Statistical method

A. Description

We used differences-in-differences (DID) estimators of intertemporal treatment effects to assess the effet of SSB tax on the sugar content of newly marketed SSBs in France or the United Kingdom (our outcome).(8) Specifically, these estimators compared the outcome evolution in France or the United Kingdom that has announced/implemented the tax (the treated country) to that of countries that have not (the countries control group), from the last year before the tax has been announced/implemented to the *lth* year after that annoucement/implementation. We estimate the effect of having announced/implemented the tax for the first time *l* years ago. SSB tax's instantaneous is estimated for $l = 0$ and dynamic effects for $(l \geq 1)$. We did not use these notations in the main text for simplicity's sake. These estimators correspond to estimate effects in 2016 ($l = 0$), 2017 ($l = 1$), 2018 ($l = 2$), and 2019 ($l = 3$) displayed in Exhibit 3 in the main text for the United Kingdom. And to those in 2018 ($l = 0$) and 2019 ($l = 1$) for France in Exhibit 4 in the main text. The DID approach used in the study is valid even if there are heterogeneity in the effects of the tax over time.(8)

Applying de chaisemartin and D'Hautefeuille (2021) to our sharp (treatment does not vary within country c and year t) and staggerred treatment adoption design (countries have maintained the tax after they have announced/implemented for the first time in year *t-l*), we first set the following notations. For any l $\in \{0, \ldots, 7\}$ and $t \in \{2012 + l, \ldots, 2019\}$, let $N^1_{c,t,l} = \sum_{i \in c, F_{c,1=t-l}} N_{i,c,t}$ denote the number of taxed newly marketed SSBs *i* in France or the United Kingdom (c=FR, UK) for the first time at year *t-l*, where for any country *c*, $F_{c,1} = min\{t: Tax_{c,t} = 1\}$ denotes the first year at which country *c* has announced/implemented the SSB tax, $Tax_{c,t} = 1$. In our setting, $F_{UK,1}$=2016 and $F_{FR,1} = 2012\ or\ 2018$ for the United Kingdom and France, respectively. It results that $N^1_{UK,t,l} > 0$ for $(t, l) \in \mathcal{T}^{UK} = \{(2016{,}0), (2017{,}1), (2018{,}2), (2019{,}3)\}$, and $N^1_{UK,t,l} = 0$ otherwise. For the 2012 French tax, we have $N^1_{FR,t,l} > 0$ for $(t, l) \in \mathcal{T}^{FR} = \{(2012{,}0), (2013{,}1), (2014{,}2), (2015{,}3)\}$, and $N^1_{FR,t,l} = 0$ otherwise.[1] For the 2018 French tax, $N^1_{FR,t,l} > 0$ for $(t, l) \in \mathcal{T}^{FR} = \{(2018{,}0), (2019{,}1)\}$, and $N^1_{FR,t,l} = 0$ otherwise. We have the convention that $F_{c,1} = 2020$ if country *c* has not announced/implemented it, $Tax_{c,t} = 0$. Let $N^{nt}_t = \sum_{c: F_{c,1>t}} N_{c,t}$ denote the number of untaxed newly marketed SSBs in countries control group from period 2010 to *t*, where $N_{c,t}$ is the number of newly marketed SSBs in country *c* at period *t*. In our setting, N^{nt}_t is always strictly positive. Finally, let $Y_{c,t} = 1/N_{c,t} \sum_{i \in c,t} Y_{i,c,t}$ denote the observed average of the sugar content in grams per 100 mL of newly marketed SSBs in country *c* at period *t*.

We define the estimate of the SSB tax effect on the sugar content of newly marketed SSBs in treated country, $treated = UK, FR$, in t of having announced/implemented the tax for the first time *l* years ago, as:

[1] More dynamic effects can be considered, but it turns out that the French excise tax had no effect in the 4 years following its implementation (see below).

$$DID_{treated,t,l} = \begin{cases} \left(Y_{treated,t} - Y_{treated,t-l-1}\right) - \sum_{c:F_{c,1>t}} \frac{N_{c,t}}{N_t^{nt}} \left(Y_{c,t} - Y_{c,t-l-1}\right), & for\ (t,l) \in \mathcal{T}^{treated} \\ 0, & otherwise \end{cases}$$

In our setting for all $(t,l) \in \mathcal{T}^{treated}$, $Y_{UK,t-l-1} = Y_{UK,2015}$ for the United Kingdom; $Y_{FR,t-l-1} = Y_{FR,2011}$ for 2012 French tax; and $Y_{FR,t-l-1} = Y_{FR,2017}$ for 2018 French tax. $DID_{treated,t,l}$ is the DID estimator comparing the evolution of the sugar content in grams per 100 mL of newly marketed SSBs from period $t-l-1$ to t in France or the United Kingdom and in countries belonging to the countries control group from 2010 to year t. To illustrate, $DID_{UK,t=201\ \ ,l=3}$ is the DID estimator comparing the evolution of the sugar content in grams per 100 mL of newly marketed SSBs from 2015 to 2019 in the United Kingdom, that announced the tax in 2016 and in countries belonging to the countries control group (Germany, Italy, and Spain) from 2010 to 2019. This estimator corresponds to the estimate effect in 2019, so 3 years ago after SDIL announcement, displayed in Exhibit 3 in the main text.

B. Placebo estimators: Plausibility of common trends hypothesis

De chaisemartin and D'Hautefeuille (2021) shows that $DID_{treated,t,l}$ is an unbiased estimator of the cumulative effect of having announced/implemented the tax for *l+1* years if the common trends assumption holds, i.e. the trends of the mean sugar content would have been the same in both the countries control and France or the United Kingdom in the absence of SSB tax. In other words, any selection bias implied by using data from the control countries group to build the counterfactual and not captured by the fixed effects is either constant over time, or, if it does evolve over time, the evolution is linear.

It is also possible that France or the United-Kingdom and countries control group have experienced different evolution of SSBs sugar content over time, but the DID approach can still produce unbiased estimators provided that those differential evolutions are accounted for by the change in country's covariates. Thus, we also integrated in regressions time- and country-varying covariates that may affect companies' strategy regarding SSB sugar content, such as the country's variable indicators of health (childhood obesity rate,(9) share of out-of-pocket medical expenses over total health spending,(10) death rate due to NCDs among populations aged 30--70 years (11) and dietary and high body mass index risks (12)); the consumer price index of mineral waters, soft drinks and fruit and vegetable juices; and the proportion of SSBs with artificial sweeteners in each country over time. However, health indicators except the share of out-of-pocket medical expenses, and price index were not statistically significant in all regressions investigated. It was difficult to distinguish health indicators effects with our DID estimation strategy given their weak variability over time. In our estimations below, the share of out-of-pocket medical expenses controlled for sugar content variations caused by changes in a country's health context. For example, if out-of-pocket medical expenses increase (i.e., the health care system becomes less protective), an individual may be more motivated to adopt healthier food habits such as purchasing healthier food products, which in turn may encourage SSBs companies to remove sugar. The proportion of SSBs with artificial sweeteners controlled for time-varying reformulation strategies regarding the use of artificial sweeteners in SSBs recipes.

The common trends assumption is not directly testable, but to assess its plausibility de Chaisemartin and D'Hautefeuille (2021) propose "long-difference" placebo estimators computed using pre-policy observations. (13) Contrary to standard tests used in event-study model, the test deployed in the analysis is robust even if tax effects are heterogeneous over time.(8) Following their analysis and notions defined above, we define

$$DID^{pl}_{treated,t,l} = \left(Y_{treated,t-2l-2} - Y_{treated,t-l-1}\right) - \sum_{c:F_{c,1>t}} \frac{N_{c,t}}{N^{nt}_t}\left(Y_{c,t-2l-2} - Y_{c,t-l-1}\right)$$

for $treated = UK, FR$ and if $(t,l) \in \mathcal{T}^{treated}$, and we let $DID^{pl}_{treated,t,l} = 0$ otherwise. The *lth* placebo estimator, $DID^{pl}_{treated,t,l}$, compares the evolution of the sugar content in grams per 100 mL of newly marketed SSBs in a country *c* that has announced/implemented the tax (either France or the United Kingdom) for the first time in year *t-l*, and in countries that have not from 2010 to year *t, as* $DID_{treated,t,l}$, but between periods *t*−2*l*−2 and *t*−l−1 instead of *t*−*l*−1 and *t*.

We did not use these notations in the main text for simplicity's sake. In Exhibits 3 and 4, these estimators correspond to the estimated difference in the evolution of the sugar content from 2014 to 2015 ($t = 2016, l = 0$), 2013 to 2015 ($t = 2017, l = 1$), 2012 to 2015 ($t = 2018, l = 2$), and 2011 to 2015 ($t = 2019, l = 3$) displayed in Exhibit 3 in the main text for the United Kingdom. And to those in 2016 to 2017 ($t = 2018, l = 0$) and 2015 to 2017 ($t = 2019, l = 1$) for France in Exhibit 4 in the main text. To further illustrate if necessary, $DID^{pl}_{UK,t=2019,l=3}$ is the DID estimator comparing the evolution of the sugar content in grams per 100 mL of newly marketed SSBs from 2011 to 2015 in the United Kingdom, that announced the tax in 2016 and in countries belonging to the countries control group (Germany, Italy, and Spain). It corresponds to the Estimated differences in the evolution of the sugar content from 2011 to 2015 in Exhibit 3 in the main text.

If common trend assumption holds, then de chaisemartin and D'Hautefeuille (2021) show that $E[DID^{pl}_{treated,t,l}] = 0$. So finding an estimation of $DID^{pl}_{treated,t,l}$, or say differently an estimated difference in the evolution of the sugar content in the United Kingdom or France and in Germany, Italy, and Spain between periods *t*−2*l*−2 and *t*−l−1, for $(t,l) \in \mathcal{T}^{treated}$, significantly different from 0 would imply that the common trend assumption is violated: France or the United Kingdom experienced different trend before announcement/implementation of the tax than the countries belonging to the countries control group used to reconstruct France or the United Kingdom counterfactual trend. Thus, the lth placebo estimator assesses whether common trends assumption holds over *l+1* years, the number of years over which the assumption has to hold for the *lth* estimated dynamic effect, $DID_{treated,t,l}$, to be unbiased.