NOT SO SWEET?
THE IMPACT OF THE PORTUGUESE SODA TAX ON PRODUCERS

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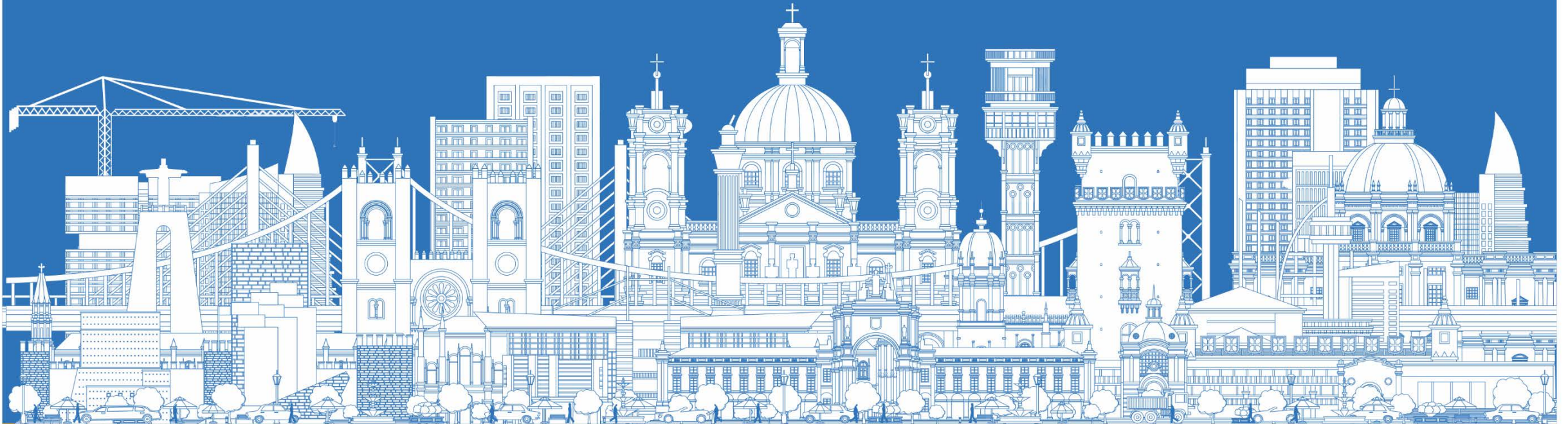
MOTIVATION

Soda Taxes

- Implemented in more than **50 countries**
- Efficiently **discourage the consumption of soda**, hence **targeting health issues** like diabetes of type II
- Implementation **encouraged by the WHO** since 2016

The Portuguese case

- One of the first soda taxes structured in **brackets based on sugar content** and **levied on producers**
- Recent studies show the **superiority of multi-rate soda taxes** in terms of welfare (O'Connell & Smith, 2021)
- This design **inspired many countries**

Producers

- Producers are amongst the **most directly impacted** actors
- **No micro level research** yet focusing on these firms

IN A NUTSHELL

Research question: What is the impact of the Portuguese soda tax on sugar sweetened beverages (SSBs) producers?

Data: Administrative dataset covering the **universe of private firms in Portugal** from 2012 to 2019.

Methodology: Difference-in-differences design, exploiting the implementation of a soda tax in Portugal in 2017, and comparing SSBs producers to bottled water producers.

Main findings:

- The tax created a **sustained shock** for SSBs producers, which **exacerbated** over the years. As a consequence, domestic sales and producer's profits decreased significantly.

- No impact on the **labour force**.

- Neglectable impact on **corporate income tax**.

LITERATURE AND DATA

01

LITERATURE

On prices and consumption

SSBs prices: Rise in response to soda taxes

Consumption of SSBs: Significantly decreases thanks to soda taxes. Estimated effects range from 6% to 46%

Surveys: Allcott et al. (2019, JEP); Cawley et al. (2019)

Individual impacts are **heterogenous**, varying with income level, age, and initial consumption amount (Allcott et al., 2019, QJE; Dubois et al., 2020; Fearne et al., 2019)

At the firm level

Study of **stock market reaction to the announcement of a soft drinks tax** in the UK. Findings: **negative abnormal stock returns** on the day of the announcement (Law et al., 2020)

Gonçalves and Santos (2020) highlight that Portuguese SSBs producers **reformulated their drinks towards lower sugar content** as response to the soda tax

DATA

Accounting data covering the universe of **private firms in Portugal** from **2012 to 2019**. Source: Central Balance Sheet – Harmonized Panel (CBHP) from **Banco de Portugal**

Treatment group: Producers of non-alcoholic **soft drinks** (CAE 11072)

Counterfactual: Bottled still and sparkling **water** producers (CAE 11071). Commonly used as a counterfactual in the literature because not impacted by the tax (even indirectly), but as the industry is similar to SSBs, it would be impacted similarly by the same shocks

Classification based on main economic activity

19 SSBs producers, 27 bottled water producers, 297 observations

Outcomes considered: Net income, total income, total expenses, turnover, total sales, domestic sales, exported sales, average wage, number of employees, number of employees working in R&D, cash, receivables, liabilities, income tax

ECONOMETRIC SPECIFICATION

02

DIFFERENCE IN DIFFERENCES

$$y_{it} = \alpha_i + \gamma_t + \beta\, SSB * post + \varepsilon_{it} \qquad (1)$$

y_{it}	outcome variable of firm *i* at time *t* (IHS transformed)
α_i	firm fixed effects
γ_t	year fixed effects
SSB	dummy that takes the value 1 if the firm is a soft drinks producer
$post$	dummy that takes the value 1 for the post-tax years, 2016 to 2019
ε_{it}	error term clustered at the firm level (Bertrand et al., 2004)

EVENT STUDY

$$y_{it} = \alpha_i + \gamma_t + \sum_{2012}^{2014} \delta_t\, SSB * year_t + \sum_{2016}^{2019} \delta_t\, SSB * year_t + \varepsilon_{it} \qquad (2)$$

y_{it}	outcome variable of firm *i* at time *t* (IHS transformed)
α_i	firm fixed effects
γ_t	year fixed effects
SSB	dummy that takes the value 1 if the firm is a soft drinks producer
$year$	year dummies
ε_{it}	error term clustered at the firm level (Bertrand et al., 2004)

RESULTS

03

BASELINE PROFIT & LOSS STATEMENT

Net income significantly decreased in some years as a consequence of the tax. The effect exacerbates over time.

DiD estimates

	(1) Net Income	(2) Total Income	(3) Total Expenses
SSB *Post	-0.193	-0.007	-0.477
	(0.205)	(0.014)	(0.335)
Adjusted R2	0.093	0.075	0.062
N	297	297	297

Note: Standard clustered at the firm level. Scaling factors: net income*10^{-6}, total income*10^{-8}, total expenses*10^{-2}. Table: Coefficients from equation (1), *p<0.1, **p<0.05, ***p<0.01. Figure: Coefficients from equation (2) along with the 90% and 95% confidence intervals.

Event study coefficient plots
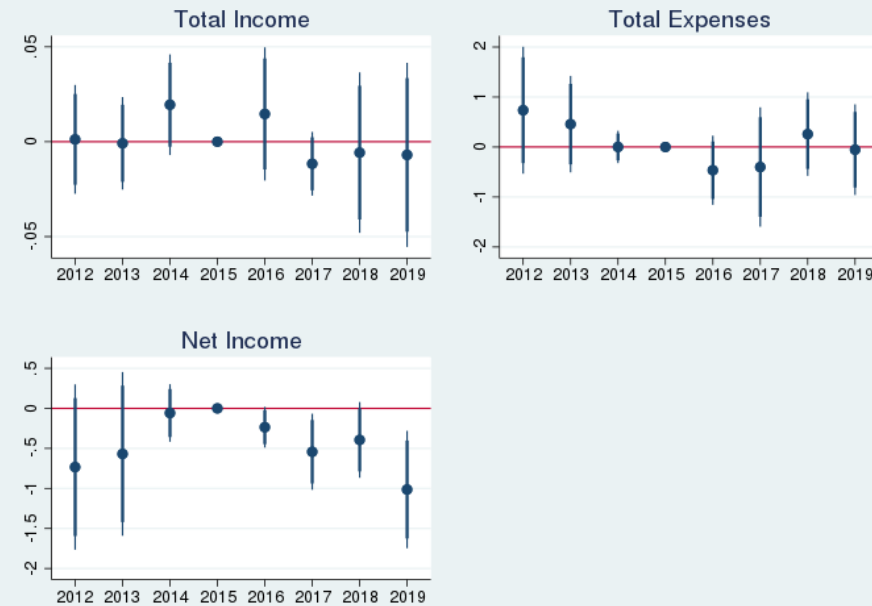
SALES

Domestic sales significantly decreased in all post-tax years.
The effect exacerbates with time.
Proof of concept: exported sales remained unchanged.

DiD estimates

	(1) Turnover	(2) Total Sales	(3) Domestic Sales	(4) Exported Sales
SSB*Post	0.001	0.003	-0.125*	-0.039
	(0.017)	(0.017)	(0.072)	(0.035)
Adjusted R2	0.061	0.058	0.100	0.068
N	297	297	297	297

Note: Standard error clustered at the firm level. Scaling factors: turnover$*10^{-8}$, total sales$*10^{-8}$, domestic sales$*10^{-6}$, exported sales$*10^{-8}$. Table: Coefficients from equation (1), *p<0.1, **p<0.05, ***p<0.01. Figure: Coefficients from equation (2) along with the 90% and 95% confidence intervals.

Event study coefficient plots

LABOUR FORCE

SSBs producers did not modify their labour force to cope with the tax.

DiD estimates

	(1) Average Wage	(2) Nb of Employees	(3) Nb of employees in R&D
SSB*Post	0.073	-0.046	-0.000
	(0.43)	(0.110)	(0.000)
Adjusted R2	0.011	0.048	0.095
N	297	297	107

Note: Standard error clustered at the firm level. Scaling factors: average wage$*10^{-2}$, number of employees$*10^{0}$, number of employees in R&D$*10^{-6}$. Table: Coefficients from equation (1), *p<0.1, **p<0.05, ***p<0.01. Figure: Coefficients from equation (2) along with the 90% and 95% confidence intervals.

Event study coefficient plots

BALANCE SHEET

SSBs producers' capacity to convert receivables into cash was hindered. Corporate income tax decreased by 236'000 euros. Income from the tax amounts to around 200M euros.

DiD estimates

	(1)	(2)	(3)	(4)
	Cash	Receivables	Liabilities	Income Tax
SSB*Post	-0.240	0.047	0.444**	-0.005
	(0.167)	(0.028)	(0.182)	(0.123)
Adjusted R2	0.078	0.162	0.030	0.042
N	297	297	297	297

Note: Standard errors clustered at the firm level. Scaling factors: cash*10^{-6}, receivables*10^{-8}, liabilities*10^{0}, income tax*10^{0}. Table: Coefficients from equation (1), *$p<0.1$, **$p<0.05$, ***$p<0.01$. Figure: Coefficients from equation (2) along with the 90% and 95% confidence intervals.
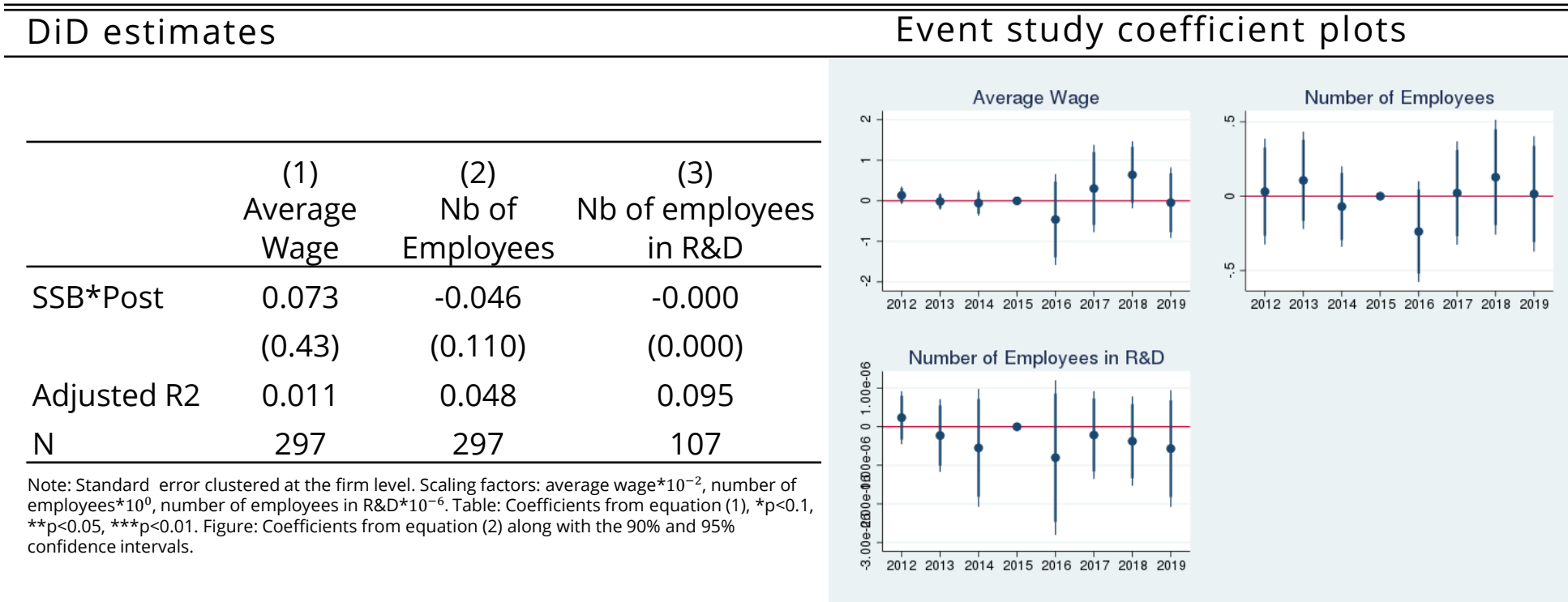
Event study coefficient plots
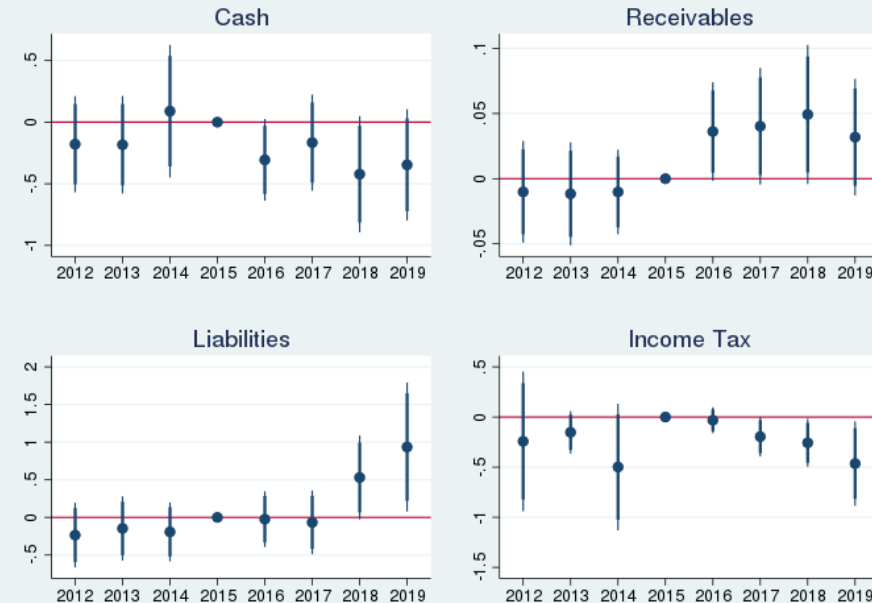
ROBUSTNESS CHECKS

- Extreme values: **1% winsorization**, and **dropping the largest firm** of the dataset

- Business area: keeping firms producing **90% or more of their turnover** from their main economic area

- Alternative transformations: **ln(y) and ln(y+1)**

- Treatment intensity: exploiting the fact that exported products are not subject to the tax to build a **treatment intensity measure** based on sales destination

CONCLUDING REMARKS

04

CONCLUDING REMARKS

- The soda tax generated a **sustained shock** for SSBs producers, which **exacerbated over the years.**

- The **profit** and domestic sales of SSBs producers was strongly negatively impacted.

- The tax did **not impact the labour force of SSBs producers**.

- The tax **generated large profits for the state**, even when taking into account the forgone corporate income tax.

Thank you

Additional material

APPENDIX

Soda taxes around the world

Descriptive statistics

The Portuguese soda tax structure

Balance tests

Inverse hyperbolic sine transformation

Bottled water producers as counterfactual

Firms classification

Robustness checks

Bottled water producers as counterfactual

Anticipation effects

RISING POPULARITY OF SODA TAXES

Europe:
Norway
Finland
Latvia
United
 Kingdom
Ireland
Belgium
France
Hungary
Spain (Catalonia)
Portugal
St Helena

Western Pacific:
Philippines
Brunei
Cook Islands
Fiji
Palau
French
 Polynesia
Kiribati
Nauru
Samoa
Tonga
Vanuatu

Americas:
USA (8 local)
Bermuda
Mexico
Dominica
Barbados
Panama
Ecuador
Peru
Chile

Africa:
Morocco
Mauritius
Seychelles
South Africa

Middle East & Southeast Asia:
Saudi Arabia
Bahrain
Qatar
United Arab Emirates
Oman
India
Thailand
Malaysia
Maldives

DESCRIPTIVE STATISTICS

Table 2: **Summary statistics**

		Water Producers (Comparison)					SSBs Producers (Treatment)			
	Obs	Mean	Std. dev.	Min	Max	Obs	Mean	Std. dev.	Min	Max
Pre-tax										
Net Income	96	346'882	2'653'941	-5'088'466	11'400'000	48	473'910	3'539'913	-7'839'936	14'800'000
Total Income	96	8'752'184	10'300'000	0	38'600'000	48	42'300'000	96'400'000	0	320'000'000
Total Expenses	96	8'405'302	9'065'132	26'204	30'100'000	48	41'800'000	94'200'000	0	310'000'000
Turnover	96	8'267'268	9'750'781	0	38'400'000	48	40'200'000	91'700'000	0	306'000'000
Sales	96	7'766'008	9'083'547	0	32'200'000	48	39'300'000	89'100'000	0	297'000'000
Domestic Sales	96	7'570'468	8'984'236	0	32'200'000	48	30'600'000	68'400'000	0	233'000'000
Exported Sales	96	195'539	411'316	0	2'851'476	48	8'638'491	21'500'000	0	79'900'000
Average Wage	96	13'013	5'573	0	31'010	48	13'035	10'189	0	62'251
Number of Employees	96	55	67	0	315	48	142	325	0	1'212
Employees in R&D	34	0.18	0.46	0	2	18	2	5	0	13
Cash	96	220'444	449'128	71	3'100'799	48	590'814	2'343'760	0	15'700'000
Receivables	96	1'646'639	1'955'405	0	9'828'467	48	7'348'327	15'900'000	0	64'300'000
Liabilities	96	12'100'000	22'100'000	8'095	123'000'000	48	38'400'000	109'000'000	86'272	412'000'000
Income Tax	96	-75'090	1'347'197	-12'600'000	2'187'857	48	138'366	854'436	-2'762'697	2'971'260
Post-Tax										
Net Income	99	1'109'984	3'393'949	-2'133'503	15'900'000	54	939'923	2'971'643	-1'092'650	13'000'000
Total Income	99	10'200'000	12'400'000	0	55'900'000	54	39'100'000	90'600'000	0	317'000'000
Total Expenses	99	9'052'056	10'300'000	4'912	40'000'000	54	38'100'000	88'300'000	0	309'000'000
Turnover	99	9'522'968	11'800'000	0	55'300'000	54	37'900'000	88'100'000	0	307'000'000
Sales	99	8'889'901	10'700'000	0	48'200'000	54	37'300'000	86'500'000	0	298'000'000
Domestic Sales	99	8'739'701	10'700'000	0	48'200'000	54	32'100'000	76'700'000	0	260'000'000
Exported Sales	99	150'200	259'005	0	968'772	54	5'271'218	10'800'000	0	39'000'000
Average Wage	99	12'738	6'817	0	29'780	54	16'559	25'077	0	159'987
Number of Employees	99	53	68	0	333	54	130	330	0	1'264
Employees in R&D	34	0.09	0.29	0	1	21	2	4	0	10
Cash	99	560'315	1'000'692	0	4'797'750	54	469'200	1'020'181	0	5'080'177
Receivables	99	1'594'349	2'182'461	0	14'800'000	54	11'200'000	23'300'000	0	82'700'000
Liabilities	99	9'655'651	16'500'000	1'437	89'000'000	54	36'000'000	105'000'000	2'776	404'000'000
Income Tax	99	211'702	859'451	-1'057'868	5'623'661	54	320'996	1'009'489	-269'367	4'515'820

THE PORTUGUESE SODA TAX

	January 2017	January 2018	January 2019
<25 g /L			1 €/hl
>= 25 g/L, <50g /L	8.22 €/hl	8.34 €/hl	6 €/hl
>= 50 g/L, <80g /L			8 €/hl
>= 80 g/L	16.46 €/hl	16.69€/hl	20 €/hl

Panel A: Drinks with added sugar or other sweeteners and drinks with an alcoholic strength between 0.5% and 1.2%

	January 2017	January 2018		October 2019	
	Concentrates	Concentrates in liquid form	Concentrates in solid form	Concentrates in liquid form	Concentrates in solid form
<25 g /L				6 €/hl	10 €/hl / 100kg nw
>= 25 g/L, <50g /L	8.22 €/hl	50 €/hl	83.35 €/100kg nw	36 €/hl	69 €/hl / 100kg nw
>= 50 g/L, <80g /L				48 €/hl	80 €/hl / 100kg nw
>= 80 g/L	16.46 €/hl	100.14 €/hl	166.90 €/100kg nw	120 €/hl	200€/hl / 100kg nw

Panel B: Concentrates intended for the preparation of beverages with added sugar or other sweeteners

Note: Author's own depiction based on *Codigo dos impostos especiais de consumo* (CIEC) article 87

- First discussed in May 2016

- The tax is approved in Dec 2016 and **implemented in Feb 2017**

- **Modified 3 times** since then (Jan 2018, Jan 2019, Oct 2019)

- Tax base: **sweet beverages** (including concentrates)

- **Levied on producers**

- The tax scheme **excludes** fruit juices and nectars & milk beverages

BALANCE TESTS

Table A1: **Balance test**

	P-values	
	(1) Full sample	(2) Sample without largest firm
Net Income	0.225	0.690
Total Income	0.081	0.352
Total Expenses	0.080	0.347
Turnover	0.078	0.336
Sales	0.073	0.312
Domestic Sales	0.090	0.398
Exported Sales	0.034	0.080
Average Wage	0.415	0.507
Number of Employees	0.178	0.987
Employees in R&D	0.359	0.267
Cash	0.164	0.332
Receivables	0.042	0.134
Liabilities	0.211	0.517
Income Tax	0.062	0.205

Note: P-values of t-test comparing SBBs and water producers in 2015

The difference in the means of the two groups is sometimes significant when using the full sample. This is **driven by an outlier**: the largest firm in the dataset

In column (2), we **exclude this firm** and the two groups are not significantly different

INVERSE HYPERBOLIC SINE

To cope with the **right skeweness** of some of the outcome variables, we use the **inverse hyperbolic sine (IHS) transformation**.

This allows the model to **include nonpositive values**, as opposed to a log transformation. (net income, exports,...)

As the IHS transformation depends on the scale of the variable, **we rescale the outcome variables** (Aihounton & Henningsen, 2019).

One should **interpret the magnitudes** of the estimates of IHS transformed variables with a grain of salt (Bellemare and Wichman, 2020).
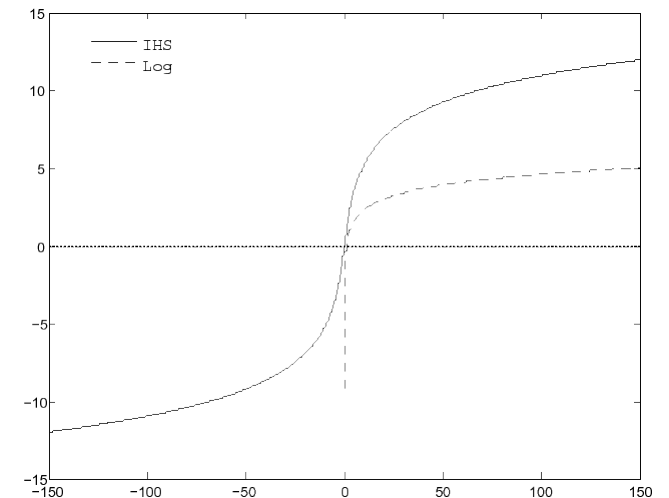
COUNTERFACTUAL – BOTTLED WATER PRODUCERS

Producers of bottled water are commonly used as a counterfactual in the literature (Etilé et al., 2018; Gonçalves & Pereira dos Santos, 2020; Taylor et al., 2019)

- Water is **not directly impacted by the tax**

- **No substitution effect** and no change in bottled water consumption after tax

- Water and SSBs **industries are very similar** in terms of cost structures and inputs (except for sugar), and are hence likely to be similarly impacted by other shocks and trends

FIRMS CLASSIFICATION

Firms are categorized based on the **main code of economic activity.**
It is possible that a firm's **main business is the production of sweet beverages**, but that **part of its revenue is generated by water**, or vice versa.

3 ways to address this potential issue:

- We **delete from our sample the only firm which main business area switched** from producing SSBs to water during the period of analysis

- Since the **tax is defined at the product level while our data is at the firm level**, and given that firms produce more than one drink, there is heterogeneity in treatment intensity within the treatment group

- We conduct a **robustness check** where we drop all firms that generate less than 90% of their revenue outside of their main business area (from 297 to 265 observations)

ROBUSTNESS CHECK – EXTREME VALUES

Table A2: **Effects of the soda tax on the main outcome variables: Extreme values robustness check**

	(1) Net Income	(2) Total Income	(3) Total Expenses	(4) Turnover	(5) Total Sales	(6) Domestic Sales	(7) Exported Sales
				A. 1% winsorization			
SSB *Post	-0.211*	-0.006	-0.085	0.001	0.003	-0.130*	-0.033
	(0.106)	(0.006)	(0.084)	(0.017)	(0.017)	(0.071)	(0.029)
Adjusted R2	0.092	0.073	0.041	0.062	0.058	0.101	0.060
N	297	297	297	297	297	297	297
				B. Sample without largest firm			
SSB *Post	-0.178	0.001	-0.524	0.007	0.008	-0.139*	-0.004
	(0.222)	(0.014)	(0.371)	(0.018)	(0.018)	(0.072)	(0.011)
Adjusted R2	0.092	0.111	0.066	0.093	0.086	0.102	-0.001
N	289	289	289	289	289	289	289

Note: Standard errors in parentheses clustered at the firm level. *p<0.1, **p<0.05, ***p<0.01. Scaling factors: net income$*10^{-6}$, total income$*10^{-8}$, total expenses$*10^{-2}$, turnover$*10^{-8}$, sales$*10^{-8}$, domestic sales$*10^{-6}$, exported sales$*10^{-8}$.

The estimates are **comparable to the main specification in terms of signs, magnitudes and significance.**

The effects are **not driven by extreme values.**

ROBUSTNESS CHECK – BUSINESS AREA

Table A3: **Effects of the soda tax on the main outcome variables: Business area robustness check**

	(1) Net Income	(2) Total Income	(3) Total Expenses	(4) Turnover	(5) Total Sales	(6) Domestic Sales	(7) Exported Sales
SSB *2012	-0.680	0.004	0.814	-0.007	-0.008	0.008	-0.003
	(0.562)	(0.016)	(0.692)	(0.020)	(0.020)	(0.100)	(0.015)
SSB *2013	-0.576	0.002	0.509	-0.008	-0.008	-0.049	-0.001
	(0.559)	(0.012)	(0.529)	(0.020)	(0.020)	(0.074)	(0.015)
SSB *2014	-0.126	0.022	0.015	0.014	0.013	-0.044	0.029
	(0.193)	(0.014)	(0.183)	(0.010)	(0.010)	(0.055)	(0.022)
SSB *2016	-0.122	0.019	-0.508	0.020	0.020	-0.098**	0.015
	(0.119)	(0.019)	(0.376)	(0.020)	(0.020)	(0.046)	(0.019)
SSB *2017	-0.420*	-0.007	-0.440	-0.006	-0.005	-0.157**	-0.011
	(0.244)	(0.008)	(0.651)	(0.009)	(0.009)	(0.065)	(0.018)
SSB *2018	-0.319	0.008	0.270	0.007	0.007	-0.153**	0.001
	(0.250)	(0.017)	(0.457)	(0.017)	(0.017)	(0.067)	(0.019)
SSB *2019	-0.814**	0.005	-0.075	0.005	0.005	-0.246**	0.003
	(0.387)	(0.023)	(0.498)	(0.022)	(0.022)	(0.099)	(0.016)
Adjusted R2	0.098	0.120	0.093	0.094	0.090	0.091	0.039
N	265	265	265	265	265	265	265

Note: Standard errors in parentheses clustered at the firm level. *$p<0.1$, **$p<0.05$, ***$p<0.01$. Scaling factors: net income*10^{-6}, total income*10^{-8}, total expenses*10^{-2}, turnover*10^{-8}, sales*10^{-8}, domestic sales*10^{-6}, exported sales*10^{-8}.

keeping firms producing **90% or more of their turnover** from their main economic area

The PTA still holds for all outcomes and all pre-tax years

ROBUSTNESS CHECK – LOGARITHMIC TRANSFORMATION

Table A4: **Effects of the soda tax on the main outcome variables: logarithmic transformations robustness check**

	(1) Net Income	(2) Total Income	(3) Total Expenses	(4) Turnover	(5) Total Sales	(6) Domestic Sales	(7) Exported Sales
				A. ln(y)			
SSB *Post	-1.825***	-0.234	-0.161	-0.048	-0.220*	-0.212**	0.062
	(0.642)	(0.363)	(0.149)	(0.175)	(0.113)	(0.099)	(0.519)
Adjusted R2	0.218	0.012	0.043	0.005	0.031	0.057	0.015
N	138	283	293	275	267	261	171
				B. ln(y+1)			
SSB *Post	-1.764***	-0.673	-0.699	-0.552	-0.446	-0.335	-1.343
	(0.620)	(0.621)	(0.489)	(0.676)	(0.756)	(0.775)	(0.987)
Adjusted R2	0.151	-0.003	0.054	0.019	0.015	0.022	0.005
N	143	297	297	297	297	297	297

Note: Standard errors in parentheses clustered at the firm level. *p<0.1, **p<0.05, ***p<0.01. Scaling factors: net income*10^{-6}, total income*10^{-8}, total expenses*10^{-2}, turnover*10^{-8}, sales*10^{-8}, domestic sales*10^{-6}, exported sales*10^{-8}.

sales*10⁻.

The estimates are robust to the different transformations of the dependent variables.

ROBUSTNESS CHECK – TREATMENT INTENSITY

Table A5: **Effect of the soda tax on the main outcome variables: DiD with treatment intensity robustness check**

	(1) Net Income	(2) Total Income	(3) Total Expenses	(4) Turnover
SSB_int *Post	-0.161	-0.014	-0.611	-0.007
	(0.192)	(0.013)	(0.383)	(0.016)
Adjusted R2	0.090	0.084	0.072	0.065
N	297	297	297	297

Note: Standard errors in parentheses clustered at the firm level. *p<0.1, **p<0.05, ***p<0.01. Scaling factors: net income*10^{-6}, total income*10^{-8} , total expenses*10^{-2}, turnover*10^{-8}.

The estimates are comparable to the main specification with treatment dummy.

ROBUSTNESS CHECK – BALANCED PANEL

Table A6: **Effects of the soda tax on main outcome variables: balanced panel robustness check**

	(1) Net Income	(2) Total Income	(3) Total Expenses	(4) Turnover	(5) Total Sales	(6) Domestic Sales	(7) Exported Sales
SSB*Post	-0.166	-0.013	-0.163*	-0.005	-0.003	-0.162*	-0.052
	(0.231)	(0.0161)	(0.0846)	(0.0195)	(0.019)	(0.079)	(0.041)
Adjusted R2	0.113	0.103	0.039	0.078	0.072	0.148	0.107
N	232	232	232	232	232	232	232

**The estimates and magnitudes are comparable to the main specification.
Total expenses becomes significant at the 10% level.**

ANTICIPATORY EFFECTS

Firms and consumers may respond to the tax and **adapt their behaviour before the actual implementation of the tax**. Taylor et. Al (2019) find that in Berkeley, California, purchases of soft drinks dropped months before the soda tax was implemented.

By using 2016 as the first post-tax year, we **enable the model to capture potential anticipation effects**.