Effective policies to promote sugar reduction in soft drinks: lessons from a comparison of six European countries

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Abstract

Background Many countries have sought to incentivise soft drinks manufacturers to reduce sugar in their products as part of efforts to address a growing prevalence of obesity. Are their policies effective?

Methods Using a difference-in-differences design, we compared trends in the sugar content of 10,695 new sugar sweetened beverages (SSB) launched between 2010 and 2019 in six European markets, including the UK and France (taxes designed to incentivise reformulation), the Netherlands (policy based on voluntary agreements to reduce sugar), Germany, Italy, and Spain (no national policies).

Results The announcement in 2016 and adoption in 2018 of the UK tax led to yearly reductions in average sugar content of 17% (95% CI: 15% to 19%) to 31% (13% to 48%) between 2016 and 2019, compared to 2015, while the 2018 French tax produced a 6% (95% CI: 5% to 7%) sugar reduction only in 2018, compared to 2017, shortly after it was redesigned to provide a stronger incentive for reformulation. Voluntary agreements implemented in the Netherlands in 2014 led to an 8% (95% CI: 4% to 13%) sugar reduction only in 2015, compared to 2013.

Conclusion The analysis supports the conclusions that sugar reductions in new SSBs have been greater in countries that have adopted specific policies to encourage them; a sugar-based tax design encourages more sugar reductions than a volume-based tax design; the tax rate and the amount of the tax reduction from switching to the next lower tier in a sugar-based tax design may be critical to incentivize reformulation.

Keywords : Public health policy; Food policy; Soda tax; Food reformulation; Policy design.

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Introduction

Strong and consistent evidence links high consumption of sugar-sweetened beverage (SSB) to increased risk of weight gain,[1] obesity,[2] type 2 diabetes,[3] and cardiovascular disease.[4] Regular SSB consumption is also associated with a higher overall mortality.[5] To address the health risks caused by SSBs, governments throughout the world have enacted policies seeking to decrease the consumption of such beverages and, more recently, policies to incentivise beverage manufacturers to cut the amount of sugar contained in SSBs. SSB taxes have been recommended by the World Health Organization as an effective intervention, capable of achieving both goals.[6]

As of January 2022, 48 SSB taxes had been implemented worldwide.[7] The UK's "Soft Drinks Industry Levy" (SDIL)[8] was one of the first taxes on SSBs explicitly designed to achieve both goals, with a particular focus on the second. The SDIL has a two-tiered design based on SSB sugar concentration: a lower rate of £0.18 ($0.24; €0.21) per litre for beverages containing more than 5g of sugar per 100mL; and a higher rate of £0.24 ($0.33; €0.28) for those above 8g of sugar per 100mL. Drinks with less than 5g of sugar per 100mL are not levied. It was intentionally announced in 2016, two years before implementation in 2018, to allow manufacturers time to adjust. France also enacted a tax in 2018 to achieve both goals.[9] It replaced an excise tax with a flat tax of €0.075 ($0.085) per litre implemented in 2012. It is a tax with a sliding scale design based on added-sugar content. The tax rate starts at €0.03 ($0.04) per litre for drinks containing ≤1g of added sugar per 100mL and progressively rises to more than €0.24 ($0.28) per litre for drinks containing 15g of added sugar per 100mL (see Figure 1; Appendix Table A1).

A systematic review published in 2022[10] shows that SSB taxes have been effective in reducing the purchase of targeted SSBs by increasing their prices, although the degree to which companies may change SSBs consumer prices in response to tax can vary depending on the design of the taxes,[11] the types of stores [12], beverages [13] and package sizes.[13] Evaluations of their effectiveness in encouraging companies to actually reduce the sugar content of SSBs are still limited. Only the SDIL,[14–17] the Portuguese sugar tax[18] and the South Africa's Health

Promotion Levy[19] were evaluated for this outcome. They found evidence of reduction in sugar content, but only one study[17] provided statistical testing to show reformulation following tax. However, it is important from a public health perspective to investigate whether SSB taxes can incentivise SSB manufacturers to remove sugar from their products, and what tax designs would encourage them to do so, as it has been suggested that incentivising reformulation could have a larger impact on diet and health than changing consumer behaviour.[20,21]

An alternative policy, which can also contribute to SSB reformulation, is a policy fostering companies' voluntary sugar reduction decisions through the joint setting of sugar reduction agreement between public authorities and soft drink manufacturers (thereafter called Public-Private Partnerships policy, PPP). PPPs for sugar are increasingly being adopted in developed countries due to the success achieved for salt[22] in reducing salt/sodium content in foods[23,24] and population salt/sodium intakes.[23–26] Since 2014, the Netherlands has been one of the few countries to have such a policy for SSBs.[27] In 2015, the Dutch public health authorities succeeded in getting the entire soft drinks sector to commit to a 10% reduction in energy intake from soft drinks by 2020 (details in Appendix A).

The main objective of this study was to assess the effects over time of SSB tax and PPPs adopted in the UK, France and the Netherlands to encourage SSB manufacturers to reduce the sugar content of SSBs. We focused our analysis on the effects of these policies on the time trends in SSB sugar content from 2010 to 2019. Our evaluations were carried out in comparison to the evolutions of the sugar content of SSBs in Germany, Italy, and Spain where there is no national tax on SSBs or a PPP involving the entire soft drinks sector. This analysis may provide important guidance for policymakers about the best policies to favour sugar reduction in SSBs, and then a decrease in the incidence of SSB-related diseases.

[Figure 1 about here]

Method

Data

Assessing the effects over time of SSB tax and PPP requires collecting precise data on marketed SSBs (including new, existing, and removed ones) and their sugar content over time at brand level.[17] Such branded food databases have been developed in some countries[28] but too few follow changes over time. We overcame this shortcoming by focusing our assessment using a third-party composition database, as recommended by WHO Europe,[29] on new SSBs launched on the market (thereafter called new SSBs) for which a brand-level database with a harmonised food classification across countries exists: The Mintel Global New Products Database (GNPD). A new SSB for Mintel can be a new product; a reformulated product; an existing product with a new variant (e.g. new flavour) or a new packaging; or a product relaunch. The country name; year of the launch; manufacturer, brand and product names; SSB subcategory (i.e. fruit-flavoured still drinks, carbonated soft drink, flavoured water, and iced tea) and the sugar content in grams per 100mL of new SSBs launched in France, Germany, Italy, the Netherlands, Spain and the UK each year from January 1, 2010 to December 31, 2019, were compiled in a database for our analysis. We also used the ingredients list to construct an indicator variable taking the value one if a drink contains artificial sweeteners and zero otherwise. The database contains information for 10,695 new SSBs. Further information on GNPD can be found in Appendix B.

Interestingly, and in line with other studies,[14–17] more than 75% of new SSBs in the UK in 2018 and 2019 were below 5g/100mL (i.e., below which no levy applies), while the first and third quartile distributions were between 0 and around 10g/100mL for each year in the 2010--2015 period (Figure 2). In other countries, however, there is no clear trend (Appendix Figures C1—C5).

[Figure 2 about here]

Empirical strategy

We used de Chaisemartin and D'Hautefoeuille difference-in-differences (dCDH) estimators[30] to quantify the changes in the average sugar content of all new SSBs combined and in each SSB category, when their number is large enough, in France, the Netherlands or the UK, after the announcement/implementation of the tax or PPP. More specifically, the effect of the policy, that was announced/implemented in country *c* for the first time in year F_c, in $F_c + l$, for $l \geq 0$, is estimated using a dCDH estimator, denoted $DID_{c,l}$, comparing the $F_c - 1$-to-$F_c + l$ evolution of the average sugar content of new SSBs in country *c* (the UK, France or the Netherlands) and in the control group countries. In our setting, F_{UK}=2016, $F_{FR} = 2018\ or\ 2012$, $F_{DU} = 2014$ for the United Kingdom France and the Netherlands, respectively.

We chose these estimators because they are robust to heterogeneous and dynamics policy/treatment effects, unlike the estimators computed in the commonly-used event-study regression.

Germany, Italy, and Spain were used as control countries because no national tax or PPP was implemented for SSBs during the period. Spain is in the control group countries although there is a tax in Catalonia region since 2017, but it is currently a local action.[31,32] We implicitly assumed that the local Catalonia tax has no spillover effect on the average sugar content of SSBs marketed in other Spanish regions. We assessed the robustness of our results by removing Spain from our control group countries.

The dCDH estimators are unbiased under the parallel trends assumption: in the absence of policy, the time evolutions of the average sugar content of new SSBs would have been the same in the control group countries and in France, the Netherlands or the UK. We partially mitigated the assumption by including covariates in the estimations. The DID estimator is unbiased even if those two groups of countries may have experienced different evolutions of average SSBs sugar content over time, provided those differential evolutions can be accounted for by changes in covariates.[30]

We used time- and country-varying covariates that may affect consumers' preferences for sugar and companies' strategy regarding SSB sugar content, but not directly correlated to the decision to implement a tax or a PPP. The share of out-of-pocket medical expenses over total health spending[33] across countries and time to control for sugar content variations caused by changes in a country's health context. The annual agricultural producer price index of sugar across countries, deflated by the GDP deflator,[34] controls for the change in the cost of the main raw material in SSBs. The share of national brand beverages by SSB category per year in each country was also used because national brands can have different strategies than retailer brands.[17]

dCDH propose placebo estimators computed using pre-policy observations to test the parallel trends assumption underlying dCDH estimators.[30] These are DID estimators, denoted $DID_{c,l}^{pl}$, that compare the differences in the evolution of the average sugar content of new SSBs in the treated country and in control group countries from year $F_c - 1$ to $F_c - l - 2$, for $l \geq 0$. Finding placebo estimators significantly different from 0 implies that the parallel trends assumption is violated.

In all estimations reported below, Germany, Italy, and Spain were used as control countries, and we used the three covariates described above and SSB category fixed effects to account for different trends in average sugar content across SSB categories, because the parallel trends assumption is violated without them. Appendix F details the dCDH estimators.

Limitations

The nature of GNPD limits the evaluation to new SSBs. However, the proposed analysis can be a relevant assessment of what has happened in the overall SSB market for two reasons. Companies may be more inclined to reduce the sugar content of new SSBs first in response to the policy, as this is less risky than reducing the sugar content of existing SSBs: the revenue consequences of potential negative consumers' reactions to a relatively less sweetened SSB would be less severe for a new SSB than for an existing higher-selling SSB.[35]

Second, the sugar content distribution of new SSBs and that of all SSBs marketed in the UK or France are almost similar (Appendix Figures D1, D2 and E1).

The effects of the policies on the volume of sugar purchased by consumers were not assessed, in contrast to previous SDIL evaluations.[14,15,17] However, we provided an approximation of how sugar consumption from SSBs may change assuming no change in the volume of SSB purchased.

Results

Figure 3 and Appendix Table G1 show $DID_{UK,l}$ and $DID_{UK,l}^{pl}$ estimates of the effects of the SDIL on the average sugar content of new SSBs, fruit-flavoured still drinks and carbonated soft drinks. The SDIL brought about significant drops in the average sugar content of new SSBs as early as 2016. The decreases equal to 17% (95% CI: 15% to 19%), 13% (95% CI: 5% to 21%), 31% (95% CI: 13% to 48%) and 21% (95% CI: 6% to 36%) reductions in 2016, 2017, 2018 and 2019, compared to the average sugar content observed in 2015, respectively. We found 16% (95% CI: 6% to 26%) and 18% (95% CI: 6% to 31%) reductions in the average sugar content of fruit-flavoured still drinks category in only 2018 and 2019, respectively. In contrast, we estimated statistically significant drops in the average sugar content of carbonated soft drinks for each year after tax announcement: 20% (95% CI: 7% to 32%), 11% (95% CI: 6% to 16%), 22% (95% CI: 15% to 30%) and 29% (95% CI: 11% to 46%) in 2016, 2017, 2018 and 2019, respectively. The event-study and dCDH regressions lead to similar qualitative conclusions except for new fruit-flavoured still drinks: no statistically significant reduction was found using event-study regression (Appendix H).

These reductions were driven by a twofold strategic response by UK soft drink companies. Not only have they reduced the average sugar content of fruit-flavoured still drinks and carbonated soft drinks without artificial sweeteners, as targeted by SDIL, but they have also launched a greater proportion of new carbonated soft drinks with artificial sweeteners, which have a lower average sugar content than those without (see Appendix I and J).

[Figure 3 about here]

We found no significant placebo estimators for all new SSBs combined. This suggests that there is no difference in the evolution of the average sugar content of new SSBs in the UK and control group countries in periods prior tax policy announcement. This was also the case for new fruit flavoured still drinks from 2012 to 2015 and 2011 to 2015, the periods over which the parallel trends assumption has to hold for the estimated dynamic effects of 2018 and 2019 to be unbiased.[30] No significant placebo estimator was found for new carbonated soft drinks, except for the evolution of average sugar content between 2014 and 2015.

No statistically significant reduction in the average sugar content of new SSBs was estimated for the 2012 French SSB tax (Appendix Table K1). This result suggests that our estimates of 2018 SSB tax's effects are not affected by 2012 SSB tax.

We estimated that the 2018 French SSB tax provoked a drop in the average sugar content of new SSBs equal to 6% (95% CI: 5% to 7%) reduction, compared to the average sugar content observed in 2017, only in 2018 (Figure 4 and Appendix Table G2). We also found significant reductions in fruit-flavoured still drinks sugar content equal to 15% (95% CI: 5% to 19%); carbonated soft drinks equal to 14% (95% CI: 3% to 24%); and iced tea equal to 17% (95% CI: 14% to 20%) in 2018. No significant reduction was estimated in 2019. We found similar qualitative conclusions for the three SSB categories using event-study regressions, but not for all SSBs (Appendix H). The parallel trends assumption seems to be plausible from 2016 to 2017 and 2015 to 2017 for all DID estimators, except for iced tea between 2015 to 2017.

[Figure 4 about here]

The Dutch PPP generated a slight statistically significant increase in the average sugar content of new SSBs in 2014, but a significant reduction equal to 8% (95% CI: 4% to 13%) was estimated in 2015, compared to the average sugar content of new SSBs observed in the Netherlands in 2013 (Appendix Table L1). These variations can be due to the fact that consultations were held with SSBs operators in 2014 but agreements were not published until 2015. No statistically significant decrease was found in subsequent years.

Discussion

We found that sugar reductions in new SSBs have been larger in countries that have adopted specific policies to promote them. Our results suggest that the SDIL was the most successful policy in reducing the sugar content of new SSBs, compared with the two French SSB taxes and with the PPP implemented in the Netherlands.

Assuming a volume of sales of 3,542,574 thousands of litres for drinks in 2015 covered by the SDIL for retailers and manufacturer branded products,[15] 27,046 thousands households and a UK household size of 2.4 people in 2015,[36] our estimates result in average reductions in sugar consumption from SSBs of 19.2g and 12.9g per person per week in 2018 and 2019, respectively. Our reductions are within the range of 7-38g reduction in sugar consumption from SSBs per person per week found in a modelling study if manufacturers respond to the SDIL.[20] In this range, the decreases would be associated with a reduction in the number of obese individuals of 0.2-0.9% and in incidence of type 2 diabetes of 5.8-31.1 per 100 000 person-years. In France, the significant reduction found in 2018 brings about a reduction equals to 2.9g of sugar consumption per person per week, assuming an average daily consumption of 110mL per person.[37]

Our results are consistent, although our estimated effects are lower, with those obtained in the existing evaluations of the impact of the SDIL on SSBs sugar content. To our knowledge, there is still no such evaluation for the French tax. In their assessments of the SDIL, Public Health England found a 44% reduction in sales-weighted average total sugar content between 2015 and 2019.[15] A separate analysis found a 38% reduction in 2019.[17] It also found that the proportion of levy-eligible SSBs with a total sugar content above 5g of sugar per 100mL fell by 30.7 and 33.8 pp (28.7 and 31.3 pp for those above 8 g) in May 2018 and February, 2019 respectively. Our equivalent analysis found 24.2 (95% CI: 17.5 to 30.9) pp and 14.9 (95% CI: 7.6 to 22.3) pp reductions in the percentage of new SSBs with sugar content above 5g per 100mL in 2018 and 2019, respectively. Those over the high levy sugar threshold fell by 34.2 (95% CI: 12.7 to 55.6) pp in 2018 (Appendix Tables M1 and M2). These changes suggest a manufacturers' strategic reaction of bunching at the low levy sugar threshold to avoid the tax. Indeed, the percentage of beverages with a sugar content between 4.5 and <5g of sugar per 100mL increased by 9.0 (95% CI: 0.41 to 17.6) pp in 2018. No significant variation in the proportion of new SSBs with a sugar content between 7.5 and <8g was found (see Appendix Tables M1 and M2).

One of our key assumptions was that the local Catalonia tax has no effect on the average sugar content of Spanish SSBs. Roughly similar statistically significant reductions in the average sugar content of new SSBs in the UK and France were found when Spain was removed from the control group countries, except for French fruit-flavored still drink in 2018 (Appendix Tables N1 and O1).

Our analysis suggests two guidelines for policymakers. First, a sugar-based tax design encourages more sugar reduction than a volume-based tax design. Second, the level of the tax rate and the amount of the tax reduction that could be achieved by switching to the next lower levy tier in a tiered sugar-based tax design may be critical to incentivize manufacturers to reformulate. The latter guideline rests on two assumptions supported by our results.

The first assumption is that the higher the tax rate relative to the price of a beverage, the greater the incentive for a company to reduce the sugar content of the beverage to avoid tax or reduce the amount of tax due. The lower effectiveness of the 2018 French tax compared to the SDIL in incentivizing sugar cut may support this assumption: Tax rates in France can be up to 3.5 times lower than those of the SDIL (Figure 1).

The second assumption, which directly follows from the first, is that the larger the amount of the tax reduction resulting from the switch to the next lower levy tier, relative to the price of a beverage, the stronger the incentive for a company to reduce the sugar content to the next lower levy tier. The estimated manufacturers' strategic response to the SDIL to bunch at the low but not at the high levy sugar threshold may support this assumption. Reducing the sugar content of a SSB just below 5g/100mL results in avoiding tax and thus a tax reduction of £0.18/L ($0.24/L; €0.21/L), accounting for 5.3% (95% CI: 4.4% to 6.7%) of the median price of SSBs with ≥5 to <8g of sugar per 100mL. In contrast, switching at a sugar content level just below 8g/100mL entails a tax cut of £0.06/L ($0.09/L; €0.07/L), accounting for only 2.4% (95% CI: 1.6% to 3.0%) of the median price of SSBs above 8 g/100mL. Median prices are from another study (Table 1[17]). The incentive effect of the SDIL might be strengthened by increasing the amount of the tax cut resulting from the switch to a sugar content level just below 8g/100mL.

Our results also support the finding that sugar-based taxes may be more effective at changing manufacturer behaviour than public health policy based on voluntary reformulation.[15–17] However, we acknowledge that our estimates of the impact of the Dutch PPP are lower than those found in the literature. An Austrian voluntary strategy which encourages manufacturers to gradually reduce the sugar content of SSBs below 7.4g/100mL found a 10.4% sugar reduction in 2017 compared to 2010. PPP encouraging salt/sodium reductions in processed foods also found larger reductions.[23,24] Providing recommendations on the design of PPP is beyond the scope of this study, however, we can underline that the PPP adopted in the Netherlands has met the key conditions for success identified in an earlier study[38]: a strong government leadership and pressure; the involvement of a large number of manufacturers; the publication of guidelines or reduction targets; and an effective monitoring and evaluation.

The scope of the evaluation was limited by the nature of the GNPD data. Extending the scope of the evaluation would require access to data on nutrient composition of branded foods in different countries, from year to year, matched with purchase or consumption data.[39,40] Given the established role of food and diet in the causation of chronic diseases, the creation of such a dataset should be a priority.

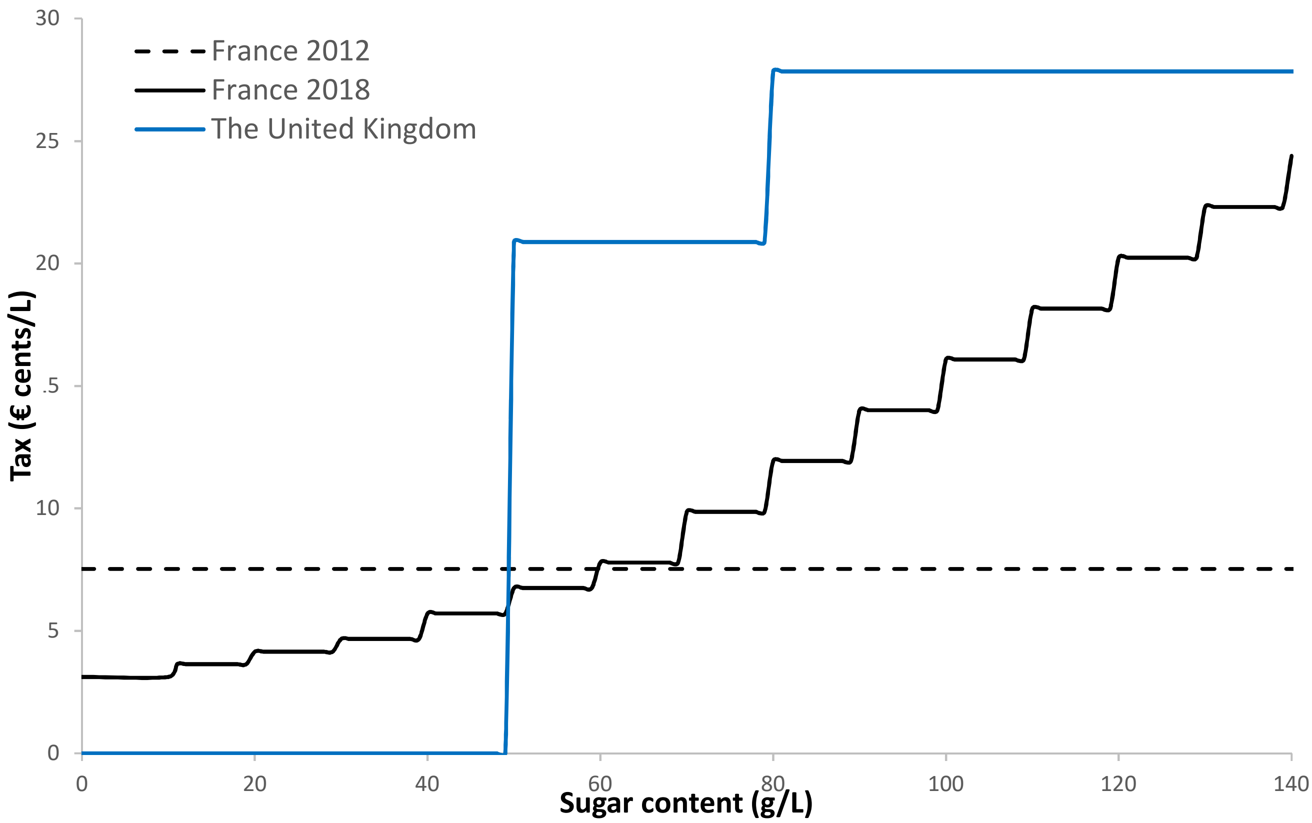

Figure 1: Comparison of tax rate levels with respect to sugar content in the French tax (2012 and 2018) and SDIL designs (in Euro cents per litre)

Sources: Service public and House of commons

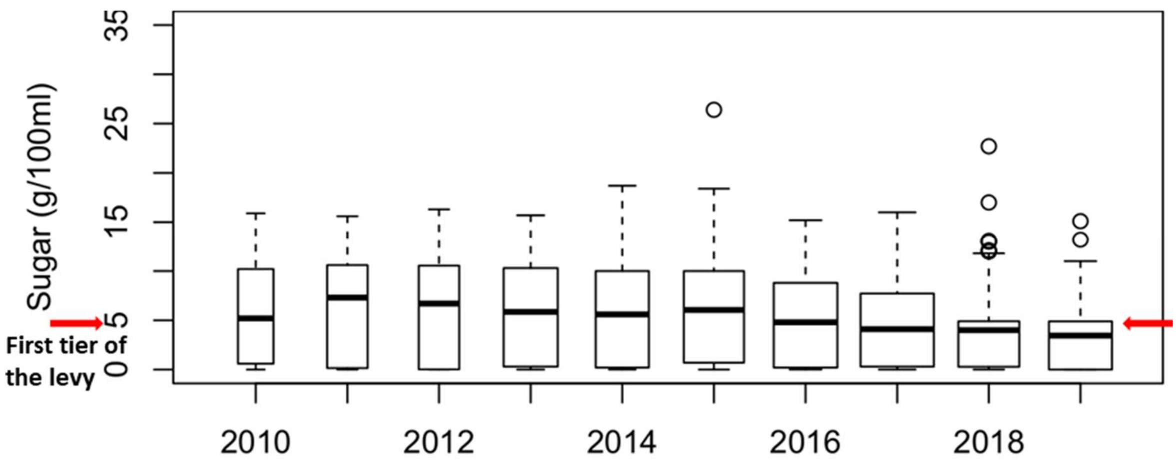

Figure 2: Evolution of the sugar content distribution of new SSBs in the United Kingdom (in g/100 mL)

Source: Mintel GNPD data, January 2010 to December 2019

Note: The black bold middle line indicates the median (50th percentile), while the black box contains the 25th to 75th percentiles of the dataset. The black whiskers mark the 5th and 95th percentiles, and values beyond these upper and lower bounds are considered outliers, marked with a circle.

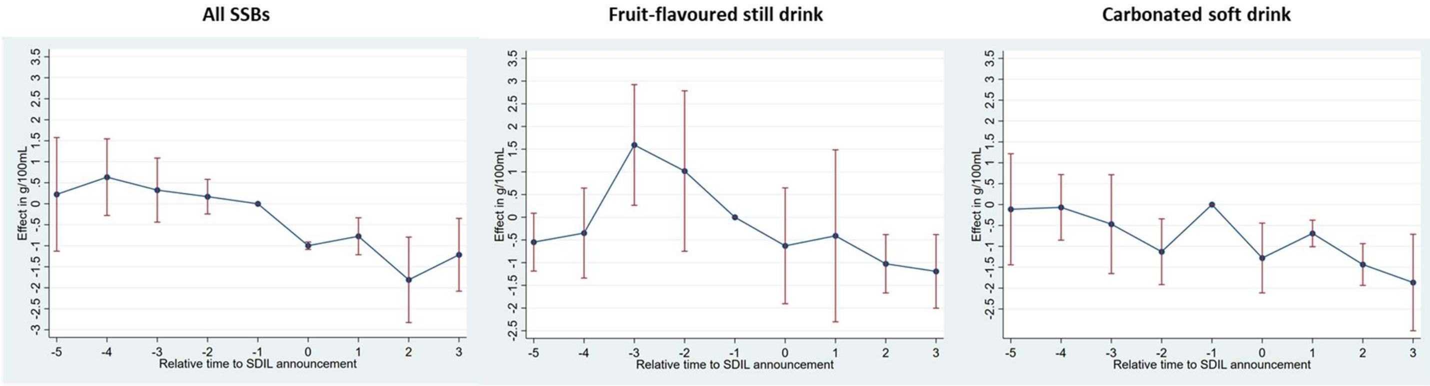

Figure 3: SDIL's effects on the average sugar content of all new SSBs combined and in fruit-flavoured still drink and carbonated soft drink categories

Notes: These figures show to the right of zero the $DID_{UK,l}$ dCDH estimates of the effects of the SDIL in $F_{UK} = 2016$, the year of SDIL announcement, (l=x=0) and in 2017 (l=x=1), etc. To the left of zero, $DID_{UK,l}^{pl}$ placebo estimates are shown. At x=−1, the placebo is normalized to 0. Placebo dCDH estimator $DID_{UK,l}^{pl}$ that compares the differences in the evolution of the average sugar content of new SSBs in the UK and in control group countries from year $F_{UK} - 1$ to $F_{UK} - l - 2$ is shown at x= $-l - 2$, for $l = 0, 1, 2, 3$. All estimated evolutions are compared to the average sugar content of all new SSBs, fruit-flavoured still drink or carbonated soft drink observed in $F_{UK} - 1 = 2015$ in the UK. The effects of the SDIL on iced tea category were not reported given their limited number in GNPD for the UK market over the period (15 and 12 in 2016 and 2019, respectively, and 24 in 2017 and 2018). Germany, Italy, and Spain were used as control countries. All estimators' standard errors are computed using a block bootstrap at country level (1000 replications). 95% confidence intervals relying on a normal approximation are shown in red.

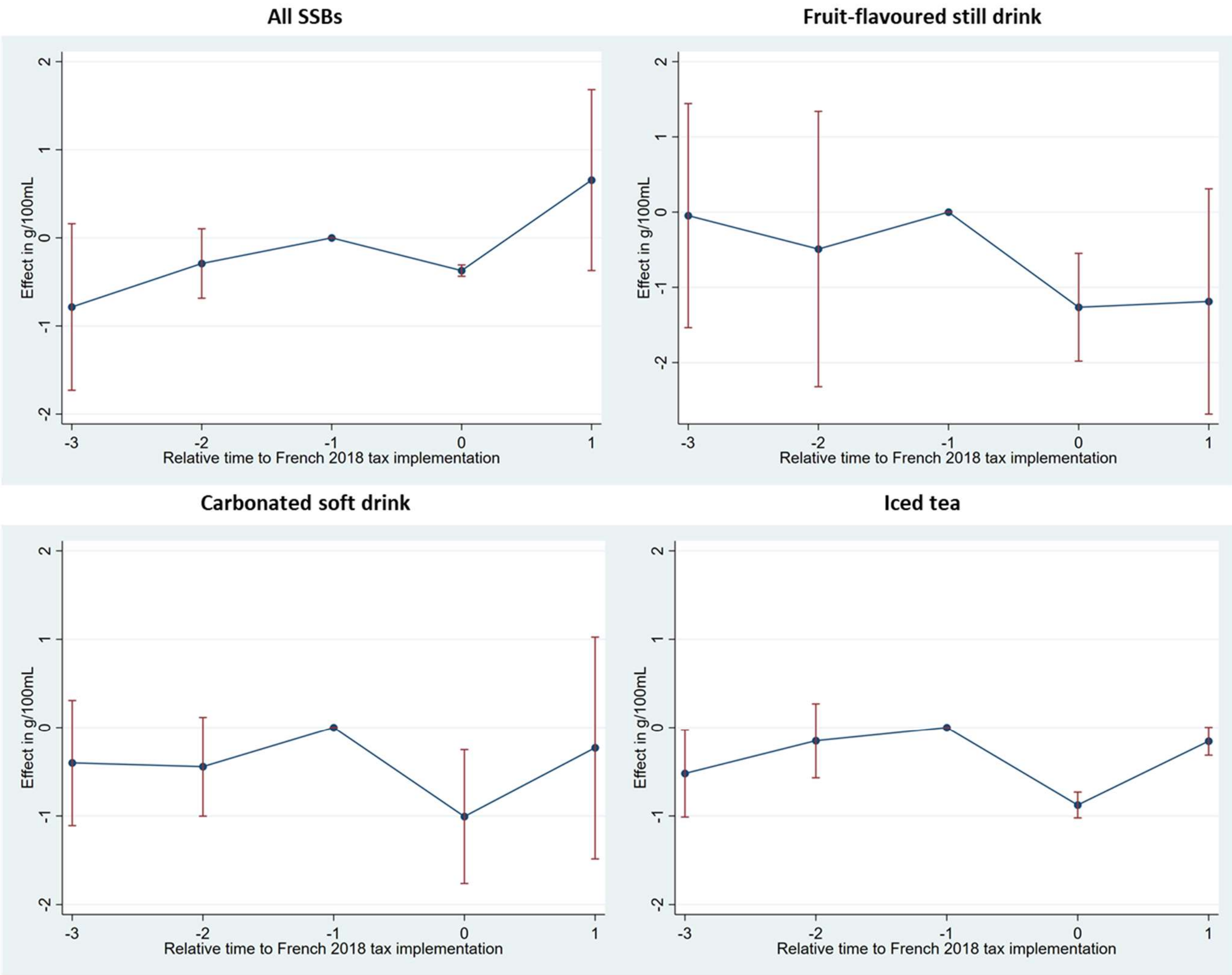

Figure 4: French 2018 SSB tax's effects on the average sugar content of all new SSBs combined and in each SSB category

Notes: These figures show to the right of zero the $DID_{FR,l}$ dCDH estimates of the effects of the French 2018 SSB tax in $F_{FR} = 2018$, the year of its implementation, (l=x=0) and in 2019 (l=x=1). To the left of zero, $DID_{FR,l}^{pl}$ placebo estimates are shown. At x=−1, the placebo is normalized to 0. Placebo dCDH estimator $DID_{FR,l}^{pl}$ that compares the differences in the evolution of the average sugar content of new SSBs in France and in control group countries from year $F_{FR} - 1$ to $F_{FR} - l - 2$ is shown at x= $-l - 2$, for $l = 0, 1$. All estimated evolutions are compared to the average sugar content of all new SSBs, fruit-flavoured still drink, carbonated soft drink or iced tea observed in $F_{FR} - 1 = 2017$ in France. Germany, Italy, and Spain were used as control countries. All estimators' standard errors are computed using a block bootstrap at country level (1000 replications). 95% confidence intervals relying on a normal approximation are shown in red.

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Key points

- Although there is conclusive evidence that SSB taxes are associated with higher prices of taxed beverages and lower sales, there is limited evidence on their effectiveness in incentivizing soft drink manufacturers to cut sugar.
- Sugar reductions in SSBs have been greater in countries that have adopted specific policies to encourage them.
- The UK SDIL was the most successful policy in reducing the sugar content of new SSBs, compared with the two French SSB taxes and the Dutch public health policy based on voluntary reformulation.
- A sugar-based tax design encourages more sugar reduction than a volume-based tax design.
- The level of the tax rate and the amount of the tax reduction that could be achieved by switching to the next lower levy tier in a tiered sugar-based tax design may be critical to incentivize manufacturers to reformulate.

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Data sharing

The statistical code for the analyses are available from https://github.com/oallais/SSB-TAX-Sugar-reduction. The Stata 15 module DID_multiplegt was used for all estimations. Mintel Global New Products Database (GNPD) data are not publicly available but can be purchased from Mintel Group Ltd (https://www.mintel.com/). The authors are not legally permitted to share the data used for this study but interested parties can contact Mintel Group Ltd (https://www.mintel.com/contact-us) to inquire about accessing this proprietary data.

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