions and

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[11] Our simulation is based on the average figure i.e. 45 g of sugar.

Table 9
Compares changes in demand for households based on their life stage.

Net change in demand (per person per year)			
Life stage	Demand variables	Banning promotions	Soft drinks levy
Pre-family	Δ in share	−26.69%	−2.71%
	Δ in expenditure	−30.10%	−2.87%
	Δ in quantity	−43.52%	−1.77%
Young family	Δ in share	−18.14%	−2.87%
	Δ in expenditure	−20.99%	−2.80%
	Δ in quantity	−30.10%	−1.87%
Middle family	Δ in share	−16.13%	−1.87%
	Δ in expenditure	−17.95%	−1.79%
	Δ in quantity	−24.19%	−1.09%
Older family	Δ in share	−22.83%	−2.77%
	Δ in expenditure	−24.96%	−2.69%
	Δ in quantity	−32.91%	−1.81%
45 + no children	Δ in share	−28.31%	−1.93%
	Δ in expenditure	−31.15%	−1.86%
	Δ in quantity	−39.72%	−1.09%

Source: Own computation based on Kantar Worldpanel data.

Table 10
Compares changes in demand for households based on their annual income level

Net change in demand			
		Banning promotions	Soft drinks levy
£0 - £29,999	Δ in share	−24.52%	−2.40%
	Δ in expenditure	−27.77%	−2.33%
	Δ in quantity	−35.54%	−1.41%
£30,000 - £39,999	Δ in share	−20.33%	−2.14%
	Δ in expenditure	−22.10%	−2.12%
	Δ in quantity	−31.88%	−1.31%
£40,000 - £49,999	Δ in share	−29.17%	−2.46%
	Δ in expenditure	−31.58%	−2.63%
	Δ in quantity	−45.26%	−1.64%
£50,000 - £59,999	Δ in share	−16.12%	−2.15%
	Δ in expenditure	−20.76%	−2.14%
	Δ in quantity	−25.39%	−1.36%
£60,000 - over	Δ in share	−28.33%	−1.33%
	Δ in expenditure	−32.25%	−1.36%
	Δ in quantity	−48.40%	−0.63%

Source: Own computation based on Kantar Worldpanel data.

the soft drinks levy on body weights using changes in annual sugar consumption per person. We have also estimated the changes in annual calorie consumption per person.

First, Table 11 shows that for the average household, banning promotions on soft drinks will reduce annual sugar (calories) consumption per person by 9.1 per cent (12.6 per cent), which is equivalent to 0.85 kg loss of body weight. On the contrary, the soft drinks levy will reduce annual sugar (calories) consumption per person by 3.9 per cent (3.55 per cent) which is equivalent to 0.36 kg loss of body weight. The current results support the argument that price promotions increase the consumption of unhealthy foods (Watt et al., 2020) since banning them reduces soft drinks purchases more than taxation. Results also support the argument that taxing unhealthy foods reduces their consumption (Briggs et al., 2017; Guerrero-López et al., 2017). In addition, combining both taxation and banning promotions will be more effective in reducing calorie and sugar intake. Despite the huge reduction in calories and sugar purchases, there could be trade-offs to other less healthy food products like snacks and candy which have not been taxed or restricted from promotions. In that case, the changes could be lower than estimated.

Second, we compare the impact of both policies on households based on their SIMD. For the ban on promotions, the lowest reduction in sugar (calories) consumption of 0.13 per cent (3.49 per cent) was estimated for households living in the most deprived areas (quintile 1); equivalent to a 0.01 kg. reduction in body weight. In contrast, the highest reduction of

17 per cent was estimated for households living in the least deprived areas (quintile 5); equivalent to a 1.39 kg. reduction in body weight. However, if soft drinks are taxed, the lowest reduction in sugar (calories) is 3.1 per cent (2.9 per cent) for a household in the fourth quintile, which is equivalent to a weight loss of 0.28 kg. whilst the highest reduction of 4.8 per cent (4.3) was estimated for households in the second quintile, which is equivalent to 0.46 kg. of weight loss.

Third, we compare the impact of both policies on a household by their location. For the ban on promotions, the least reduction in sugar (calories) consumption of 2.5 per cent (6.3 per cent) was estimated for households living in remote small towns, which is equivalent to an annual weight loss of 0.29 kg. Whilst the highest reduction in sugar (calories) consumption of 21.1 per cent (25 per cent) was estimated for those in accessible rural areas, which is equivalent to an annual weight loss of 2 kg. For the soft drinks levy, like the ban on promotions, the lowest reduction in sugar (calorie) consumption of 2.1 per cent (1.99 per cent) was estimated for households living in remote small towns, which is equivalent to an annual weight loss of 0.24 kg. However, the highest reduction of 4.23 per cent (3.9 per cent) was estimated for households living in other urban areas; this is equivalent to an annual weight loss of 0.41 kg. Colchero, Molina, and Guerrero-López (2017) also found that the effect of food policies tends to vary by location of the household. Therefore, to achieve the highest effect, the tax level should vary by location.

Fourth, we compare the impact of both policies on households based on their life stage. For the ban on soft drinks promotions, the lowest reduction in annual sugar (calorie) consumption was 1.4 per cent (5.9 per cent) for households in the older family group; equivalent to a weight loss of 0.15 kg. Whereas the highest reduction in annual sugar (calorie) of 13 per cent (16.27 per cent) was estimated for households in the 45 + no children group; equivalent to an annual weight loss of 1.15 kg. For the soft drinks levy, the lowest reduction in sugar (calorie) consumption of 3.5 per cent (3.2 per cent) was estimated for older family households; equivalent to an annual weight loss of 0.31 kg. But the highest reduction in sugar (calorie) was 4.95 per cent (4.47 per cent) for older families, which is equivalent to an annual weight loss of 0.51 kg. The results of the ban on promotion are opposite that of the soft drinks levy. Our results confirm previous studies like that of Garcia-Muros et al. (2017) that accessed the distributional effects of carbon-based taxes in Spain; they found that the tax incidence differs by the life stage of the household head. This confirms our results that fiscal policy measures like taxes and restrictions on promotion will have a different impact on households based on their life stage. Contrary to findings by Briggs et al. (2013) the tax is more effective on the older family households than other household types.

Finally, we compare the impact of both the ban on promotions and the soft drinks levy on households based on their income groups. For the ban on promotions on soft drinks, the lowest reduction in sugar (calorie) consumption was 0.2 per cent (4.19 per cent) for households earning £50,000 - £59,999 per annum; equivalent to an annual weight loss of 0.02 kg. However, the highest reduction in sugar (calorie) was 17.6 per cent (20.8 per cent) for households earning £40,000 - £49,999 per annum; equivalent to an annual weight loss of 1.55 kg. For the soft drinks levy, the lowest reduction in sugar (calorie) was 3.49 per cent (3.13 per cent) for households earning £60,000 – over; equivalent to a weight loss of 0.23 kg. However, the highest reduction in sugar (calorie) consumption was 4.58 per cent (4.08 per cent) for households earning £50,000 - £59,999 per annum; equivalent to an annual weight loss of 0.38 kg. High-income earners reduce their consumption more probably due to the substitution towards more healthy drinks

In summary, our results suggest that banning promotions is more effective across different demographic groups than implementing the soft drinks levy. This is supported by Liu, Lopez, and Zhu (2014) who found that banning advertisements for carbonated soft drinks was more effective than taxing them based on their calorie content. Furthermore, we have shown that banning promotions has the potential to reduce

Table 11
Comparison of changes in body weight, sugar, and calorie consumption across different households.

Socioeconomic characteristics	Changes in weight (kg person per year)		Changes in annual sugar consumption (per person per year)		Changes in annual calorie consumption (per person per year)	
	Banning promotions	Soft drinks levy	Banning promotions	Soft drinks levy	Promotion	Soft drinks levy
Average person	−0.85	−0.36	−9.06%	−3.89%	−12.58%	−3.55%
SIMD 1	−0.01	−0.39	−0.13%	−4.03%	−3.49%	−3.68%
SIMD 2	−0.71	−0.46	−7.33%	−4.77%	−11.99%	−4.32%
SIMD 3	−0.87	−0.35	−8.53%	−3.45%	−12.18%	−3.18%
SIMD 4	−1.19	−0.28	−13.07%	−3.13%	−15.93%	−2.88%
SIMD 5	−1.39	−0.33	−16.97%	−4.02%	−20.24%	−3.68%
Large urban areas	−0.71	−0.35	−9.61%	−3.84%	−14.54%	−3.44%
Other urban areas	−0.45	−0.41	−4.66%	−4.23%	−7.77%	−3.88%
Accessible small towns	−0.55	−0.25	−7.14%	−3.31%	−9.64%	−3.06%
Remote small towns	−0.29	−0.24	−2.53%	−2.12%	−6.27%	−1.99%
Accessible rural areas	−2.00	−0.38	−21.09%	−4.04%	−25.43%	−3.67%
Remote rural areas	−1.53	−0.35	−16.10%	−3.69%	−17.70%	−3.43%
Pre-family	−0.66	−0.51	−5.47%	−4.25%	−10.62%	−3.90%
Young family	−0.39	−0.35	−4.93%	−4.37%	−8.35%	−3.96%
Middle family	−0.60	−0.34	−6.45%	−3.72%	−8.63%	−3.34%
Older family	−0.15	−0.51	−1.44%	−4.95%	−5.92%	−4.47%
45 + no children	−1.15	−0.31	−12.99%	−3.49%	−16.27%	−3.21%
£0 - £29,999	−0.72	−0.38	−7.19%	−3.80%	−11.00%	−3.47%
£30,000 - £39,999	−0.32	−0.36	−3.39%	−3.83%	−6.99%	−3.52%
£40,000 - £49,999	−1.55	−0.34	−17.65%	−3.92%	−20.82%	−3.64%
£50,000 - £59,999	−0.02	−0.38	−0.20%	−4.58%	−4.19%	−4.08%
£60,000 - over	−0.87	−0.23	−13.09%	−3.49%	−17.52%	−3.13%

Source: Own computation based on Kantar Worldpanel data.

body weights (not considering the impact of exercise). It is also worth mentioning that changes in demand and nutrients did not consider the implications of heavy drinkers on the effect of the soft drinks levy. Li and Dorfman (2019) found that this group of consumers is usually addicted to sugar-sweetened beverages and respond less to "sin" taxes.

5. Conclusion

Policymakers are advocating for a ban on soft drinks promotions in the UK. This comes after the successful implementation of the soft drinks levy. Empirical studies assessing the impact of the soft drinks levy suggest that the levy has been very effective in reducing both sugar purchases and body weights. However, there is limited information about the effectiveness of restricting promotions on soft drinks and how the results would compare with the soft drinks levy.

Therefore, our paper provides results on the heterogeneity of changes in household demand and nutrient purchases of beverages when soft drinks are taxed versus when promotions are restricted. To achieve this, we have modified the EASI demand model to incorporate promotional indices of beverages consumed in Scotland. Changes in purchases were assessed by comparing the pre-tax (promotion) scenario with the post-tax scenario (banning promotions). Comparisons were made based on the net total effect of both policies on demand, energy, and nutrient purchases.

The results from the present study suggest that banning promotions on soft drinks would be more effective in reducing calorie and sugar purchases than taxing soft drinks. Effectiveness of the ban on promotions varied by the socioeconomic characteristics of the household i. e. lower-income households, pre-family households, households in remote small towns, and households living in most deprived areas in Scotland. This advocates for targeted policies instead of the usual one-size-fits-all governmental policy. Banning promotions could reduce the annual quantity of beverage intake by 35.8 per cent whilst the soft drinks levy results in a 1.36 per cent reduction in annual beverage intake. Banning promotions reduces annual sugar intake by 9 per cent compared to 3.9 per cent for soft drinks levy. Translating this into changes in body weight show that the average person will lose 0.85 kg. and 0.36 kg. per annum by the ban on promotions or a soft drinks levy, respectively. The marginal changes in body weight suggest that other

avenues such as tax on and/or restricting promotions on dietary fat should be explored to achieve a larger impact. More importantly, larger reductions in body weights could only be achieved if the reduction in sugar purchases is sustained over a long period.

The rationale for implementing policies that restrict promotions on soft drinks is presented in this paper. Given the similarities in the consumption between Scotland and the rest of the UK, the results provide a clear guideline for both Scottish and UK food and drink policymakers. In summary, the paper advocates for restricting promotions to effectively control the soaring rates of overweight and obesity in Scotland.

We acknowledge that the data used for the analysis does not fully represent the consumption behaviour of consumers. First, the dataset excludes purchases from restaurants and vending machines suggesting that changes in consumption may be lower than expected. Second, since the analysis is based on purchased data, we do not consider actual consumption which excludes spoilage and food waste. Third, we do not consider substitution from soft drinks to less healthy foods like snacks and candies as well as healthier foods such as fruits and vegetables, which could change the impacts of both policies. Though these limitations are presently insurmountable, we believe their impacts are negligible and the results are plausible.

CRediT authorship contribution statement

Wisdom Dogbe: Methodology, Formal analysis, Validation, Writing – original draft, Visualization. **Cesar Revoredo-Giha:** Conceptualization, Data curation, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence

the work reported in this paper.

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