Department of Economics- FEA/USP

Price impact of taxes on sugary drinks in Brazil

PAULA CARVALHO PEREDA

CAROLINA POLICARPO GARCIA

WORKING PAPER SERIES Nº 2021-06

Price impact of taxes on sugary drinks in Brazil

Paula Carvalho Pereda (pereda@usp.br)

Carolina Policarpo Garcia (policarpo.carolina@gmail.com)

Abstract:

Sugary drink consumption is an important contributor to the current global epidemic of obesity. In recent years, 50 countries or jurisdictions have implemented taxes on sugary drinks as an instrument to discourage consumption. Against the tide, Brazil reduced taxes on these beverages in 2017 and 2018. However, a recent debate – raised by the federal government – has started over taxation of sugary and alcoholic beverages (sin taxes). The effectiveness of this policy will depend on how the taxes are transferred to prices. In this sense, this paper we aim to quantify the impacts of the tax reduction on prices of sugary drinks in Brazil, and therefore to contribute to the debate by calculating the pass-through of taxes to prices of these products in the Brazilian context. We analyze the Brazilian market using a panel data of products, by brand, collected by Euromonitor from 2013 to 2018. Our results suggest that the transfer of taxes to prices depends on the firm size and the type of product, with pass-through rates ranging from 15-124%.

Keywords: Tax incidence; sugar-sweetened beverages; difference-in-differences.

JEL Codes: H22; D10; I18.

Price impact of taxes on sugary drinks in Brazil

Paula Pereda *
University of Sao Paulo, Brazil

Carolina Policarpo Garcia †
Competition and Markets Authority, UK

March 5, 2021

Abstract

Sugary drink consumption is an important contributor to the current global epidemic of obesity. In recent years, 50 countries or jurisdictions have implemented taxes on sugary drinks as an instrument to discourage consumption. Against the tide, Brazil reduced taxes on these beverages in 2017 and 2018. However, a recent debate – raised by the federal government – has started over taxation of sugary and alcoholic beverages (sin taxes). The effectiveness of this policy will depend on how the taxes are transferred to prices. In this sense, this paper we aim to quantify the impacts of the tax reduction on prices of sugary drinks in Brazil, and therefore to contribute to the debate by calculating the pass-through of taxes to prices of these products in the Brazilian context. We analyze the Brazilian market using a panel data of products, by brand, collected by Euromonitor from 2013 to 2018. Our results suggest that the transfer of taxes to prices depends on the firm size and the type of product, with pass-through rates ranging from 15-124%.

Keywords: Tax incidence, sugar-sweetened beverages, difference-in-differences.

JEL Classification: H22, D10, I18.

Acknowledgement: This study was supported by Bloomberg Philanthropies through a sub-award agreement 5104695 between the University of North Carolina at Chapel Hill and Center for Epidemiological Studies in Nutrition and Health. We thank Ana Clara Duran, Bernard Appy, Victoria Jaeger for comments and two anonymous referees for their contributions. We also thank members of the Brazilian ACT Alliance for their contributions in the discussions of Manaus Tax Shelter in Brazil.

*Email: pereda@usp.br
†Email: policarpo.carolina@gmail.com

1 Introduction

The consumption of sugar-sweetened beverages (SSBs) is an important contributor to the current worldwide epidemic of obesity and is also linked to several other negative health outcomes (Singh et al. (2015), Malik et al. (2013), Vartanian et al. (2007), Te Morenga et al. (2013), Zheng et al. (2015)). Because of this increasingly pressing public health issue, several countries have been discussing ways to regulate and decrease consumption of SSBs through economic instruments, mainly taxes. Around 50 countries or jurisdictions have now implemented SSB taxes, a policy encouraged by the World Health Organization (WHO) (WCRFI, 2018).

The mechanism by which taxes reduce consumption is straightforward: the tax increases prices and decreases purchases, reducing the consumption of SSBs. However, the price increase must be such that it changes consumer behavior and significantly reduces consumption of SSBs. Therefore, the effectiveness of a tax policy in reducing consumption depends on three main factors: how much of the tax is transferred to consumers through shelf prices ("pass-through rate"); the extent to which the price increase translates into consumption reduction (consumers sensitivity to prices, or price elasticity of demand); and to which beverages (if any) consumers will switch in response to the price increase (the substitutability of the good with respect to other goods). This paper contributes to the public policy debate on the first question.

The pass-through rate (PT) of a tax to consumers depends on buyers' and sellers' sensitivity to prices,[1] on the type of tax (e.g., excise tax, sales tax), size of the tax, beverage type, among other factors (Berardi et al. (2016); Bergman and Hansen (2010); Grogger (2017)). In the empirical literature, there is evidence of both overshifting (pass-through rate above 100%) and undershifting of taxes (pass-through rate below 100%) on cigarettes (DeCicca et al. (2013); Harding et al. (2012); Hanson and Sullivan (2009); Sullivan and Dutkowsky (2012)), and alcohol (Kenkel (2005); Young and Bielińska-Kwapisz (2002)).

There are few empirical papers on pass-through of SSB taxes, mainly comparing prices of specific countries or jurisdictions where the policy was adopted with other similar regions to estimate the pass-through of SSB taxes to final prices (Cawley and Frisvold (2017); Falbe

[1] In perfectly competitive markets, if demand is relatively more elastic than supply, producers will pay most of the cost of the tax. Conversely, if supply is relatively more elastic than demand, the tax burden will be greater for buyers.

et al. (2015); Cawley et al. (2018b,a); Grogger (2017); Bonnet and Réquillart (2013); Berardi et al. (2016). The main limitation of this approach is the lack of representativeness of data (normally based on primary data collected at specific locations or by online procedures), which threatens the external validity of the results to other settings. The literature focuses on American states and European countries, with the exception of Bonnet and Réquillart (2013), who studied the tax incidence in Mexico. However, these studies found important evidences that should be explored. First, they found evidence that pass-through rates range from 7% to 140%. Second, they found the existence of heterogeneities of the PT regarding the beverage types (juices or soda drinks) (Falbe et al. (2015); Bonnet and Réquillart (2013)) and firm size (Berardi et al. (2016); Cawley and Frisvold (2017)).

Very few papers have adopted a structural approach that estimates price elasticities and simulates the impact of different taxes on final prices. Bonnet and Réquillart (2013) [2]and Anderson et al. (2001)[3] simulated the impacts of an *ad valorem* and an excise tax on soft drinks on prices and consumption considering the strategic price response from manufacturers and retailers. The former found that the pass-through is brand-specific and that the excise tax is overshifted to consumers and the ad valorem tax is undershifted. The latter found that both taxes may be passed on to consumers by more than 100%. The analysis corroborated Cournot results with homogeneous demand (Delipalla and Keen (1992); Anderson et al. (2001)).

In this paper, we assess how changes in taxes on some beverages changed the final prices of SSBs in Brazil. Unlike other countries and contrary to the WHO's recommendation, the Brazilian government decreased taxes on many beverages, including some sugary drinks in 2017 and 2018. We take advantage of those recent changes, restricted to some beverages, to estimate the pass-through of taxes to SSB prices in Brazil. This is a relevant issue since a debate emerged in Brazil over taxing sugary and alcoholic beverages (called "sin taxes"), and understanding the

[2]The authors used data from a panel of French consumers. First, they estimated price elasticities of demand for many products using a random coefficients logit model. Then, they estimated the supply side of the model assuming manufacturers and retailers use nonlinear pricing in their vertical relationships. The authors assumed that the contract that best represents the vertical relationship between processors and retailers is a two-part-tariff contract where the processors have the entire bargaining power, meaning that how profits are shared, through the fees, are affected.Lastly, using estimates of the demand and supply models, the authors simulated the impact on consumer prices and consumption under alternative tax policies.

[3]Anderson et al. (2001) also analyzed how ad valorem and excise taxes behave in an oligopolistic industry with differentiated products and Bertrand firms.

transmission to prices is important to design the policy.

We follow the literature that analyzes the impacts of changes in taxes on final prices by using a reduced form analysis (differences-in-differences model). We have a panel data on volumes and average implicit prices by brand and firm and use changes in taxes on some of the beverages over time to obtain evidence of the pass-through of taxes to final prices of SSBs.

This paper is organized as follows. Section 2 briefly describes the tax structure in Brazil and explains the changes in taxes in Brazil from 2013 to 2018. In Section 3 we present a theoretical model that motivates the results. Section 4 describes the data, while Section 5 explains the empirical strategy and discusses all the estimates and the results of the policy change. Finally, Section 6 presents our final remarks.

2 Taxes on manufactured products

The Brazilian tax system is composed of several taxes and accessory obligations, which makes it highly complex. Most of the taxes are federal, such as taxes on income and salaries, as well as taxes on goods and services. There are fewer state-level taxes and municipal taxes, mainly on property, vehicles and some services and other goods.

One of the main federal taxes in Brazil is the Tax on Manufactured Products (IPI in the Portuguese acronym). The IPI is an excise tax levied on domestic and foreign industrial products (it is not imposed on exports).[4] The taxable event is the outflow of the domestic product from the manufacturing establishment or the customs clearance of imported products. For domestic products, the taxable amount is the price of the product leaving the facility, while for imported products the taxable amount is the customs price plus import taxes. The tax rate varies from 0% to 30%, depending on the nature of the product (according to the degree of essentiality of the product). As IPI is a non-cumulative tax, companies get an IPI credit for the purchases of raw materials, packaging and other intermediate goods incorporated into their own production. [5]

[4]An industrial process is characterized as any operation that modifies the nature, functionality, presentation or the purpose of a product.

[5]Decree 7,212/2010 describes all the rules about charging, inspection and administration of the tax.

2.1 IPI subsidies on sweetened beverages in Brazil

In summary, the credit system for the IPI works as follows. The IPI paid by the manufacturer of an input can be offset against the amount of IPI owned by the manufacturer of the final product. Suppose manufacturer A produces concentrate, a syrup used as the main input in many soft drinks. Manufacturer A is charged a 10% IPI rate for the syrup, whose price is $100. Manufacturer A then pays $10 in taxes, which is paid as a credit by manufacturer B, the syrup's buyer. Manufacturer B uses syrup as an input to produce soft drinks, which are sold to final consumers for $200 and whose IPI rate is 5%. Therefore, the final tax to be paid by manufacturer B would be $10 (5% of $200). However, as $10 was already paid by manufacturer A and credited to manufacturer B, manufacturer B does not pay any taxes.

The complexity of the Brazilian tax system, including tax exemptions and subsides, creates many distortions. Like any other manufacturer, producers of concentrates located in the Manaus Tax Shelter (ZFM in Portuguese) are exempt from IPI. When purchasing concentrates from manufacturers located in the ZFM, manufacturers of sweetened beverages accumulate as a credit the (unpaid) tax that would be paid upstream by manufacturers of concentrates. The mechanism works as a subsidy to manufacturers of soft drinks whose suppliers of concentrate are located in the ZFM. The distortion in the system means the higher the IPI tax rate on syrup is, the greater will be the benefit for producers of soft drinks whose supplier of concentrate is located in the ZFM. It is, therefore, a relevant subsidy for (mainly big) producers of sweetened beverages that buy inputs from this region.[6]

As of 2017, for example, the IPI rate for concentrates was of 20%, while the IPI rate for carbonated drinks was 4%. This means that manufacturers of soft drinks obtained a credit of 20% on the price of the purchased syrup (not paid at the source when manufactured in the ZFM) and owed an IPI rate of 4% for the final soft drink, which resulted in an IPI credit balance that was used to offset other federal taxes.

The Tax Expenses Report, issued by the Brazilian Federal Revenue Sevice, estimated that the Manaus Tax Shelter allowed a tax waiver of R $ 3.8 billion on the soft drink industry. This subsidy

[6] Companies benefited by this tax paradox include vertically integrated firms such as Coca-Cola, Pepsi and Ambev whose production of syrup is concentrated in the ZFM while the production of the final drinks is spread across the country.

was reversed in 2018, when the IPI rate for concentrates was reduced from 20% to 4%.[7]

In our analysis, the IPI subsidy might have the following effect on the result: First, the tax changed for concentrates (input for manufacturing soft drinks) only after June of 2018, while the reduction in the rate for beverages like soft drinks (that use concentrates as inputs) changed in 2017. In this sense, we separate the results in two time periods (including and excluding 2018) to understand how it might affect the estimates. Second, we observe in our data concentrates that can be used by final consumers. In the next subsection we describe the IPI changes in more detail.

2.2 Changes in IPI from 2013 to 2018

Against the global trend and the recommendation from international organizations (WHO, 2016), in 2016 and again in 2018 the Brazilian government decreased the IPI tax rate on many beverages, sweetened and unsweetened, as well as alcoholic beverages.

Not all beverages had the IPI rate decreased, though, as shown in Table 1. The first column shows the beverage categories relevant for this study, while the second column provides a description of the category. The third, fourth and fifth columns show the IPI rate for each beverage category in 2013-2016, 2017 and 2018 respectively.

In December 2016, the IPI rate for still and sparkling waters decreased from 15% to 4%. Flavored and functional bottled waters, low calorie and regular cola carbonates, non-cola carbonates, liquid concentrates, juices containing less than 24% fruit or between 25-50% fruit, energy drinks and sports drinks had their taxes reduced from 27% to 4%. The unaffected beverages (which will be part of the control group in the estimation) are juices made of 100% fruit, coconut and other plant waters, and ready-to-drink (RTD) coffee and tea.

In May 2018, the government again changed some IPI rates, including a decrease in the rate for concentrates from 20% to 4%. However, as explained in the former subsection, a high tax rate on sugary drink inputs provides a sizable subsidy for the industry, due to the distortion generated by the IPI credit system and tax exemptions for manufacturers located in ZFM. After many complaints from the soft drink industry, including threats from big companies to leave

[7] From 2019 on, there were two other tax changes on syrup producers and the IPI rate is set to increase to 8% after June 2020.

the country, the decree was repealed and in 2019 the IPI rate eas increased to 12%.[8] [9]

In this paper, we will use the changes in the IPI implemented at the end of 2016 and in 2018 to identify the impact of tax changes on the final prices of sweetened beverages.

[8]See this article (in Portuguese) from the Brazilian Senate over the debate to reinstate higher taxes for concentrates: https://www12.senado.leg.br/noticias/materias/2018/07/10/senado-suspende-decreto-que-alterou-imposto-sobre-xarope-para-refrigerante.

[9]At the end of 2017, the Ministry of Health started a debate on increasing taxes to help mitigate future health problems. See this article (in Portuguese): https://saude.estadao.com.br/noticias/geral,ministerio-da-saude-vai-propor-aumento-de-impostos-para-refrigerantes-e-sucos-com-acucar,70001994159. In 2020, the Brazilian Ministry of Economy, during the World Economic Forum, indicated that "sin taxes" on alcoholic beverages and sugary drinks should be included in a new tax reform proposal. See https://news.bloombergtax.com/daily-tax-report-international/brazils-sin-tax-explained-how-it-may-affect-beer-tobacco.

Table 1: IPI rate on all beverages from 2013-2018, Brazil

ID	Euromonitor Product	Description	2013 to 2016	2017	2018
1	Bottled water	Still and sparkling without sugar	15%	4%	4%
1a	Flavored water[2]	Flavoured, and functional bottled waters	27%	4%	4%
2	100% Juice	Packaged 100% juice obtained from fruits or vegetables by mechanical processes	0%	0%	0%
3	Juice Drinks (up to 25%)	Frozen and unfrozen juices that are manufactured using a base of concentrated juice or a pasteurized purée of the fruit pulp (fruit content of nectars is lower than 24%)	27%	4%	4%
4	Nectars	Frozen and unfrozen juices that are manufactured using a base of concentrated juice or a pasteurised purée of the fruit pulp (fruit content of nectars from 25% to 50%)	27%	4%	4%
5	Liquid Concentrates	Concentrates and syrups, or alternatively known squashes or dilutables, which are diluted with water before consumption	20%	20%	4%
6	Coconut and Other Plant Waters	Packaged beverages fully or partially derived from the liquid contained in coconuts or root-based plants/vegetables	0%	0%	0%
7	Non-Cola Carbonates[1]	Lemonade/lime, ginger ale, tonic water, orange carbonates, and others	27%	4%	4%
8	Regular Cola Carbonates	Standard regular cola carbonates	27%	4%	4%
9	Low Calorie Cola Carbonates	Cola carbonates that have lower calorie content than regular cola carbonates	27%	4%	4%
10	RTD Coffee	Packaged ready-to-drink coffee	0%	0%	0%
11	RTD Tea	Beverages based on brewed tea or tea extract (sweetened, carbonated or still)	0%	0%	0%
12	Energy Drinks	Drinks containing stimulant compounds (e.g. caffeine)	27%	4%	4%
13	Sports Drinks	Hypotonic drinks with low concentration of salt and sugar	27%	4%	4%

Notes: [1] Soft drinks that contain fruit juice (or guarana and açai) might have 25% (or 50%) reduced IPI rate. The reduction is applied when producers meet the quality standards required by the Brazilian Ministry of Agriculture. [2] Flavored waters and bottled water are in the same category in Euromonitor.

Source: Euromonitor for product description. Decrees 7,212/2010, 7,660/2011, 7,879/2012, 8,017/2013, 8,950/2016 and 9,394/2018 for IPI rates over time.

3 Theoretical framework

We present here the model behind the transmission of taxes to prices by firms. Consider that a manufacturer maximizes its profit (Π^f):

$$\Pi^f = \sum_{j \in G_f} [(w_j - \mu_j) q_j + F_j] \tag{1}$$

Where it is also subject to the participation constraint of each retailer $\Pi^r \geq \tilde{\Pi}^r$. G_f is the set of products sold by manufacturer f, w_j is the wholesale price of product j, μ_j is the constant marginal cost to produce product j, $q_j(p)$ is the quantity sold of product j, F_j is the fixed price received for product j, Π^r is the profit of retailer r and $\tilde{\Pi}^r$ is a fixed reservation utility normalized to zero without loss of generality.

In turn, retailer's profit (Π^r) maximization is:

$$\Pi^r = \sum_{j \in S_r} [(p_j - w_j - c_j) q_j^r - F_j] \tag{2}$$

Where S_r is the set of products sold by retailer r, p_j is the price of product j and c_j is the constant marginal cost to distribute product j.

When manufacturers' margins are set to zero ($w_j = \mu_j$), and fixed prices allow profit sharing between manufacturers and retailers. The first order condition of the retailer's problem is

$$\sum_{k=1}^{J} (p_k - \underbrace{\mu_k - c_k}_{C_k}) \frac{dq_k}{dp_j} + q_j = 0 \qquad \text{for all } j \in G_f \tag{3}$$

Let $Q(p)$ be the $G \times 1$ share vector and $\Delta(p) \equiv \frac{dq_k'}{dp_k}$ the $G \times G$ Jacobian matrix of first derivatives. C is the $G \times 1$ marginal cost vector and P the $G \times 1$ price vector. Then in vector notation the first-order condition is:

$$\Delta(p)(P - C) + Q = 0$$

Rearranging the terms we have:

$$C = P + \Delta(p)^{-1} Q \tag{4}$$

The tax determines the difference between p_s and p_d: $p_d = (1+\delta)p_s$. p_s is the value received by the seller and price paid by the buyer. Therefore, the retailer's problem becomes:

$$\max_{\{p_k\}_{k \in G_f}} \sum_{j=1}^{J} \left[\left(\frac{1}{1+\delta} p_j - w_j - c_j \right) q_j^r - F_j \right] \tag{5}$$

Which means the first order condition is

$$P^d = \left[C - \Delta(p)^{-1} Q \right] \left(1 + \delta \right) \tag{6}$$

Final prices (p_d), therefore, depend on the tax rate change and on several characteristics of the supply market and consumer responsiveness. We explore these heterogeneities in our empirical exercise, explained in the next sections.

4 Data

To evaluate the change in IPI rate on final prices, we use annual beverage sales data compiled by Euromonitor from 2013 to 2018 (last available) for Brazil (Euromonitor-Passport, 2019). Euromonitor's data are based on industry research, such as economic indicators, company reports and trade interviews, and not on primary data collection. Although the information is widely used by companies and researchers, it should be mentioned that it is proprietary and its exact sources are not publicly available, meaning that its quality has not been subject to independent evaluation (Bandy et al., 2019).

Euromonitor's dataset provides information on total retail values (in millions of R$) and volume (in millions of liters) per year for 13 types of soft drinks and 87 brands. The data also have information on the producing company. SSBs in the data include carbonates, concentrates, some juices, ready-to-drink (RTD) coffees and teas, sports and energy drinks. We generate average implicit prices by dividing total values by volume for each brand.

Columns 1 and 2 in Table 2 report the 13 categories of drinks present in Euromonitor's data and used in the estimations. All categories in Column 2 of Table 2 have a one-to-one correspondence with the categories from Table 1. In Column 3 we propose an aggregation based on the classification of the products in the Brazilian law that establishes the IPI rates, except for the "Others", which are composed of the products whose IPI rates remain the same during the period we analyzed.

Columns 4 and 5 in Table 2 show the distribution of brands and firms by type of product, respectively. Note there is some dispersion both in terms of brands and firms offering the different categories of products. In particular, the markets for carbonated drinks, RTD coffee and sports drinks seem to be more concentrated than the markets for water and juices, although these numbers must be read carefully, since Euromonitor's data include only the biggest brands in the market.[10]

[10] We consider all mergers and acquisitions in the period to account for the number of firms.

Table 2: Number of big brands and firms that sell in the market by product, Brazil, 2018

ID	Euromonitor Product	Proposed Aggregation	Number of brands	Number of firms
1	Bottled Water	Water	11	7
2	100% Juice	Others	9	9
3	Juice Drinks (up to 24%)	Juice/nectars	5	5
4	Nectars	Juice/nectars	11	10
5	Liquid Concentrates	Concentrates	7	6
6	Coconut and Other Plant Waters	Others	6	6
7	Non-Cola Carbonates	Carbonates	11	5
8	Regular Cola Carbonates	Carbonates	4	4
9	Low Calorie Cola Carbonates	Carbonates	3	2
10	RTD Coffee	Others	1	1
11	RTD Tea	Others	6	5
12	Energy Drinks	Energy/sports	9	8
13	Sports Drinks	Energy/sports	4	3
		Total	87	

Notes: Column 3 "Proposed Aggregation" shows the category we created based on changes in the IPI rate using the Brazilian coding system. The "Others" classification comprises all products whose IPI rate did not change over the time period we analyze.
Source: Euromonitor.

Table 3 shows the descriptive statistics of prices (mean and standard deviation) per product in three time slices: 2013, 2015, and 2018. Prices are in Brazilian Reais (R$) per liter and in 2018 values.[11] There was a decrease in prices for almost all products between 2013-2015, except for regular cola carbonates (real prices increased 2%). On the other hand, the prices of all products increased between 2015-2018. We highlight the prices of juice drinks (up 24%), which decreased by 34% from 2015-2013 and 32% from 2018-2013. According to Yuba et al. (2013), the food industry brought to the Brazilian diet many foods and beverages made from industrial ingredients and additives (products called ultra-processed) at a very affordable price in recent

[11] Prices were deflated using the National Consumer Price Index for Food and Beverages (IPCA-AB) from 2013-2018.

decades, considerably reducing prices. Bottled water, in our sample, is more expensive on average than many carbonates due to the great variability in the brands compiled by Euromonitor (e.g., luxury brands), as the standard deviation indicates, and to the differences in package sizes (in Brazil, carbonates are traded in much larger sizes than bottled water, for example).

Table 3: Mean and standard deviation of prices in Brazilian Reais by product, 2013, 2015 and 2018

		2013		**2015**		**2018**	
ID	Product	Mean	SD	Mean	SD	Mean	SD
1	Bottled Water	3.75	4.77	3.44	4.27	4.07	5.04
2	100% Juice	12.99	4.10	11.6	3.09	12.42	3.00
3	Juice Drinks (up to 24%)	10.24	9.30	6.75	6.02	6.96	5.33
4	Nectars	10.03	5.69	9.97	8.07	14.71	13.45
5	Liquid Concentrates	15.58	5.25	13.5	4.38	14.18	4.63
6	Coconut and Other Plant Waters	16.06	4.72	14.00	1.89	16.3	4.42
7	Non-Cola Carbonates	2.77	1.32	2.58	1.21	2.77	1.38
8	Regular Cola Carbonates	2.48	1.21	2.53	1.11	3.07	1.09
9	Low Calorie Cola Carbonates	3.79	0.92	3.62	0.90	4.06	1.05
10	RTD Coffee	18.93	3.04	13.77	3.28	15.43	N.A.
11	RTD Tea	11.75	16.49	9.71	11.58	10.28	9.28
12	Energy Drinks	26.78	9.05	21.78	6.28	22.77	7.40
13	Sports Drinks	8.18	1.23	7.98	0.56	8.91	0.54

Notes: There is only one brand of RTD coffee compiled by Eurmonitor data. In 2018, 1 R$=0.258 US$.

Source: Euromonitor.

5 Empirical strategy and results

5.1 Methodology

To assess the pass-through of taxes to SSB prices, we adopt a difference-in-differences approach. We estimate a simple model to understand the effect of changes in the IPI rate on retail prices of SSBs in Brazil. Our treated units are the products that were affected by changes in IPI: bottled water, juice drinks, nectars, liquid concentrates, carbonated drinks, energy drinks and sport drinks.[12] Therefore, the products in the control group are 100% juice, coconut and other plant water, RTD coffee and RTD tea. We seek to estimate the average impact of the change in the IPI rate (the treatment) on the implicit average price of these products. Formally, we estimate an equation akin to Equation 7:

$$\log p_{ifpt} = \theta T_{ifpt} + \alpha_i + \alpha_f + \alpha_p + \alpha_t + \epsilon_{ifpt} \tag{7}$$

where p_{ifpt} is the retail price of brand i of product p produced by firm f in year t. The variable T_{ifpt} denotes the treated products and is one from 2017 and/or 2018 on depending on the product (see Table 1). Then, θ is the coefficient of interest and measures the average effect of the decreased tax rate on the final price. The data structure allows us to include a variety of fixed effects that control for any time-invariant characteristics that may affect price levels within brand (α_i), firm (α_f) and product (α_p), such as product type, product quality, brand loyalty and firm reputation. We also include year fixed effects (α_t) to take into account common shocks that affect products, brands and firms uniformly. ϵ_{ifpt} is the idiosyncratic error term and includes any other factors not taken into account in the regression. In some specifications, we include the initial price in 2013 as a control (excluding this year from the analysis). By doing this, we obtain the treatment effect relative to products in the control group with the same initial price as the treated product. We also explore heterogeneities of the effects in terms of firm size and product category. All standard errors are clustered at the product level.

While the difference-in-differences method has been used successfully in many areas of economics, we should note the limitations of the approach in the context of this study. By adopting a difference-in-differences approach, we use the products in the control group to infer what would have happened to the prices of the products in the treated group in the absence of the treatment. This is a strong assumption: we expect that the trend in prices of the products in the control group to be similar to the trend in prices of the treated group before the treatment, and that this would also be the case in the after-treatment period in the absence of treatment.

[12] All these products had a change in rate in 2017, except for liquid concentrates (2018).

In other words, the method requires that the products in the control group are a good counterfactual to the products that were affected by the tax change (after controlling for the brand, firm, and product fixed effects). While we provide some robustness tests for our estimates, we must recognize that prices of different product categories might respond differently to tax changes, something we are unable to test. Another important limitation refers to the dataset used. As explained in section 4, Euromonitor provides an aggregated data set from where we calculate average prices from total revenues and total volumes by brand and year. This means that we are unable to take into account differences in prices and responses to the tax change of the same product across regions and that may be related to socioeconomic and demographic characteristics. Despite these limitations, we believe this study provides relevant empirical evidence to support the debate on the pass-through of taxes to prices of SSBs.

5.2 Average effects

We start the analysis by estimating the average treatment effect, setting aside potential heterogeneous effects, which will be dealt later in this section. Table 4 shows the results for our difference-in-differences estimates. We divide the estimates into two panels: Panel A, which includes all data for the 2013-2018 period (before the change in the IPI rate of liquid concentrates); and Panel B, which includes data for the 2013-2018 period.[13] Specification (1) includes year fixed effects and product fixed effects, specification (2) adds the initial price of the product in 2013 as a control, specification (3) includes year and product fixed effects and a time trend for each product category, specification (4) adds firm fixed effects while specification (5) replaces the firm fixed effects by brand fixed effects (as they cannot be included together).

Our preferred specification is specification (5), which includes year, product category and brand fixed effects, as well as a product-specific trend over time. We prefer this specification – instead of specification (4), which includes firm fixed effects – because brands can play an important role in consumer choice and price levels and, therefore, on the response of prices

[13]As explained in section 2, due to inconsistencies in the debt and credit system, the IPI rate for concentrates works as a subsidy for many SSB that use concentrates as input. To disentangle the impact of the tax decrease from the reduction in the subsidy of SSB, we took advantage from the fact that the tax rate for concentrates changed a year later than the tax rate for the other SSB drinks by running separated regressions for the 2013-2017 and the 2013-2018 periods.

to tax changes. In both panels, we observe a negative correlation between the reduction of the IPI rate and prices. Specification of the subsample covering the 2013-2017 period is statistically significant at the 10% level, meaning that the average reductions of 11 percentage points and 23 percentage points in the IPI rates for water and sugary drinks, respectively, reduced prices by 3.5% on average (average pass-throughs of 16% for sugary drinks, and 32%, for bottled water).

Table 4: Average impact of change in IPI rate on consumer prices.

	(1)	(2)	(3)	(4)	(5)
Panel A: 2013-2017					
IPI reduction	0.023	0.063***	-0.066	0.078	-0.035**
	(0.037)	(0.020)	(0.055)	(0.089)	(0.016)
Observations	476	458	476	476	475
R squared	0.517	0.990	0.530	0.776	0.995
Panel B: 2013-2018					
IPI reduction	0.018	0.058***	-0.058	0.063	-0.027
	(0.037)	(0.017)	(0.050)	(0.075)	(0.018)
Observations	563	539	563	563	562
R squared	0.523	0.987	0.533	0.776	0.993
Year FE	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes
Firm FE	No	No	No	Yes	No
Brand FE	No	No	No	No	Yes
Product trend	No	No	Yes	Yes	Yes
Initial price	No	Yes	No	No	No

Notes: This table shows the effects of reductions of IPI rate on final price. Prices are in logarithm. Panel A estimates using data between 2013 and 2017 (before the change in IPI rate of liquid concentrates). Panel B includes data for the 2013-2018 period. Treated units are bottled water, juice drinks, nectars, liquid concentrates, carbonated drinks, energy drinks and sport drinks. The control group considers 100% juice, coconut and other plant water, RTD coffee and RTD tea. Clustered standard errors at the product level in parentheses. Regressions are weighted by annual sales volume of the brand. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5.3 Heterogeneous effects: product category

We now disaggregate the results by product category. Table 5 shows the estimates for different categories of products and different changes in IPI rates in 2017 and 2018 for both sub-samples of 2013-2017 (Panel A) and 2013-2018 (Panel B). We aggregate still and sparkling waters in a single *Waters* category. This means that the estimated coefficient will be the average effect of the change in the IPI rate from 15% to 4% in 2017. We also aggregate juice drinks and nectars; non-cola carbonates, regular cola carbonates and low calorie cola carbonates into a single *Carbonates* category; and energy and sports drinks. For all categories but concentrates, the IPI rate changed in 2017.

In terms of use of controls and different sets of fixed effects, the specifications are similar to the ones presented in Table 4. Estimates from Panel A and Panel B are broadly consistent. Again, we prefer specification (5) due to the relevance of the fixed effects included. As per Panel A, for all product categories except juices/nectars, we find a negative impact of the reduction in the IPI rate in 2017 for the product categories on prices, all statistically significant at different levels. We find a positive correlation between the IPI rate reduction on juices/nectars and their prices. A possible explanation for this counter-intuitive result is a simultaneous demand change during this period regarding the consumption of this product. According to the Brazilian Association of Soft Drinks and Non-Alcoholic Beverages, while the consumption of soda drinks fell 24% from 2010 to 2017, the consumption of juices and nectars increased 48% in the same period. The strong demand growth for juices and nectars may help explain why prices increased even with a decrease in the IPI rate.

Taking results from Panel A, specification (5), we find that water prices dropped 3.4% when the IPI rate decreased from 15% to 4%, a pass-through rate of 31%. Carbonated and energy/sports drinks had their prices reduced in 4.4% and 3.4% respectively when the IPI rate decreased from 27% to 4%. These results translate in pass-through rate of 19% for carbonated[14]and of 15% for energy/sports drinks. For concentrates (Panel B), results suggest a small increase in prices at the same time that the IPI rate decreased, although the estimated impact is statistically significant at the 10% level only. Our results are in the same interval of PT rates estimated by the literature (Falbe et al. (2015); Cawley and Frisvold (2017); Cawley et al. (2018a)). Falbe et al. (2015) also found higher pass-through rates for sodas when compared to other beverages.

[14]We also estimate the robustness of this estimate by excluding the category of "Non-cola carbonates" due to the potential reduction in taxes on soft drinks produced from Brazilian fruits. When excluding this category, the pass-through rate of carbonates is 21.3% in 2017, and 25.2% in 2017-2018.

Table 5: Change in IPI rate impact on final prices by type of product.

	(1)	(2)	(3)	(4)	(5)
Panel A: 2013-2017					
Water	-0.016	0.008	-0.091*	0.060	-0.034**
	(0.031)	(0.014)	(0.044)	(0.079)	(0.013)
Juices/nectars	-0.196***	0.043**	0.350***	0.397***	0.065**
	(0.032)	(0.017)	(0.058)	(0.054)	(0.024)
Carbonated	0.051	0.074***	-0.102**	0.050	-0.044***
	(0.032)	(0.018)	(0.045)	(0.079)	(0.014)
Energy/sports	-0.010	0.008	-0.092*	0.061	-0.034*
	(0.031)	(0.015)	(0.046)	(0.081)	(0.018)
Observations	476	458	476	476	475
R squared	0.519	0.990	0.533	0.778	0.995
Panel B: 2013-2018					
Water	-0.004	0.015	-0.088*	0.066	-0.032*
	(0.033)	(0.014)	(0.048)	(0.080)	(0.015)
Juices/nectars	-0.198***	0.045**	0.399***	0.425***	0.078**
	(0.034)	(0.020)	(0.062)	(0.056)	(0.029)
Carbonated	0.048	0.075***	-0.112**	0.042	-0.052***
	(0.035)	(0.018)	(0.048)	(0.080)	(0.016)
Energy/sports	-0.019	0.003	-0.098*	0.055	-0.038*
	(0.033)	(0.014)	(0.050)	(0.081)	(0.021)
Concentrates	-0.070**	-0.048***	-0.015	0.025	0.017*
	(0.027)	(0.012)	(0.025)	(0.021)	(0.009)
Observations	563	539	563	563	562
R squared	0.525	0.988	0.536	0.778	0.994
Year FE	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes
Firm FE	No	No	No	Yes	No
Brand FE	No	No	No	No	Yes
Product trend	No	No	Yes	Yes	Yes
Initial price	No	Yes	No	No	No

Notes: This table shows the effects of reductions of IPI rate on final price. Prices are in logarithm. Panel A estimates using data between 2013 and 2017 (before the change in IPI rate of liquid concentrates). Panel B includes data for the 2013-2018 period. Treated units are water (bottled water), juice/nectars (juice drinks, nectars), concentrates (liquid concentrates), carbonated (carbonated drinks), and energy/sports (energy drinks and sport drinks). The control group considers 100% juice, coconut and other plant water, RTD coffee and RTD tea. Clustered standard errors at the product level in parentheses. Regressions are weighted by annual sales volume of the brand. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5.4 Heterogeneous effects: product category and firm size

We also analyze the heterogeneous effects on prices by firm size. We classify firms into "smaller" or "larger" by dividing them using the median of sales volume of each product. Smaller firms are 50% of firms that sold fewer liters by Euromonitor, while larger firms are the 50% that sold more liters of that product. Table 6 shows the estimated coefficients. Specifications (1) and (3) are similar to the ones presented in column (4) of Table 5, while specifications (2) and (4) replicate the same model as column (5) of the same table. Columns (1) and (2) refer to the 2013-2017 subsample and Columns (3) and (4) consider data from 2013-2018.

Results for the sub-samples covering the 2013-2017 and the 2013-2018 periods are consistent with each other. The estimated coefficients suggest that only the smaller firms producing water and energy/sport drinks passed on the reduction in the IPI rate to final prices, while only the larger firms producing carbonates passed on the tax reduction to final prices. Prices of bottled water sold by the smaller firms fell 13.7%, a pass-through rate of 124%. Energy/sports drinks sold by smaller firms had their prices decreased by 5.1%, which translates into a pass-through rate of 22%. It is noteworthy that Berardi et al. (2016); Cawley and Frisvold (2017) also found heterogeneity of tax incidence estimates by firms.

We also find a negative and statistically significant effect for small firms producing concentrates (pass-through rate of 12.5%), while positive effects for larger firms. This result is consistent with the subsidy observed in the industry for soft drinks that use liquid concentrates as inputs. Many larger firms are vertically integrated and place their concentrates production in the Manaus Tax Shelter. These companies would have less incentives when compared to the smaller ones to pass on the tax reduction to final prices.

Table 6: Impact of change in IPI on consumer prices by firm size.

	2013-2017		2013-2018	
	(1)	(2)	(3)	(4)
Panel A: 50% of smaller firms				
Water	-0.053	-0.137***	-0.059	-0.137***
	(0.070)	(0.013)	(0.070)	(0.016)
Juices/nectars	-0.132	0.155	-0.113	0.172
	(0.169)	(0.088)	(0.161)	(0.097)
Carbonated	0.021	0.021	0.014	0.028
	(0.129)	(0.052)	(0.145)	(0.065)
Energy/sports	0.116	-0.051***	0.117	-0.065***
	(0.215)	(0.014)	(0.236)	(0.018)
Concentrates			0.799	-0.020**
			(0.657)	(0.009)
Panel B: 50% of larger firms				
Water	0.076	-0.017	0.083	-0.015
	(0.079)	(0.013)	(0.079)	(0.016)
Juices/nectars	0.839***	-0.018	0.905***	-0.019
	(0.250)	(0.016)	(0.259)	(0.021)
Carbonated	0.055	-0.061***	0.046	-0.073***
	(0.087)	(0.014)	(0.088)	(0.016)
Energy/sports	0.055	-0.033	0.049	-0.036
	(0.082)	(0.020)	(0.082)	(0.023)
Concentrates			-0.107	0.023**
			(0.093)	(0.009)
Year FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Brand FE	No	Yes	No	Yes
Product trend	Yes	Yes	Yes	Yes
Observations	476	475	563	562
R squared	0.785	0.995	0.791	0.995

Notes: This table shows the effects of reductions of IPI rate on final price. Prices are in logarithm. Columns (1) and (2) present estimates using data from 2013-2017 (before the change in IPI rate of liquid concentrates). Columns (3) and (4) include data for the 2013-2018 period. Panel A shows the estimates for the 50% of smaller firms in each product, while Panel B presents the same estimates but for products sold by larger firms. We divide the firms by the median of volume sold in the first year of analysis (2013). Treated units are water (bottled water), juice/nectars (juice drinks, nectars), concentrates (liquid concentrates), carbonated (carbonated drinks), and energy/sports (energy drinks and sport drinks). The control group considers 100% juice, coconut and other plant water, RTD coffee and RTD tea. Clustered standard errors at the product level in parentheses. Regressions are weighted by annual sales volume of the brand. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6 Final Remarks

A global debate over the tax increase on sugary drinks has occurred in the recent years. Brazil – against the trend – chose to decrease relevant taxes on beverages in 2017 and 2018. In this paper, we quantify the price impacts of changes in the IPI rate on beverages. This is a relevant matter, especially due to the recent debate in the country over taxing sugary and alcoholic drinks by the federal government.

While there has been growing literature calculating the pass-through rate of SSBs in other countries, the literature is still new in Brazil and in many other developing and underdeveloped countries. Our study seeks to fill this gap and contribute to this literature. Then, we construct a panel of prices by brand over time (2013-2018) in Brazil using Euromonitor data. We take advantage of the recent reduction in the IPI rate restricted to some beverages to estimate the pass-through of taxes to SSB prices. We find an average pass-through rate of 30% for water, 19% for carbonated drinks, and 15% for energy/sports drinks. Most of the price reductions are observed for the smaller firms: 124% for water brands (2017); 24% for energy drinks (2017); and 12.5% for liquid concentrates (2018). Results suggest that only the larger firms producing carbonated drinks pass on the reduced tax rates to final prices (pass-through rate of 26.5%). We find a positive effect of the tax reduction on prices of liquid concentrates. This result can be explained by the lower subsidy to soft drinks derived from the tax reduction due to the distortions of the tax system.

Understanding how much of the tax is transferred to final prices is relevant to design tax policy. Differential pass-through rates by type of product might raise a discussion about distinct taxation on juices and soft drinks, for example. We believe our evidences are also relevant to highlight the distortions in the current Brazilian tax system due to observed subsidies in the Manaus Tax Shelter. Finally, in terms of public policy, another relevant contribution is to understand the differential strategic behavior or larger and smaller firms in Brazil.

This study has several limitations, which also means some interesting avenues for future research. We were unable to assess beverage package sizes, as well as analyze the heterogeneity by distribution channel. Moreover, we use data based on industry research, not primary data. Although these data are widely used by companies and researchers, the Euromonitor data are proprietary and the sources and methodology are not publicly available.

References

Anderson, S. P., De Palma, A., Kreider, B., 2001. Tax incidence in differentiated product oligopoly. Journal of Public Economics 81 (2), 173–192.

Bandy, L., Adhikari, V., Jebb, S., Rayner, M., 2019. The use of commercial food purchase data for public health nutrition research: A systematic review. PLoS ONE 14 (1), 1–19.

Berardi, N., Sevestre, P., Tepaut, M., Vigneron, A., 2016. The impact of a 'soda tax'on prices: evidence from french micro data. Applied Economics 48 (41), 3976–3994.

Bergman, U. M., Hansen, N. L., 2010. Are excise taxes on beverages fully passed through to prices? the danish evidence.

Bonnet, C., Réquillart, V., 2013. Tax incidence with strategic firms in the soft drink market. Journal of Public Economics 106, 77–88.

Cawley, J., Crain, C., Frisvold, D., Jones, D., 2018a. The pass-through of the largest tax on sugar-sweetened beverages: The case of boulder, colorado. Tech. rep., National Bureau of Economic Research.

Cawley, J., Frisvold, D. E., 2017. The pass-through of taxes on sugar-sweetened beverages to retail prices: The case of berkeley, california. Journal of Policy Analysis and Management 36 (2), 303–326.

Cawley, J., Willage, B., Frisvold, D., 2018b. Pass-through of a tax on sugar-sweetened beverages at the philadelphia international airport. Jama 319 (3), 305–306.

DeCicca, P., Kenkel, D., Liu, F., 2013. Who pays cigarette taxes? the impact of consumer price search. Review of Economics and Statistics 95 (2), 516–529.

Delipalla, S., Keen, M., 1992. The comparison between ad valorem and specific taxation under imperfect competition. Journal of Public Economics 49 (3), 351–367.

Euromonitor-Passport, 2019. Food brand retail - brand shares in brazil from 2012 to 2018. Euromonitor Passport.

Falbe, J., Rojas, N., Grummon, A. H., Madsen, K. A., 2015. Higher retail prices of sugar-sweetened beverages 3 months after implementation of an excise tax in berkeley, california. American journal of public health 105 (11), 2194–2201.

Grogger, J., 2017. Soda taxes and the prices of sodas and other drinks: evidence from mexico. American Journal of Agricultural Economics 99 (2), 481–498.

Hanson, A., Sullivan, R., 2009. The incidence of tobacco taxation: evidence from geographic micro-level data. National Tax Journal, 677–698.

Harding, M., Leibtag, E., Lovenheim, M. F., 2012. The heterogeneous geographic and socioeconomic incidence of cigarette taxes: Evidence from nielsen homescan data. American Economic Journal: Economic Policy 4 (4), 169–98.

Kenkel, D. S., 2005. Are alcohol tax hikes fully passed through to prices? evidence from alaska. American Economic Review 95 (2), 273–277.

Malik, V. S., Pan, A., Willett, W. C., Hu, F. B., 2013. Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. The American journal of clinical nutrition 98 (4), 1084–1102.

Singh, G. M., Micha, R., Khatibzadeh, S., Shi, P., Lim, S., Andrews, K. G., Engell, R. E., Ezzati, M., Mozaffarian, D., of Diseases Nutrition, G. B., (NutriCoDE, C. D. E. G., et al., 2015. Global, regional, and national consumption of sugar-sweetened beverages, fruit juices, and milk: A systematic assessment of beverage intake in 187 countries. PLOS one 10 (8), e0124845.

Sullivan, R. S., Dutkowsky, D. H., 2012. The effect of cigarette taxation on prices: an empirical analysis using local-level data. Public Finance Review 40 (6), 687–711.

Te Morenga, L., Mallard, S., Mann, J., 2013. Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials and cohort studies.

Vartanian, L. R., Schwartz, M. B., Brownell, K. D., 2007. Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. American journal of public health 97 (4), 667–675.

WCRFI, 2018. Building momentum: lessons on implementing a robust sugar sweetened beverage tax. Tech. rep., World Cancer Research Fund International.
URL www.wcrf.org/buildingmomentum

WHO, 2016. Taxes on sugary drinks: Why do it? World Health Organization.

Young, D. J., Bielińska-Kwapisz, A., 2002. Alcohol taxes and beverage prices. National Tax Journal, 57–73.

Yuba, T. Y., Sarti, F. M., Campino, A. C. C., do Carmo, H. C. E., 2013. Evolucao dos precos relativos de grupos alimentares entre 1939 e 2010, em sao paulo, sp. Revista de Saúde Pública 47 (3), 549–559.

Zheng, M., Allman-Farinelli, M., Heitmann, B. L., Rangan, A., 2015. Substitution of sugar-sweetened beverages with other beverage alternatives: a review of long-term health outcomes. Journal of the Academy of Nutrition and Dietetics 115 (5), 767–779.