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Who Bears the Costs of the UK Soft Drink Tax? An Empirical Study of Medium-Term Effects

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Abstract

Using five years post-tax data on CPI prices, national employment as well as firm-level employment, we provide novel evidence on the medium-term effects of the UK Soft Drinks Industry Levy (SDIL). Applying a difference-in-differences research design, we find that neither consumers nor employees visibly bore the costs of the tax. However, given the falling trend in beverage prices in the UK, consumers faced a 6% less decline in soft drink prices compared to prices of levy-exempt beverages, since the introduction of the tax. Employees in the soft drink manufacturing industry were unaffected by the tax, whilst employees in the beverage manufacturing industry even benefitted from it through significant employment increases. Our study offers policy advice for other countries which are yet to implement soft drink taxes. We advocate the implementation of tiered tax designs, such as in the UK, due to its positive impact on employment and minimal burden for consumers.

Keywords: public health policy; soft drink taxation; UK sugar tax

1. Introduction

Increasing health concerns, such as obesity and the associated non-communicable diseases (NCDs)[1], have urged governments worldwide to address the excess sugar intake of the population (World Health Organization, 2023a). Hereby, the UK is one of the countries suffering the most from this health issue, having the third highest obesity rate in Europe in 2016, succeeding Malta and Turkey (Metcalfe & Sasse, 2023). By 2016, it was inevitable for the UK government to encounter this adiposity epidemic, with an obesity rate striking nearly 30% (Metcalfe & Sasse, 2023).[2] Consequently, the UK Soft Drinks Industry Levy (SDIL)[3] was implemented in April 2018 (HM Revenue & Customs, 2024a). Its two-tiered policy design aims at encouraging manufacturers to reduce the sugar content of their beverage portfolio through reformulation (HM Revenue & Customs, 2024a); the less sugar is added to a drink the lower the tax burden. However, as prevalent for excise taxes, producers often shift the extra costs arising through the tax onto other stakeholder groups to maintain pre-tax profits. Considering that the UK soft drink tax is a producer-imposed tax, it is not intended to be passed down to consumers (e.g. in the form of higher product prices) or employees (e.g. job cuts). Thus, to understand the effectiveness of the UK soft drink tax, it is vital to first question "Who bears the costs of the UK soft drink tax?". To identify which party carried the tax burden I perform difference-in-differences analyses using firm-level and national employment data, as well as product price data on soft drink prices. I find that neither employees nor consumers visibly bear the tax burden. However, the tax introduction decelerated the

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[1] Non-communicable diseases are chronic diseases, such as cardiovascular health issues (e.g. strokes), diabetes, cancer etc. They account for 74% of worldwide deaths (World Health Organization, 2023b).

[2] As shown in Figure 2 in Metcalfe and Sasse (2023).

[3] For simplified comprehension, I hereafter speak of the UK soft drink tax in lieu of the UK Soft Drinks Industry Levy.

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general trend of falling soft drink prices in the UK. By using medium-term data, my study captures effects which have not been materialised in other previous short-term studies on employment and prices.

This paper is structured as follows. Chapter 2 outlines the institutional setting of the UK soft drink tax and offers an extensive literature review on soft drink taxation. In Chapter 3, I outline my empirical strategy and describe the data. Chapter 4 elaborates on the empirical results. Robustness checks are presented in Chapter 5. Lastly, Chapter 6 concludes, summarises limitations and offers an outlook on future research.

2. Theoretical Background

2.1. Institutional Setting

Excise taxes have become a favourable tool to nudge the population's consumption pattern into a certain direction. Often referred to as "sin taxes", they are levied on the consumption of goods which are associated with (high) future costs for society (Allcott et al., 2019; de la Feria, 2024). For example, the intake of tobacco and alcohol or the use of fuel often come at the cost of the environment or a person's health. By taxing these types of products, their prices increase, leading to a decline in demand and herewith limiting their negative impacts (de la Feria, 2024).

Nowadays, excise taxes are often levied on sugar-sweetened beverages (SSBs),[4] in order to curb the population's excess sugar intake. While the WHO's recommendation on an adult's daily sugar consumption is 50 g, a regular 600 ml soft drink bottle[5] already exceeds this threshold (World Bank, 2020). Hence, worldwide obesity levels have been continuously rising since more than four decades (Metcalfe & Sasse, 2023), making excise taxes on sugary drinks inevitable nowadays. According to the World Health Organization (2023a), more than 108 countries have adopted sugar-sweetened beverage taxes as at July 2022. Whilst the UK is one of the European countries most affected by high obesity rates (Metcalfe & Sasse, 2023), it is also one of the most recent countries in Europe to have adopted a tax on sugar-sweetened beverages (see World Bank, 2020, Appendix 1).

Thus, the UK Soft Drinks Industry Levy, a national tax on sugar-sweetened beverages, was announced in March 2016 and implemented in April 2018 (HM Revenue & Customs, 2024a). The excise tax is imposed on soft drink producers and importers and comprises all types of soft drinks with more than 5 g of added sugar per 100 ml. Alcoholic drinks with more than 1.2% alcohol content, milk products, as well as fruit and vegetable juices are exempt from the levy (HM Revenue & Customs, 2024a). A tiered volume-based tax rate is applied to motivate producers to reduce the sugar content of their beverages by reformulating them. The two tiers are defined as follows: 18 pence per litre for beverages with a sugar content between 5 g to 8 g per 100 ml; 24 pence per litre for beverages with more than 8 g sugar per 100 ml (HM Revenue & Customs, 2024a). In April 2023, the tax was extended to also encompass concentrates with more than 5 g sugar per 100 ml. All concentrates are taxed at the higher rate of 24 pence per litre (HM Revenue & Customs, 2024b).

Whilst a common consensus has revealed that sugar-sweetened beverage taxes can successfully reduce sugar consumption and herewith improve public health (World Bank, 2020), the estimated level of impact varies significantly across studies and countries. This can be partially attributed to the different policy designs and through which channels they are passed through. Whilst uniform taxes aim at cutting consumption levels through higher product prices for consumers, tiered tax designs focus on reducing overall sugar levels in beverages through product reformulation on the manufacturer's side (World Health Organization, 2023a). Despite most countries applying uniform tax rates (e.g. a single tax rate on all sugary products), the UK government decided to introduce a tiered tax rate to decrease the sugar content in soft drinks instead of just targeting consumption through prices. Thus, its primary objective is to incentivise soft drink manufacturers to reformulate their products and to introduce low-sugar alternatives in their product portfolio in order to evade the tax (HM Revenue & Customs, 2016). Therefore, the UK government provided manufacturers with a two-year lead time to improve their sugar-sweetened beverage portfolio beforehand. Hence, the change should already take place on the manufacturing side instead of just transferring the tax burden onto the consumer.

As obesity levels kept on increasing (Metcalfe & Sasse, 2023), despite the introduction of the soft drink tax, the British government was forced to further intervene in the population's diet choices. Hence, in April 2022, the government implemented a compulsory calorie labelling law. All restaurants and other businesses (e.g. online deliveries) offering non-prepacked food (i.e. served meals) are obliged to display calorie information on their menu (Department of Health and Social Care, 2022). I assume that this law could affect employment levels in the soft drink industry in a negative way due to its signalling effect. Consumers might refrain from purchasing soft drinks in a restaurant or cafe, once they are reminded of the high amount of calories on the menu; the tax signals the customer how unhealthy the beverage is. Thus, SSB consumption might decrease in restaurants, leading to an overall lower demand for soft drink manufacturing. This continuous decline in demand could eventually lead to job losses in the respective industry. However, I argue that this law is unlikely to distort my results, as its introduction only overlaps with my data by one year (i.e. in 2023). I also perform a robustness check, in which the overlapping year is excluded, and find that my results remain robust (see Chapter 6).

[4] SSBs are drinks which contain free sugars (i.e. added sugars and sugars naturally inherent in fruit juices and concentrates, syrups and honey) (World Health Organization, 2023a).

[5] A 600 ml soft drink bottle approximately contains 64 g of sugar according to the World Bank's (2020) example.

2.2. Literature Review

Excise taxes entail additional costs for soft drink firms and could jeopardise their profits. Thus, firms often tend to pass the tax burden onto other stakeholder groups, such as employees (e.g. reductions in staffing) or consumers (e.g. increases in prices). Hereby, current literature extensively analyses price effects, as most sugar-sweetened beverage taxes are transmitted through this channel. Effects on employment remain an understudied area. Due to the novelty of most soft drink taxes, the vast majority of empirical studies are only able to capture the short-term effects of SSB taxation. Whilst this might be the case for price effects, I expect structural changes in employment to take longer to materialise.

For example, Scarborough et al. (2020) analyse the short-term effects on prices evoked by the UK soft drink tax. They conduct an interrupted time series analysis, using more than 210,000 observations on soft drink sugar content and prices. Primarily, they divide the sample into own branded products from the supermarket chain and famous branded products, as well as low-levy products, which have a sugar content between 5 g to 8 g per 100 ml and high-levy beverages with a sugar content of 8g per 100 ml or above. Firstly, they discover a reduction of the sugar content for both, "no name" and branded sugar-sweetened beverages. Secondly, they find that prices increased by 11.8 pence per litre for branded products from the higher levy tier, passing through approximately half of the tax. Surprisingly, the prices of the branded lower taxed beverages decreased by 17.4 pence per litre. For own branded drinks the opposite effect occurred. Prices of higher taxed drinks decreased by 63 pence per litre whereas prices of lower taxed products increased by 69 pence per litre (Scarborough et al., 2020).

Clearer industry responses have been observed in the Mexican and Chilean sugar sweetened beverage markets, after the implementation and increases of their national soft drink taxes. Cuadrado et al. (2020) conduct a time series analysis to regress the increase of the Chilean soft drink tax in 2014 on soft drink prices. Their analysis is based on consumer price data two years post tax implementation. The authors estimate a 5.6% price increase of carbonated beverages, which is equivalent to a 140% pass-through of the tax. Prices of untaxed beverages, such as juices, were unaffected. Contrary to the UK soft drink tax, the Chilean SSB tax was a consumer-imposed tax, aiming to reduce the affordability of soft drinks and to stimulate healthier substitution effects. As of that, the increase in soft drink prices has been the main intention of the Chilean soft drink tax policy, which can therefore be viewed as fruitful. In the case of Mexico, Aguilar et al. (2021) also identify a significant positive effect of the national SSB tax on prices of taxed beverages. Using household purchase data from Kantar World Panel, they conduct an event study. The authors estimate a 9.7% price increase of taxed soft drinks and a pass through rate on prices of 80%. Herewith, both tax designs exceed the WHO's recommendation on a minimal pass-through rate of 20% for SSB taxes to effectively reduce consumption (World Bank, 2020).

Another major study stems from Stacey et al. (2019), who analyse price effects in the frame of the South African SSB tax. The authors use Consumer Price Index (CPI) data to perform a before and after comparison one year post tax. They find that prices of carbonated beverages increased significantly, holding a pass-through rate of approximately 70%. Similar evidence on prices is also provided for the Saudi Arabian sugar-sweetened beverage tax. Alsukait et al. (2020) also use CPI price data to derive the price effects one year after Saudi Arabia's soft drink tax introduction. Their difference in differences analysis estimates significant price increases of 55% for carbonated beverages (which relates to a pass-through rate of 110%), compared to untaxed beverage prices.

As mentioned above, most analyses focus on the consumer tax incidence of sugar sweetened beverage policies. However, excise taxes can also be shifted onto employees, by decreasing wages or reducing the number of employees to maintain pre-tax profits. Most commonly, opponents of the tax argue that the UK soft drink tax leads to major job losses (Lauber et al., 2022) or a reduction in working hours (Cawley & Frisvold, 2023). They assume that the decline in soft drink demand harms the firm's economic performance and eventually leads to staff cuts (Hattersley et al., 2020). However, prevailing literature on employment does not validate these claims.

One of the main studies in this field stems from Marinello, Leider, Pugach, and Powell (2021), which analyses the effect of SSB taxes on employment in the US state Philadelphia. The authors conduct a pre-post analysis, based on employment data from the Bureau of Labor Statistics. Overall, they do not find a significant effect of the tax on the number of employees in the private sector. Similarly, Díaz et al. (2023) perform an interrupted time series analysis, using employment data from the Ministry of Labour in Peru. As they explore the effects of the national soft drink tax, they do not observe significant impacts on wage and employment levels in the beverage manufacturing sector (Díaz et al., 2023). Another study focussing on employment changes in the beverage manufacturing sector originates from Guerrero-López et al. (2017). Using monthly survey data on the soft drink and non-alcoholic beverage manufacturing industries, they find that the Mexican soft drink tax had no significant effect on employment in the respective industries. Furthermore, Gonçalves et al. (2024) provide recent evidence on employment effects in the setting of Portugal. As the Portuguese soda tax was implemented in 2017 and partially increased in 2019, the authors employ an event study design to derive short- and medium-term effects of the tax. They retrieve wage and employment data from annual tax declarations, covering a period from 2017 to 2019. The authors find that neither wages nor employment levels in SSB companies were affected.

Given the novelty of the UK soft drink tax, literature on its tax incidence is still quite scarce. While most studies on SSB taxes in other geographical settings imply price increases and no effect on employment, this might not be the case for the

UK due to its different policy design. Compared to other soft drink taxes, which aim at increasing prices to reduce consumption of sugary drinks, the British soft drink tax is not intended to be levied on consumers. For the tax to meet its primary target of reducing the population's sugar intake and herewith obesity levels, the sugar levels in soft drinks must be substantially decreased. This is underlined by the paper of Briggs et al. (2017), who argue that product reformulation has the greatest effect on the population's health in the UK. The authors conduct several modelling studies to quantify potential industry responses to the soft drink tax. They find that reducing the sugar content in drinks, by reformulating products, would have the greatest effect on public health. However, the effect partially diminishes if the industry decides to pass the tax onto the consumer, i.e. in the form of higher product prices (Briggs et al., 2017).

Hence, to analyse the effectiveness of the UK soft drink tax, it is vital to first question "Who bears the costs of the UK soft drink tax?". My research question herewith explicitly aims to identify whether the tax burden is borne by the company or shifted onto consumers or the firms' employees.[6] The importance of identifying the incidence of the UK soft drink tax lies in the main objective of the tax. It was implemented to combat the UK's health pandemic of obesity by reducing sugar levels in drinks and herewith the overall sugar intake of the population (HM Revenue & Customs, 2016). Thus, it is intended to be primarily levied on the manufacturer side, to stimulate reformulation efforts through its two-tiered design (Scarborough et al., 2020). If passed onto consumers, in the form of higher product prices, the policy is less effective (Briggs et al., 2017). As reformulation can be costly and time intensive, manufacturers might not be necessarily encouraged to reduce the sugar content of their products and have the option to take the simpler approach of passing the tax down to consumers. A change in consumer choice, however, to purchase less sugary drinks, seems more difficult. Not having the option in the first place of purchasing so much sugar in soft drinks, as overall sugar levels have been reduced, seems more promising.

Thus, my approach focusses on identifying the incidence of the UK soft drink tax, as understanding industry reactions to the tax is essential to determine its efficiency (World Bank, 2020). Whilst a pass through of the tax onto consumers still has a positive, but reduced impact on the population's health (Briggs et al., 2017), I argue that a pass through onto employees does not affect public health at all and only bears negative consequences for society (e.g. less employment, lower wages). I postulate that companies can react in one of the following three ways to the tax. The first and most common option is to pass the tax onto consumers, by raising product prices. Another option for soft drink manufacturers is to pass the tax burden onto their employees, by either reducing current staff or not increasing wages appropriately. This approach could be taken if firms want to avoid raising prices in order to remain competitive with other beverage manufacturers (e.g. juice manufacturers, which are not affected by the tax). Lastly, firms could avoid passing the tax burden onto other stakeholders due to market competitiveness and company reputation (e.g. reducing staff could stimulate negative publicity), but also circumvent the tax burden if they reformulate their soft drinks to fall below the sugar threshold. This response would be the UK government's preferred reaction to the tax, because reformulation leads to overall lower sugar levels in soft drinks. Hence, to identify how the British soft drink manufacturing industry reacted to the tax and who now bears the consequences of it (i.e. the tax burden), I postulate the subsequent hypotheses:

> *H1: The UK soft drink tax leads to a decrease in employment in the soft drink manufacturing industry.*
>
> *H2: The UK soft drink tax leads to an increase in prices of soft drinks.*

The first hypothesis aims to identify if consumers bear the cost of the tax due to rising soft drink prices. As elaborated above, the simplest approach for manufacturers to avoid the tax burden is to solely increase soft drink prices. In line with Cawley and Frisvold (2023), I argue that the pass through of the tax highly depends on the elasticity of demand and supply[7] in a perfectly competitive market. If demand is inelastic, as there are no alternative products to the taxed soft drinks (i.e. no replacement product) and consumers are highly dependent on the good, the industry can fully pass the tax burden onto consumers (100% price pass through). Thus, despite the price increases, demand for soft drink products will not decline due to the consumers' dependency on that specific product. However, in the scenario of perfectly elastic demand, meaning there are many substitute products to the taxed soft drinks on the market, the consumer will opt for more cost-efficient alternatives, if prices of SSBs are increased. Thus, firms will refrain from raising prices and will fully absorb the tax burden (0% price pass through) or even offer price reductions, in order to stay competitive in the market. In line with Cawley and Frisvold (2023), I assume that the industry response will be somewhere in between the first scenario of fully passing the tax onto consumers and the second scenario of totally absorbing the tax burden. Similarly, the reaction of cutting staff (Hypothesis 2) seems intuitive, as increasing soft drink prices leads to a lower demand for the product. This leads to a decline in soft drink manufacturing and thus, eventually reduces the number of

[6] I assume that shareholders will not significantly be impacted by the UK soft drink tax. This is because they react extremely sensitive to dividend pay-cuts, wherefore firms usually avoid this measure (Heiden, 2002) and only use it as a last resort. Thus, I argue that it is very unlikely that the soft drink tax burden is a valid reason for soft drink companies to reduce dividend payouts.

[7] Elasticity of supply refers to the change of product supply due to a price increase. The change in the demand for a product (e.g. higher or lower consumption of it) due to price increases/decreases is known as the elasticity of demand (World Bank, 2020).

jobs in the soft drink manufacturing industry (Hattersley et al., 2020). This has been a typical argument put forward by the opposition to global soft drink taxes (Hattersley et al., 2020), which I deem to be plausible for the UK soft drink tax too. Alternatively, a possible counter argument to my second hypothesis is that consumers might substitute the now more expensive soft drinks with untaxed beverages such as low-calorie drinks or water (World Bank, 2020). Since soft drink manufacturers often produce a wide range of beverages (e.g. Coca-Cola also produces levy-exempt products such as water and juices), the substitution of products does not necessarily result in any employment losses. Rather, soft drink manufacturers might even require additional labour for reformulation and innovation of new low-sugar alternatives.

As to my knowledge, there has been no other empirical study explicitly analysing the UK soft drink tax effects on employment. As the few studies on the UK soft drink tax price effects provide twofold evidence, my analysis offers additional insights in this field. By evaluating employment and price effects within a medium-term horizon, my study accounts for structural changes that take longer to manifest in the market (e.g. structural shifts in employment and long-term manifested pricing strategies).

3. Empirical Method

3.1. Model and Methodology

To answer my research question of who bears the costs of the UK soft drink tax, I take three different approaches. First, I examine employment from a microeconomic scope, using firm-level data. Then I analyse the effect on a macroeconomic level, using national aggregate employment data of the beverage and soft drink manufacturing industries. Finally, I estimate price effects using product price data of soft drinks. I use two different employment approaches for more robust results. While the microeconomic data encompasses the most meaningful companies in the soft drink industry based on their market capitalisation and defined by The Refinitiv Business Data Classification, the macroeconomic employment analyses include randomly selected soft drink manufacturers regardless of their size. See Section 3.2 for a detailed description of the data, including its limitations.

I apply the same econometric framework to all analyses, namely difference-in-differences (DiD). This research design is common in policy analysis, as it compares the different outcomes of a treatment and control (comparison) group over time (i.e. before and after a new policy intervention) (Marcus & Sant'Anna, 2021). For DiD to identify the actual causal effect of the policy, the following prerequisite must be fulfilled. The treatment group should have developed in a similar way as the control group if no policy (treatment) had been implemented. This is also referred to as the parallel trends assumption (Angrist & Pischke, 2009; Marcus & Sant'Anna, 2021). Put in other words, both groups must have the same pre-intervention employment/price trends. To test this assumption, I make graphical comparisons and conduct event studies. Event studies are commonly used for assessing the parallel trends assumption, as they offer a more granular view on the treatment effect (Marcus & Sant'Anna, 2021). Compared to DiD, which analyses the average change in outcomes (between treatment and control group) before and after the event, event studies look at the effect of the treatment at each specific period.

To estimate the causal effect of the soft drink tax on employment and price levels, I perform high-dimensional fixed effects regressions for all three specifications. Fixed-effects models account for unobserved variables, which are constant over time but differ across groups and herewith may affect the endogenous variable (Angrist & Pischke, 2009; Wooldridge, 2021). For example, the location of a company could influence the availability of labour due to the infrastructure and economic conditions in that area. My fixed effects regression model controls for this possible variation within units. As stated by Lee (2016), the fixed effects estimator is the preferred estimator for difference in differences models.

3.1.1. Microeconomic Employment Analysis

To test my first hypothesis, that is, whether the UK soft drink tax leads to a decline in employment in the UK soft drink manufacturing industry, I estimate the following model:

$$\begin{aligned} Log(Employees)_{i;t} = \beta_0 &+ \beta_1 \cdot Tax_t \\ &+ \beta_2 \cdot Treatment_i \\ &+ \beta_3 \cdot (\mathbf{Tax_t} * \mathbf{Treatment_i}) \\ &+ \beta_k \cdot X_{i;t} + Y_{i;t-1} + \gamma_p + \varepsilon_{i;t} \end{aligned} \tag{1}$$

My dependent variable, $Log(Employees)_{i;t}$ reflects the logarithmic number of employees in each company (i) per year (t). The variable $Treatment_i$ is an indicator variable, taking the value one if a company is operating in the soft drink industry and zero if companies are alcoholic beverage producers. Tax_t is a binary variable, which is equal to zero for periods before the soft drink tax came into effect (2013-2017) and equal to one for years after the tax (2018 – 2023). My key variable of interest is the interaction term $Tax_t * Treatment_i$. It is also referred to as the treatment indicator, which takes the value of one if a unit is treated and situated in a period after the tax intervention. Otherwise, it takes the value of zero. Its coefficient β_3, also known as difference-in-differences estimator, captures the causal effect of the UK soft drink tax on employment. As I use a log-linear specification, the coefficient estimates the difference in employment changes between soft drink firms and alcohol producing firms before and after the tax intervention. To control for possible confounders, the $Unemployment\ Rate$, GDP and $Total\ Population$ are captured in the term $X_{i;t}$. I believe that these common macroeconomic indicators are likely to influence current employment levels in the soft drink manufacturing industry. Furthermore, I also control for company fixed effects (γ_p), such as the company's location for

example. All other potential confounders are encompassed in the error term $\varepsilon_{i;t}$.

Furthermore, my model also accounts for autocorrelation by including the first lag of the dependent variable ($Y_{i;t-1}$). Autocorrelation exists when the error term correlates across different time periods (Doran et al., 2017). In specific, when a variable can be defined by its previous year's value, this is called an autoregressive process (Das, 2019).[8] Put in other words, I argue that the number of employees is strongly influenced by the number of employees in the preceding year.[9] This could be caused by a company's hiring patterns or its economic growth over the past years. As I use annual data, it is sufficient to only control for the first lag (Doran et al., 2017).

Moreover, difference-in-differences models are often prone to cluster problems (Lee, 2016). This happens when error terms are correlated within a group (e.g. company) or across time periods (Imbens & Wooldridge, 2009). For example, companies often adapt their firm-specific hiring policies, which influences their number of employees over time. I control for this possible confounder by using cluster-robust standard errors,[10] as suggested by Cameron and Miller (2015). In line with Gonçalves et al. (2024), I therefore cluster at the company level.

3.1.2. Macroeconomic Employment Analyses

In addition to the microeconomic analysis (i.e. firm-level employment), I perform two macroeconomic analyses (i.e. aggregate employment) for more robust results. I first regress the soft drink tax on employment in the soft drink manufacturing industry and afterwards on employment in the entire beverage manufacturing industry. Thus, I estimate the subsequent regression model to derive the macroeconomic employment effects evoked by the UK soft drink tax:

$$\begin{aligned} Log(Employees)_{i;t} = \beta_0 &+ \beta_1 \cdot Tax_t \\ &+ \beta_2 \cdot Treatment_i \\ &+ \beta_3 \cdot (\mathbf{Tax_t} * \mathbf{Treatment_i}) \\ &+ \beta_k \cdot X_{i;t} + Y_{i;t-1} + \varphi_q + \varepsilon_{i;t} \end{aligned} \tag{2}$$

The dependent variable $Log(Employees)_{i;t}$ reflects either the logarithmic number of employees in the beverage manufacturing industry or in the soft drink manufacturing industry. Equivalent to Equation (1), the term $X_{i;t}$ comprises the $Unemployment\ Rate$, GDP and $Total\ Population$. Again, $Y_{i;t-1}$ denotes the lagged dependent variable[11] and $\varepsilon_{i;t}$ the error term. I further control for industry-specific fixed effects (φ_q).

Furthermore, I use heteroskedasticity-robust standard errors, but do not cluster at group levels due to an insufficient number of clusters. Not addressing possible cluster issues within the model could lead to an underestimation of standard errors (Lee, 2016). However, if the number of clusters is too small, this could also lead to underestimated standard errors (Cameron & Miller, 2015; Cawley & Frisvold, 2017). While Cameron and Miller (2015) postulate that more clusters lead to better statistical inference, their example underlines that fewer than 10 clusters result in extremely high rejection rates of the null hypothesis. I therefore refrain from using only two industry clusters. Thus, regression results should be treated with caution.

3.1.3. Price Analysis

Using the regression model below, I examine if the UK soft drink tax leads to increases in soft drink prices (Hypothesis 2):

$$\begin{aligned} Log(Price)_{i;t} = \beta_0 &+ \beta_1 \cdot Tax_t + \beta_2 \cdot Treatment_i \\ &+ \beta_3 \cdot (\mathbf{Tax_t} * \mathbf{Treatment_i}) \\ &+ \beta_k \cdot X_{i;t} + \omega_r + \delta_s + \varepsilon_{i;t} \end{aligned} \tag{3}$$

My dependent variable $Log(Price)_{i;t}$ denotes the logarithmic real (inflation-adjusted) price per product (i) per year (t). In the above model specification, the term $X_{i;t}$ encompasses the control variables $Unemployment\ Rate$, GDP, $Total\ Population$ and $Volume$. I argue that the first three variables can influence price levels, as these macroeconomic indicators reflect the health of the economy. If for example, there is an economic downturn, reflected in a high unemployment rate or low GDP, people tend to purchase less, leading to a decline in demand and finally decreasing prices. With the variable $Volume$ I also control for the effect of the product size on prices, because small sized drinks tend to be more expensive than larger volume packs (World Health Organization, 2023a). Furthermore, I also control for region (ω_r) and shop type (δ_s) fixed effects. All the other variables (Tax, $Treatment$, $Tax * Treatment$, error term) are identical to Equation (1). Additionally, I cluster standard errors at shop level, to control for correlated outcomes within the same shop. Unfortunately, I was not able to include a lagged price variable in this model due to the missing panel structure of my data (see subsequent Section 3.2.3).

3.2. Data

For a unified comparison, I standardise time periods and nearly all control variables for all three analyses.[12] All

[8] When the variable is only influenced by its last year's value, this is referred to as an autoregressive process of order one or just AR(1) (Das, 2019).

[9] I perform the Wooldridge test for serial correlation and find that my model suffers from autocorrelation issues. Furthermore, I also perform the Breusch-Godfrey test for autocorrelation, which tests if autoregressive processes larger than AR(1) (first lag) are present in the model (Doran et al., 2017). The test statistic indicates that my model does not suffer from autocorrelation beyond the first autoregressive process (AR(1)).

[10] Cluster-robust standard errors control for both, cluster problems and for heteroskedasticity (Cameron & Miller, 2015).

[11] In line with the previous microeconomic model (see Equation (1)), I perform the same tests for autocorrelation and thus, include a lagged dependent variable.

[12] Besides the uniform control variables $Unemployment\ Rate$, GDP and $Total\ Population$ I additionally control for $Volume$ in the price analysis.

datasets cover periods from 2013 to 2023, ensuring balanced pre- and post-tax periods. I obtained my control variables *GDP* and *Total Population* from the World Bank website. The variable *GDP* reflects the UK's annual Gross Domestic Product per capita in current US $ (World Bank, 2023a). *Total Population* encompasses all residents in the UK independent of their legal status in the country (World Bank, 2023b). I obtain the annual *Unemployment Rate* from the Office for National Statistics. The variable depicts the proportion of unemployed individuals aged 16 years or older in relation to the working population (Office for National Statistics, 2020). Missing values of the dependent variables and controls are excluded from all analyses. Detailed summary statistics and descriptions of all variables can be found in the Annex in Tables A1 and A2.

3.2.1. Microeconomic Employment Data

I obtain annual employee data from Refinitiv Eikon Worldscope, a global database which provides financial and industry information on public companies. Refinitiv is renowned for its trusted global equity indices used for market analysis. Their indices capture significant firms in a specific stock market, by including 99.5% of all publicly traded shares in a (trading) market (Refinitiv, 2023). Their sector indices are built upon the global equity indices, by appointing companies into pre-defined industry groups according to the TRBC. The Reference Data Business Classification (TRBC) is a categorisation system which groups companies in accordance with their business operations. The TRBC divides the beverage industry group into the following industries: brewers, distillers & wineries and non-alcoholic beverages. As the latter definition is quite broad, the database also offers more granular information on the company's main economic activity with the NAICS code (North American Industry Classification System).

I use the Refinitiv sector index of the UK beverage industry to derive a comprehensive constituent list of 15 UK beverage manufacturers. However, I restrict my analysis to companies having their main sales market in the UK, due to the subsequent reasons.[13] As I hypothesize that soft drink companies shift the tax burden onto their employees, I am focussing on companies directly affected by the soft drink tax. Hence, I postulate that beverage manufacturers must have their main sales market in the UK, for a portion of their sales to be noticeably affected by the new tax burden. Herewith, I exclude three companies[14] from the initial constituent list. See Table 1 for a detailed constituent list and information on the companies' UK market shares.

Table 1: Microeconomic Employment Data

#	Treatment Group	Market Cap. in £b	UK Sales in %
1	Coca-Cola Europacific Partners	26.587	17.5% (GB)
2	Britvic	2.406	71,4%
3	Fever-Tree Drinks	1.193	32%
4	A G Barr	0.675	95.6%
5	Nichols	0.365	74%
	Control Group		
1	Diageo	57.633	9.1 % (GB)
2	Chapel Down Group	0.114	97.8%
3	Daniel Thawties	0.044	100%
4	Gusbourne	0.039	78.8%
5	Artisinal Spirits Company	0.027	29.8%
6	Adnams	0.006	98%
7	Distil	0.004	90.2%

Note. Author's own overview based on market capitalisation data retrieved from Refinitiv (2024a) and sales data retrieved from annual reports in 2023 of the respective companies. The graph depicts 12 of the 15 constituents of the TRBC beverage industry group, which are included in my regression analysis. Market capitalisation is depicted in billion pounds.

Based on the TRBC of the UK beverage sector, I appoint companies to the treatment and control group as follows. Enterprises operating in the non-alcoholic beverage market are assigned to the treatment group,[15] and hereafter referred to as soft drink companies, as their main economic activity lies in soft drink manufacturing according to their NAICS code. The control group contains companies from the distillers & wineries and brewers industries and are hereafter referred to as alcoholic beverage companies.

My final sample consists of 12 beverage manufacturers, resulting in a total of 106 firm-year observations. I have an unbalanced panel, as not all companies reported employee data for each year. My dependent variable of interest, the number of employees, comprises both, full and part-time employees in a company (Refinitiv, 2024b). The number of employees range between seven to thirty thousand. In line with Guerrero-López et al. (2017), I use the logarithmic number of employees to control for the right skewness (no normal distribution) in the dependent variable. Due to the high variance in the number of employees, using the logarithm also makes

[13] My definition of main sales market is the following: either the United Kingdom (UK) or Great Britain (GB) must be within a company's three biggest sales markets according to their annual report in 2023.

[14] I exclude East Imperial as the EU is only its fifth biggest sales market, accounting for 10% of their annual sales in 2022 (London Stock Exchange, 2023). Rogue Baron is excluded from the analysis, as no employment data was available in Worldscope. Momentous Holdings Corp was also excluded, as it is a holding company (not directly involved in beverage manufacturing itself), which currently does not engage in any business operations, has no revenue (Reuters, n.d.) and does not have any publicly available information.

[15] Contrary to the TRBC classification, I appoint Fever-Tree Drinks to the treatment group, as its main product segment are carbonated non-alcoholic mixers, which are liable to the UK soft drink tax (Young, 2016).

the final results more comparable, as they will be interpreted as percentage changes instead of absolute values.

One limitation of my data is that the sector indices only cover publicly listed companies. However, Figure 1 indicates that the UK beverage market is dominated by a few, very large manufacturers. The graph depicts the UK's major beverage companies in terms of their market capitalisation as at October 2024 (Statista, 2024). It indicates that Diageo, Coca-Cola Europacific Partners and Britvic have a substantial lead in terms of market shares. I argue that manufacturers which are not listed on the stock exchange, are usually insignificant in size with a low number of employees, compared to the leading beverage manufacturers depicted in Figure 1. Furthermore, I partially account for these smaller manufacturers in my macroeconomic employment analyses (see Section 3.2.2). Hence, both micro- and macroeconomic employment analyses are representative for employment in the UK beverage sector.

3.2.2. Macroeconomic Employment Data

To analyse the effect of the soft drink tax on macroeconomic employment, I retrieve annual employment data per industry from the Business Register and Employment Survey (BRES). This annual survey covers 85,000 randomly selected companies registered for VAT and PAYE[16] in Great Britain and is considered as the governments predominant source for employment estimates (Office for National Statistics, 2022a). In the survey industries are categorised according to the UK Standard Industrial Classification (SIC). This system appoints companies into pre-defined industries based on their primary economic activity. SIC codes offer a five-level breakdown, from the section level (one digit) to the subclass level (five digits) (Office for National Statistics, 2009). I derive my statistics from the division level (e.g. manufacturer of beverages) and the class level (e.g. manufacturer of soft drinks, production of mineral waters and other bottled waters).

Based on this classification system, I define my treatment and control groups as follows. For my first macroeconomic analysis, I use manufacturers of soft drinks, production of mineral waters and other bottled waters as a treatment group. My control group consists of six alcoholic beverage manufacturing industries, which I argue to be not significantly affected by the tax reform, as beverages with an alcohol content of 1.2% or more are exempt from the tax. For my second broader macroeconomic analysis, the beverage industry serves as the treatment and the textile industry as the control group. I argue that the textile industry is unlikely to be affected by the soft drink tax and therefore offers a robust comparison group. It also fulfils the parallel trends assumption (see Chapter 4), as it exhibits the same pre-tax trend as the beverage industry before the reform in 2018. A constituent list of the treatment and control groups for my macroeconomic analyses can be derived from Table 2.

For the soft drink manufacturing analysis, I have a balanced dataset consisting of 22 industry-year observations over the period 2013 to 2023. The sample for the analysis of the beverage industry contains 71 industry-year observations and is an unbalanced panel. For both analyses, the dependent variable of interest is the logarithmic number of employees, which encompasses full- and part-time employees in an industry (Office for National Statistics, 2022a).

A limitation of this study is that manufacturing data is only available for Great Britain and not the entire United Kingdom. A separate Business Register and Employment Survey is conducted for enterprises situated in Northern Ireland and partially provides employment figures per industry as of 2016. However, as this survey does not consistently report employment statistics for the sub-classes of the beverage industry (SIC codes 1101-1107), I exclude these statistics from my analysis and continue with using Great Britain's employment data only. I postulate that my estimates are representative for the complete UK beverage manufacturing industry, as only a small portion of the manufacturers are situated in Northern Ireland (3.6%). Table 3 underlines that my GB data represents a significant portion of the UK soft drink manufacturing industry (96.4%). Secondly, BRES employment data has an inconsistent definition. Data from 2009 to 2015 only surveys VAT-registered businesses in GB, whereas data as of 2016 onwards additionally includes PAYE businesses. Furthermore, I acknowledge the fact that my data does not distinguish between employees in soft drink, mineral water and bottled water manufacturing.

3.2.3. Price data

I retrieve annual product price data (CPI price quotes in January of each year) from the Office for National Statistics (ONS) website (Office for National Statistics, 2024b). ONS publishes the constituent list of the Consumer Price Index (CPI), namely the CPI price quotes, on a monthly basis.[17] The CPI includes approximately 700 different products, for which prices are collected from roughly 20,000 different shops across the UK. Hereby, the CPI depicts a representative sample of consumer goods. If consumption patterns or product availability in the shop changes, some products get replaced. Prices are hand collected from randomly selected shops (Office for National Statistics, 2023). Furthermore, information on the region, product volume, shop code (i.e. which store the price was collected from) and shop type (i.e. if the price was collected from chains with more than 10 shops or from independent stores) can also be obtained from the dataset.

Moreover, current prices today (nominal price values) must be made comparable over the years due to rising inflation and changing purchasing power. To convert nominal prices into real (inflation-adjusted) prices, the nominal values are divided by an inflation adjustment factor, for example

[16] Pay as You Earn (PAYE) is the UK income tax system, which directly deducts the tax from the employees' wages (HM Revenue & Customs, n.d.).

[17] The data is not badged as National Statistics and is only made available for research purposes (Office for National Statistics, 2024b).

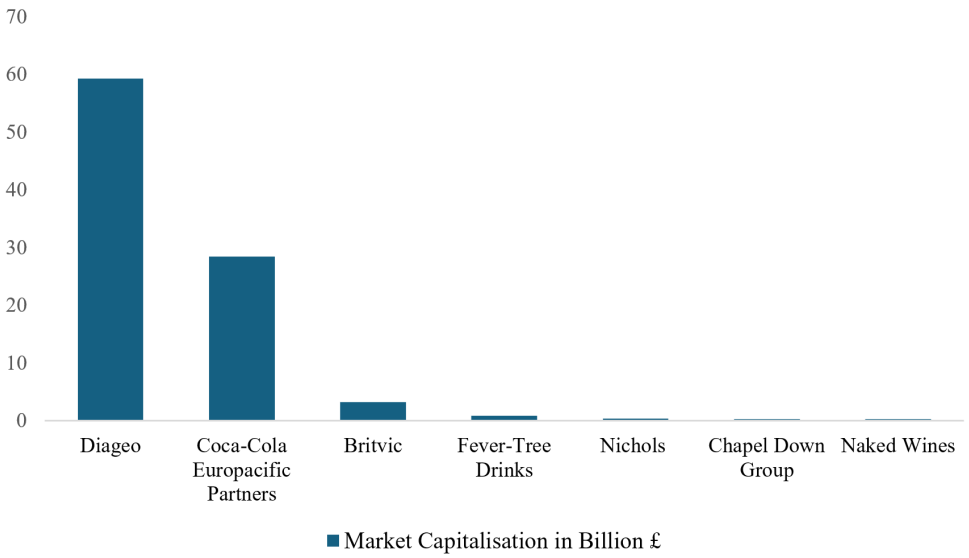

Figure 1: UK Leading Beverage Companies in 2024

Note. Adapted from "Leading beverage companies by market capitalization in the United Kingdom (UK) as of October 15," by Statista, 2024 (https://www.statista.com/statistics/1345274/uk-largest-beverage-companies-by-market-capitalization/). Copyright 2024 by Statista. The original unit of the graph was converted from USD to GBP, using the spot exchange rate of USD against GBP of 0.7888 on 15.10.2024 (Bank of England, n.d.). Despite that Naked Wines is listed as the seventh larges beverage manufacturer by Statista (2024), I have not included the company in my analysis. As Naked Wines is solely an online retailer of wine products and not a manufacturer, it is not listed in the Refinitiv sector index of the UK beverage industry, which I use to derive the key players of the UK beverage manufacturing industry.

Table 2: Macroeconomic Employment Data

#	Treatment Group	SIC Code	#	Control Group	SIC Code
1	Manufacturer of soft drinks, production of mineral waters and other bottled waters	1107	1	Distilling, rectifying and blending of spirits	1101
				Manufacture of wine from grape	1102
				Manufacture of cider and other fruit wines	1103
				Manufacture of other non-distilled fermented beverages	1104
				Manufacture of beer	1105
				Manufacture of malt	1106
2	Beverage Industry	11	2	Textile Industry	13

Note. Author's own overview. Table depicts the underlying constituent list of the macroeconomic analyses. The first row shows the industries used in the soft drink industry analysis and the second row the industries used in the beverage industry analysis. The SIC code is the unique identifier for each industry, which I have used to derive the relevant industries from the BRES survey.

the CPI (Kumaranayake, 2000). I account for inflation by deflating all prices to 2018 (midpoint of my data) price levels. Thus, the prices in this paper are presented in 2018 constant pounds (£ 2018).[18] I also standardise prices in terms of their product volumes, by using per litre prices in this study. The control variable *Volume* reflects the original volume in litres the product was sold in when its price was collected.

For my annual dataset I retrieve the CPI price quotes for January each year. I identify relevant beverage categories based on their COICOP classification. COICOP, which stands for the Classification of Individual Consumption According to Purpose, is a global framework used for classifying goods and services of household consumption (United Nations, 2018). The classification offers a granular four-level breakdown, from the two-digit division level (e.g. 01 = food and non-alcoholic beverages) to the five-digit subclass

[18] This is equivalent to saying inflation-adjusted prices or real prices.

Table 3: Soft Drink Manufacturing Industry Employment Share in 2022

Geographic Region	Number of employees in soft drink, mineral water and bottled water manufacturing	% of UK Total
Great Britain	13,000	96.4%
Northern Ireland	490	3.6%
UK	13,490	100%

Note. Author's own overview based on employment data retrieved from the Business Register and Employment Survey published by Northern Ireland Statistics and Research Agency (NISRA) (NISRA, 2023) as well as the Business Register and Employment Survey published by the Office for National Statistics (2022b). The table shows the share of employees in the soft drink, mineral water and bottled water manufacturing industry across the UK's geographic regions in 2022.

level (e.g. 01.2.6.0 = soft drinks). I use the five-digit subclass level to allocate products to the treatment and control groups.[19] All beverages under the soft drink classification are assigned to the treatment group. In line with the approaches of Gonçalves et al. (2024) and Scarborough et al. (2020), my control group is comprised of levy-exempt beverages, such as bottled water and fruit juices. An overview of the constituent list of the treatment and control group can be found in Table 4. As some items were substituted by other products over time,[20] I merged the observations for both goods to maintain a balanced time series (see shaded rows in Table 4). In 2019 the item cola flavoured drink (item ID 212011) was replaced by two different items (cola drink regular bottle and cola drink diet) of which one is taxable and the other non-taxable. To control for this discontinuity, I exclude all three items in my robustness checks and find that my estimates are robust to this change (see Chapter 5).

My dependent variable reflects the logarithmic real price per litre measured in pounds, in January each year. I exclude all prices equal to zero from my analysis, as this value indicates that the product was either temporarily out of stock or missing (i.e. not sold at the shop anymore) (Office for National Statistics, 2018). In line with Scarborough et al. (2020), I use the logarithmic price to account for the right skewness in the variable. My final sample comprises 31,957 price observations. Each item (e.g. Lemonade) has approximately 200 price observations per year, which each reflects a different hand collected price from a different store. Put differently, my price data has repeated cross-sections.

This missing panel structure leads to one of the major limitations in my analysis. Similar to Scarborough et al. (2020), I was not able to control for autocorrelation due to a missing unique product identifier. I construct a pseudo panel dataset, by calculating the average price of each item ID per year. I find that my regression results are robust to this change (see Chapter 5). Additionally, due to the unavailability of nutritional information, I can not fully ensure that all beverages in the control group are unaffected by the soft drink tax. For example, flavoured water bottles containing more than 5 g of sugar per 100 ml are not exempt from the levy and should not be appointed to the control group. Furthermore, the missing information on sugar content does not allow me to differentiate between low-levy drinks and high-levy drinks. For example, the higher tax rate of 24 pence per litre (applicable to soft drinks with more than 8 g sugar per 100 ml) might have a more significant effect on prices than the lower tax rate of 18 pence per litre (applicable to soft drinks with 5 g to 8 g sugar per 100 ml).

4. Results

The results of my difference-in-differences analyses are reported separately in the following sub-chapters. As mentioned above, a prerequisite for difference-in-differences analysis to estimate the true causal impact of a policy is the parallel trends assumption. That is, both groups should follow a similar trend before the reform has been implemented (Angrist & Pischke, 2009; Marcus & Sant'Anna, 2021). This ensures that the difference in outcomes (of treatment and control group) after the reform, can be attributed to the policy, by controlling for the normal trend in both groups (e.g. employment/price trends) (see Lee, 2016). To test the parallel trends assumption, I have performed visual inspections of the pre-tax trends for the treatment and control groups (Figures 2, 4 and 6) and conducted separate event studies (Figures 1, 3 and 5) for each analysis below.

The graphical illustrations (Figures 1, 3 and 5) are all arranged in the following way. I normalised all values of the dependent variables to one in 2017, i.e. one period before the policy intervention, as employment levels and prices vary significantly across companies, industries and products. The vertical solid black line visualises the year when the UK soft drink tax came into effect (2018), whilst the grey dashed line depicts the year of its announcement (2016). The x-axis shows how the average value of the dependent variable

[19] All items in the CPI price quote data have a four-digit class level (COICOP4 ID), but not every item is assigned a five-digit subclass level (COICOP5 ID). Information on the subclass level of item ID 310306 (bottle of mixer) is missing. As the item can be found in the overall class level mineral waters, soft drinks and juices, I still include it in the treatment group because sugar levels for mixers are usually higher than 5 g per 100 ml.

[20] Information on product replacements of the CPI constituents can be retrieved from the Office for National Statistics (2009, 2024a).

Table 4: Price Data

#	Treatment Group	Item ID	Start	End
1	Lemonade Bottle (2 L)	212008	2013	2023
2	Cola Flavoured Drink Bottle (1.75 - 2 L)	212011	2013	2019
3	Fizzy Drink / Cola Cans Pack 6-8 (0.33 L)	212012	2013	2016
4	Fizzy Energy Drink (0.25 – 0.5 L)	212015	2013	2023
5	Fizzy Bottled Drink (0.5 L)	212017	2013	2023
6	Mixer Drink Bottle (1 L)	212022	2015	2023
7	Cola / Fizzy Drink Pack 4-8 (0.33 L)	212023	2016	2023
8	Cola Drink Regular Bottle (1.25 – 2 L)	212025	2020	2023
9	Bottle of Mixer (0.125 – 0.2 L)	310306	2013	2023
	Control Group			
1	Fruit Squash (0.75 - 1.5 L)	212001	2013	2023
2	Fruit Juice not Orange (1 L)	212006	2013	2023
3	Mineral Water Still (1.5 – 2 L)	212010	2013	2023
4	Fresh / Chill Orange Juice (0.9 L)	212016	2013	2023
5	Pure Fruit Smoothie (0.75 – 1 L)	212019	2013	2021
6	Fruit Drink Bottle 4-8 Pack (0.2 L)	212020	2013	2023
7	Bottle Still Water (0.5 L)	212021	2013	2023
8	Flavoured Water Bottle (0.9 - 1.5 L)	212024	2018	2023
9	Cola Drink Diet (1.25 - 2 L)	212026	2020	2023
10	Fruit / Vegetable Smoothie (0.75 – 1 L)	212027	2021	2023

Note. Author's own overview based on item descriptions from the CPI price quote data files (Office for National Statistics, 2024b). The table depicts the underlying items of my price analysis. All item IDs which were replaced over time are highlighted, as well as their replacement product. I assign item ID 212001 (fruit squash) to the control group, even though squashes are usually syrup based and need to be diluted with water. However, this drink would only fall under the UK soft drink tax as of April 2023 (extension of the tax to also include concentrates). As the last observations in my analysis are from January 2023, and squashes were taxable after April 2023, the item was tax-exempt during my entire observational period. Due to missing information on the volume of item ID 212020 I take an approximate value for typical fruit squashes of 0.2 L per bottle.

(e.g. employees or prices) varies over time, separately for the treatment (red line) and control group (blue dashed line).

My event studies (Figures 2, 4 and 6) analyse the difference in impacts of the tax between treatment and control group for each year separately. Put in other words, Figures 2, 4 and 6 show the differential change in employment and product prices of the treatment group compared to the control group. All of the subsequent event studies are set up uniformly. The x-axis reflects the years relative to the tax event, with zero being the policy year and for example, five the fifth year after the policy (i.e. 2023). I use 2018, the year of the policy introduction, as the reference year. The grey bars surrounding the coefficient estimates are confidence levels set at the 95 percent level.

4.1. Microeconomic Employment Analysis

Figure 2 shows the average logarithmic number of employees in soft drink companies (red line) and alcoholic beverage companies (blue dashed line), relative to the reference year (i.e. 2017). The graph underlines that both groups followed similar trends in the pre-tax period. Only a short decrease in employment levels of alcohol producing firms can be observed from 2013 until 2014, compared to the employment levels in the reference year. Thereafter, both groups depict similar rising trends in employment until one year after the tax. Whilst employment of soft drink companies seems to continuously grow also hereafter, the employment level of alcohol producers fluctuates.

Figure 3 visualises the differential changes in logarithmic employment numbers[21] of soft drink companies (treatment group) compared to alcoholic beverage companies (control group). The graph underlines that there are no significant differences in employment changes between soft drink companies compared to alcoholic beverage companies before the soft drink tax was implemented (see confidence intervals intersecting with the x-axis). Furthermore, overall changes in

[21] Hereafter only referred to as employment.

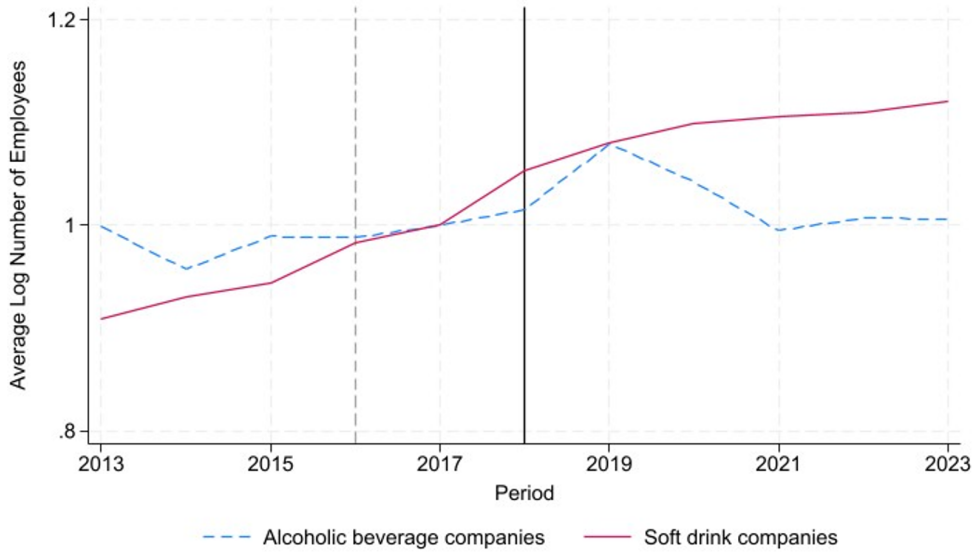

Figure 2: Parallel Trends - Microeconomic Employment

Note. Author's own overview based on employment data retrieved from Refinitiv (2024b). Graph shows the average logarithmic number of employees in soft drink companies (treatment group) and in alcoholic beverage companies (control group) from 2013 to 2023. Logarithmic number of employees is normalised to one in 2017 (i.e. one year before the tax implementation).

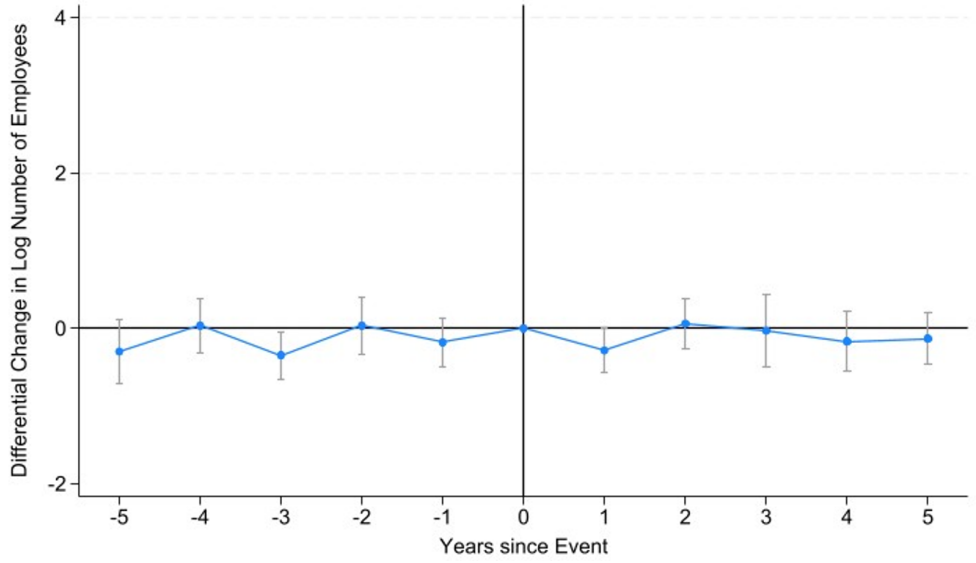

Figure 3: Event Study - Microeconomic Employment

Note. Author's own overview based on employment data retrieved from Refinitiv (2024b). Graph shows the difference in logarithmic employment changes between soft drink companies (treatment group) and alcoholic beverage companies (control group). Confidence intervals are plotted at 95 percent level.

employment between soft drink firms and alcohol producing companies also do not seem significant in the period after the tax. Put differently, the event study suggests that the soft drink tax did not lead to any significant differences in employment changes between both groups in the post-tax period.

The results of my microeconomic employment regression analysis can be retrieved from Table 5. Column (1) reports the regression results without controlling for any confounders. The regression estimates of my fully specified model (see Equation (1)) are depicted in Column (2). My coefficient of interest of the interaction term $Tax_t * Treatment_i$ (also known as difference-in-differences estimator) depicts the tax-induced difference in employment changes in soft drink companies and alcoholic beverage firms. The results in Column (1) imply that the soft drink tax leads to a significant positive change in employment in soft drink companies relative to employment changes in alcoholic beverage com-

Table 5: Employees Microeconomic Regression

Log Employees	(1)	(2)
Treatment*Tax	1.700*	0.089
	(0.860)	(0.062)
Treatment	0.069	
	(1.722)	
Tax	-1.021	-0.012
	(0.782)	(0.046)
Unemployment Rate		-0.076*
		(0.040)
GDP		-0.000
		(0.000)
Total Population		-0.000
		(0.000)
Lag Log Employees		0.871***
		(0.056)
Company FE	No	Yes
Observations	110	106
Adjusted R^2	0.063	0.995

Note. Author's own estimations. Column (1) depicts the coefficient estimates of regressing the tax event on logarithmic number of employees. The fully specified model in Column (2) additionally controls for *Unemployment Rate*, *GDP*, *Total Population* and company fixed effects. Standard errors are heteroskedasticity-robust and clustered at the company level. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

panies. However, these results are negligible, due to the low explanatory power of the unadjusted model (e.g. no control variables). Although the difference-in-differences estimator in Column (2) also indicates a positive change in employment, these results are not significant. The control variable *Unemployment Rate* has a significant negative effect on the change in employment of soft drink firms, which is intuitive as higher national unemployment can lead to less employment in soft drink companies. *GDP* and *Total Population* have close to no effect at all. Overall, the UK soft drink tax did not have a significant impact on the number of employees in soft drink companies, when analysing microeconomic data. Hence, these results could be a first indication that the tax burden, which arises from the new soft drink taxation law, is not borne by employees in soft drink firms (e.g. in the form of staff reductions).

4.2. Macroeconomic Employment Analyses

4.2.1. Soft Drink Manufacturing Industry

To validate my above microeconomic employment results, I now use macroeconomic data, to again analyse whether the tax has an effect on employees in the soft drink manufacturing industry. Figure 4 depicts the average logarithmic number of employees[22] in the soft drink manufacturing industry (red line) and alcoholic beverage manufacturing industry (blue dashed line), relative to the reference year (2017). Again, I observe similar trajectories for both groups in the pre-tax period, strengthening my parallel trends assumption. Interestingly, in the year of the tax announcement (2016) I observe a small hike in employment levels for the soft drink manufacturing industry. This indicates that solely the announcement of the tax could have had an impact on employment. Anticipating the new tax burden for their high sugary drinks, soft drink companies might have taken precautionary measures before the tax even came into effect. For example, by hiring new employees for product innovation and reformulation tasks. This phenomenon is known as the Ashenfelter Dip, where the treatment group already alters their behaviour before the (policy) event occurs, as they expect to be undertaken a treatment soon (Lee, 2016). To control for this behaviour, I perform a robustness check using the announcement of the soft drink tax in 2016 as the event indicator (see Chapter 5). I find that my results remain robust. In general, Figure 4 indicates that both groups exhibit a continuously increasing trend in employment over the complete observational period.

The subsequent event study (Figure 5) further underlines the parallel trends assumption for the treatment and control group. All coefficients in the pre-tax period are insignificant

[22] Hereafter only referred to as employment levels.

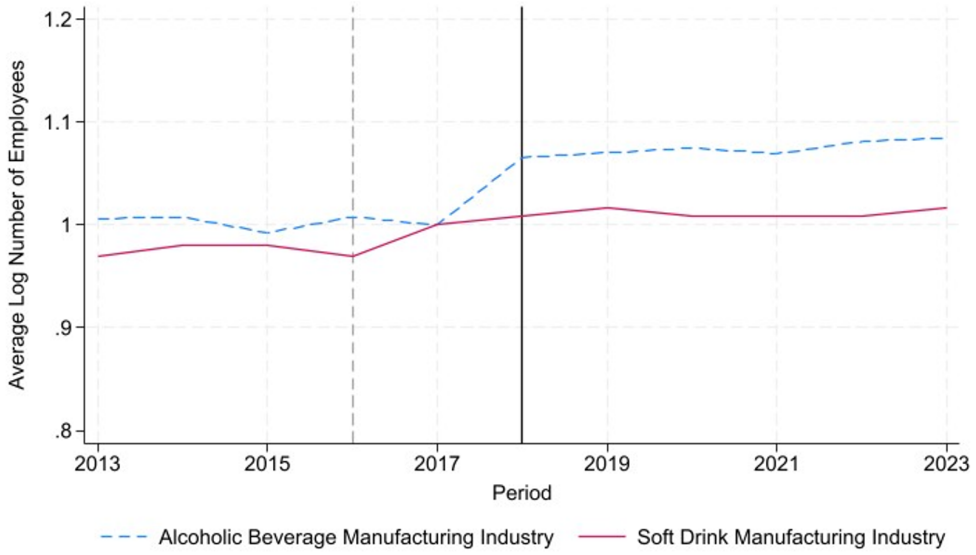

Figure 4: Parallel Trends - Macroeconomic Employment (Soft Drink Industry)

Note. Author's own overview based on employment data retrieved from Office for National Statistics (2015, 2022b). Graph shows the average logarithmic number of employees in the soft drink manufacturing industry (treatment group) and in the alcoholic beverage manufacturing industry (control group) from 2013 to 2023. Logarithmic number of employees is normalised to one in 2017 (i.e. one year before the tax implementation).

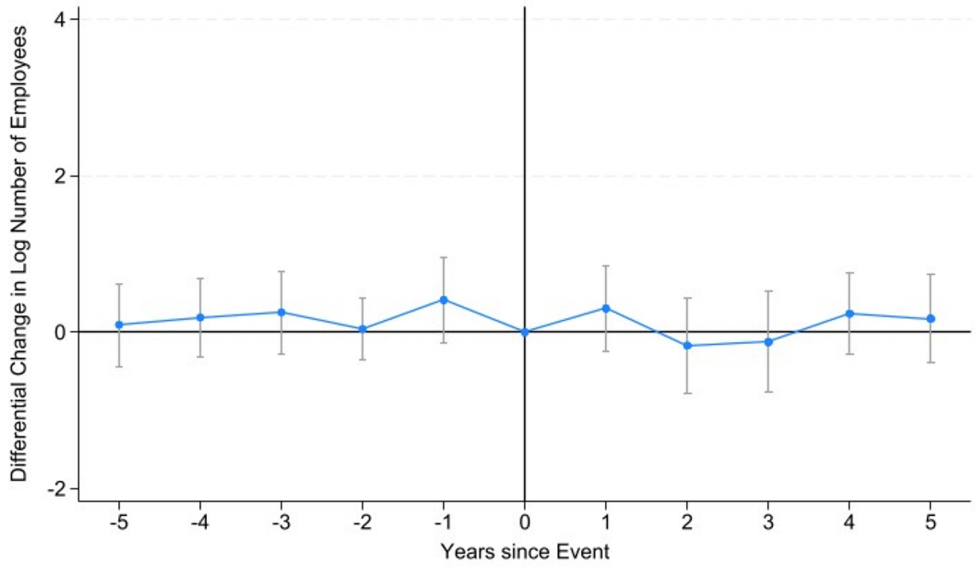

Figure 5: Event Study - Macroeconomic Employment (Soft Drink industry)

Note. Author's own overview based on employment data retrieved from Office for National Statistics (2015, 2022b). Graph shows the difference in logarithmic employment changes between the soft drink manufacturing industry (treatment group) and alcoholic beverage manufacturing industry (control group). Confidence intervals are plotted at 95 percent level.

(see confidence intervals intersecting with the x-axis), indicating that there is no significant difference between employment changes in the soft drink manufacturing industry and alcoholic beverage manufacturing industry. This pattern pertains even after the soft drink tax was implemented, implying that the policy did not lead to significant changes in employment levels of the soft drink industry, relative to employment changes in the alcoholic beverage manufacturing industry.

4.2.2. Beverage Manufacturing Industry

Employment in the beverage manufacturing industry seems to exhibit the same pattern as in the preceding analysis of the soft drink industry. Figure 6 shows the average logarithmic number of employees[23] in the textile (control group) and beverage manufacturing industries (treatment group). Employment in the beverage manufacturing indus-

[23] Hereafter only referred to as employment.

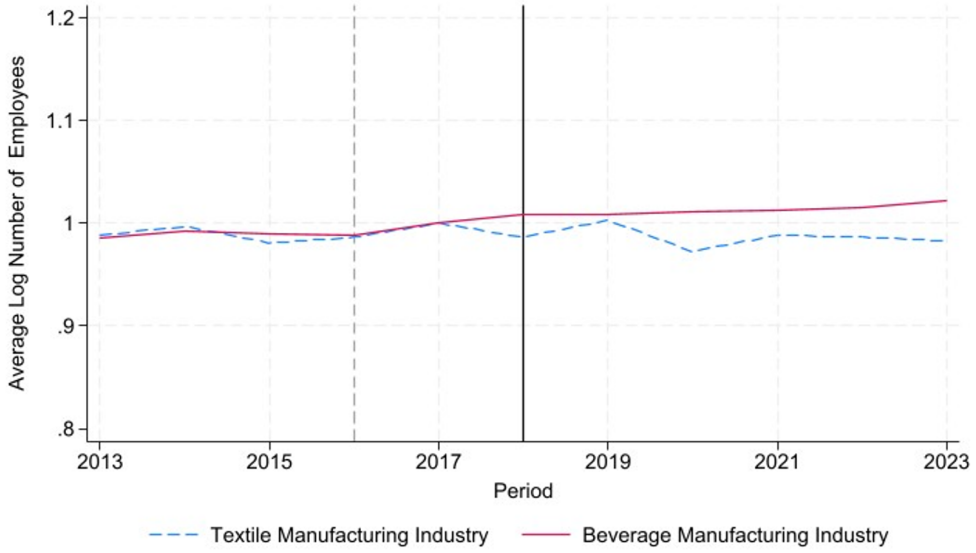

Figure 6: Parallel Trends - Macroeconomic Employment (Beverage Industry)

Note. Author's own overview based on employment data retrieved from Office for National Statistics (2015, 2022b). Graph shows the average logarithmic number of employees in the beverage manufacturing industry (treatment group) and in the textile manufacturing industry (control group) from 2013 to 2023. Logarithmic number of employees is normalised to one in 2017 (i.e. one year before the tax implementation).

try continuously rises over the entire observational period, compared to its value in the reference year (2017). Furthermore, the beverage (treatment) and textile industries (control) both have a similar positive pre-tax trend in employment, indicating strong parallel trends. Whilst the textile industry exhibits fluctuations over time, the beverage manufacturing industry demonstrates a continuous positive trend in employment, even after the tax implementation.

The event study of the beverage and textile manufacturing industries is depicted in Figure 7. Whilst the coefficient estimates seem slightly statistically significant in the first two years of the observational period (i.e. 2013 and 2014), they become insignificant afterwards. Put differently, the textile and beverage manufacturing industries have comparable logarithmic employment levels after 2015 onwards, making them valid treatment and control groups. Again, coefficient estimates for 2018 onwards are also statistically insignificant, suggesting that the soft drink tax did not lead to a significant change in employment levels of the beverage industry, compared to the change in employment levels in the textile industry.

The subsequent Table 6 presents the regression estimates for both analyses. First, I regress the tax event on the logarithmic number of employees in the soft drink manufacturing industry. Results are depicted in Columns (1) and (2). I then estimate the effect of the soft drink tax on the entire beverage manufacturing industry, of which results are presented in Columns (3) and (4). Columns (1) and (3) represent the coefficient estimates of regressing the tax on employment in the respective industries, excluding all control variables and fixed effects. The regression estimates of my adjusted models, as described in Equations (1) and (2), are shown in Columns (2) and (4).

My regression coefficient of interest, the difference-in-differences estimator, is positive when regressing the soft drink tax on logarithmic employment in the soft drink manufacturing industry in Column (1). This implies a positive change in employment in the soft drink industry, compared to the employment change in the control group. When including controls, this induced change in employment in the soft drink industry becomes negative, relative to the control group. However, both effects are statistically insignificant. Thus, my macroeconomic regression results of employment in the soft drink industry are in line with my insignificant microeconomic regression result. Therefore, I can reject Hypothesis 1, which postulates that the UK soft drink tax leads to a decrease in employment in the soft drink manufacturing industry. Put differently, my results emphasise that employees in the soft drink manufacturing industry did not bear the cost of the soft drink tax, as employment levels have not significantly decreased due to the tax implementation. A possible explanation could be that either firms might have absorbed the extra costs of the new soft drink tax burden or have passed the costs onto consumers (see Section 4.3 for price regression results). Alternatively, soft drink companies might have even bypassed the tax by reformulating their high sugary drinks just in time, before the tax came into effect. My results are in line with current literature on soft drink taxation and employment in other countries, such as Peru, Portugal and the US (Díaz et al., 2023; Gonçalves et al., 2024; Lawman et al., 2019). They all found no significant effect of soft drink taxes on employment in the soft drink manufacturing industry in their respective countries of analysis.

Contrary, when regressing the soft drink tax on employ-

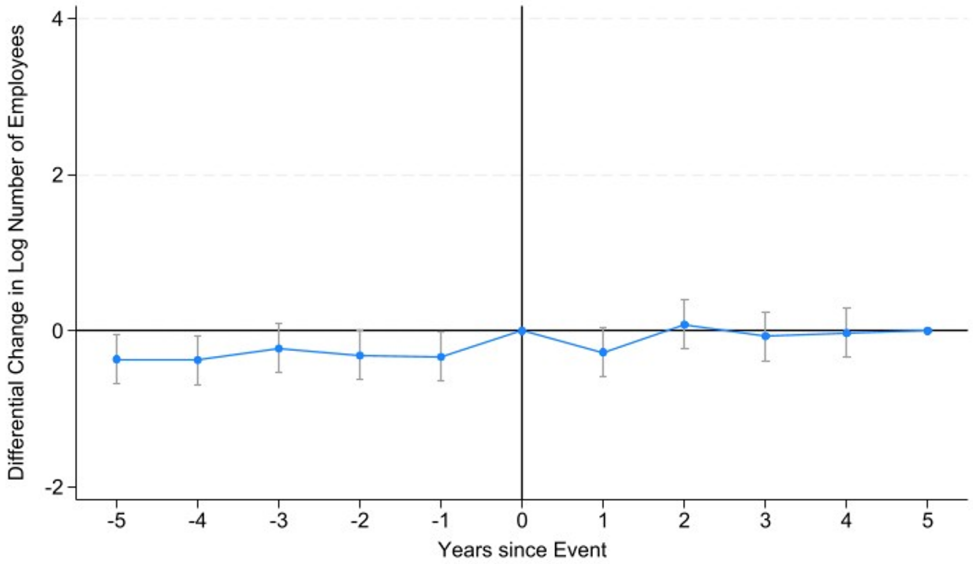

Figure 7: Event Study - Macroeconomic Employment (Beverage Industry)

Note. Author's own overview based on employment data retrieved from Office for National Statistics (2015, 2022b). Graph shows the difference in logarithmic employment changes between the beverage manufacturing industry (treatment group) and textile manufacturing industry (control group). Confidence intervals are plotted at 95 percent level. The last years' coefficient of the interaction term (Treatment * 2023) was omitted due to collinearity. Hence, only a coefficient estimate of zero is plotted without any confidence interval.

ment in the entire beverage manufacturing industry, results become highly significant (see Columns (3) and (4)). The difference-in-differences estimator of the basic unadjusted regression is positive and statistically significant (see Column (3)). Precisely, the coefficient of 0.274, which has to be back transformed first,[24] indicates that employment levels in the beverage manufacturing industry increased by 32% more than employment in the textile manufacturing industry. In Column (4) I see that this effect becomes even larger when controlling for confounding variables. Due to the UK soft drink tax, employment in the beverage manufacturing industry increased by 39%[25] more than employment in the textile industry. I also find that the *Unemployment Rate*, *GDP*, *Total Population* and the employment numbers of the previous year do not significantly influence employment levels, neither in the beverage nor in the soft drink manufacturing sector. Contrary to my initial assumption that employment levels will decline in response to the soft drink tax (see Hypothesis 1), I observe that employees in the beverage industry even benefitted from the tax, as employment has significantly increased in this sector (see Columns (3) and (4)).

To put these percentage changes into relation, absolute employment numbers before and after the tax implementation can be retrieved from Table 7. The absolute number of employees increased in both industries, the soft drink and the overall beverage manufacturing industry, after the tax was implemented. However, when controlling for the general growing trends in the industries and other influential economic indicators (e.g. GDP) in my difference-in-differences analysis, only the employment increases in the beverage manufacturing industry are significant and attributable to the soft drink tax.

I ascribe this trend to non-soft-drink manufacturing companies in the beverage market, which might have benefitted from spillover effects. For example, alcoholic beverage manufacturers often diversify their product range, also offering non-alcoholic alternatives. By anticipating the new tax burden of their competitors (soft drink manufacturing firms), they might have created substitute products (e.g. low-sugar non-alcoholic beverages). Thus, these types of firms might have hired new employees for product innovation tasks and herewith increasing overall employment levels in the beverage manufacturing industry significantly.

Whilst other studies have found no significant employment effects (Díaz et al., 2023; Gonçalves et al., 2024; Lawman et al., 2019; Marinello, Leider, & Powell, 2021), I argue that the UK has a different setting. Compared to other countries with often uniform tax rates, the UK soft drink tax has a two-tiered tax design to encourage reformulation. I postulate that this tax policy increased overall employment levels in the beverage manufacturing industry, due to increased demand for employees to fulfil new product innovation tasks. Employment levels in the soft drink industry were not significantly affected. This indicates that they might have not required additional staffing for reformulation, as they might have solely passed on the tax to consumers. However, as ar-

[24] Coefficient estimates of log-linear models are interpreted as percentage changes (Wooldridge, 2013). In this case, the percentage change is calculated as follows: $(e^{0,274} - 1) * 100 = 31.52\%$.

[25] Again, for comprehension purposes, the percentage change is calculated as follows: $(e^{0,327} - 1) * 100 = 38.68\%$.

Table 6: Employees Macroeconomic Regression

	Soft Drink Manufacturing Industry		Beverage Manufacturing Industry	
Log(Employees)	(1)	(2)	(3)	(4)
Treatment*Tax	0.613	-0.129	0.274***	0.327***
	(0.529)	(0.106)	(0.068)	(0.076)
Treatment	1.605***		-0.336***	
	(0.342)		(0.046)	
Tax	-0.320	0.360**	-0.042	-0.089
	(0.527)	(0.171)	(0.058)	(0.095)
Unemployment Rate		0.043		-0.044
		(0.096)		(0.034)
GDP		-0.000		0.000
		(0.000)		(0.000)
Total Population		0.000		-0.000
		(0.000)		(0.000)
Lag Log Employees		0.354		-0.253
		(0.308)		(0.237)
Observations	73	71	22	22
Industry FE	No	Yes	No	Yes
Adjusted R^2	0.082	0.957	0.703	0.706

Note. Author's own estimations. Coefficient estimates are presented separately for the dependent variable Log(Employees) in the soft drink manufacturing industry (Columns (1) and (2)) and in the beverage manufacturing industry (Columns (3) and (4)). Columns (1) and (3) depict the coefficient estimates of regressing the tax event on logarithmic number of employees. The fully specified (adjusted) models in Columns (2) and (4) additionally control for $Unemployment\ Rate$, GDP, $Total\ Population$ and industry fixed effects. Standard errors are heteroskedasticity-robust but not clustered due to insufficient number of industry groups. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Average Absolute Number of Employees (Macroeconomic)

#	Soft Drink Manufacturing Industry	Alcoholic Beverage Manufacturing Industry	Beverage Manufacturing Industry	Textile Manufacturing Industry
Before Tax	10,000	5,151	37,400	52,400
After Tax	13,333	5,719	47,167	50,333
Absolute Difference	3,333	568	9,767	-2,067
Change in %	33.33	11.03	26.11	-3.94

Note. Author's own overview based on employment data retrieved from Office for National Statistics (2015, 2022b). The table shows the average number of employees in absolute values before (2013-2017) and after the tax was implemented (2018-2023) for each industry separately. The change in the average number of employees is depicted in percent.

gued above, I believe that alcoholic beverage manufacturers have utilised the soft drink tax introduction to expand their product portfolio. Thus, requiring additional employees and herewith increasing overall employment in the beverage sector.

4.3. Price Regression Analysis

As employees in the soft drink manufacturing industry did not have to bear the costs of the soft drink tax, and employees in the beverage manufacturing industry even benefitted from it, I now analyse whether the tax burden was passed onto the consumer. Thus, I regress the UK soft drink tax on soft drink prices. The following two graphs highlight the strength of my price regression analysis. Figure 8 shows the development of

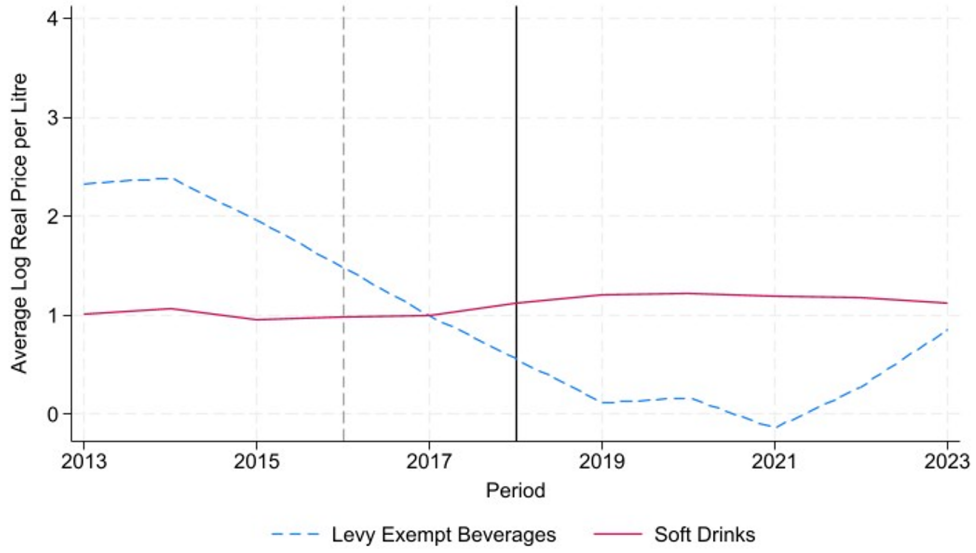

Figure 8: Parallel Trends - Prices

Note. Author's own overview based on price data retrieved from Office for National Statistics (2024b). Graph shows the average logarithmic real price per litre of soft drinks (treatment group) and levy-exempt beverages (control group) from 2013 to 2023. The logarithmic real price per litre is normalised to one in 2017 (i.e. one year before the tax implementation).

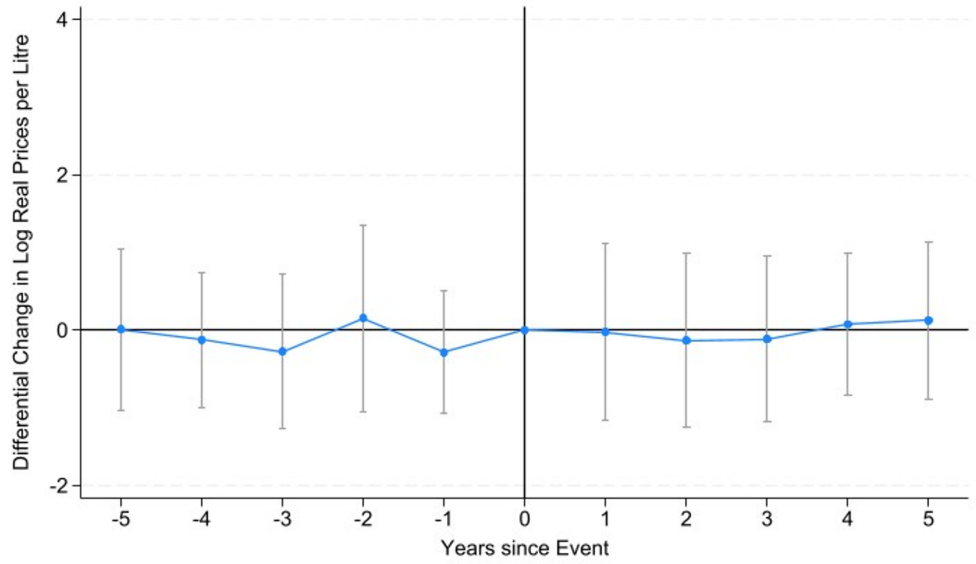

Figure 9: Event Study - Prices

Note. Author's own overview based on price data retrieved from Office for National Statistics (2024b). Graph shows the difference in logarithmic real price per litre changes between soft drinks (treatment group) and levy-exempt beverages (control group). Confidence intervals are plotted at 95 percent level.

the average logarithmic real price per litre[26] of soft drinks (red line) and levy-exempt beverages (e.g. juices and water) (blue dashed line), relative to the reference year 2017. The trend of soft drink prices seems to be relatively stable over the complete observational period and only showing a slight decline in the pre-tax period. However, the prices of levy-exempt beverages constantly decline until 2019 (and hereafter fluctuate) at a much higher rate.

I therefore conduct an event study to further investigate the parallel trends assumption. Figure 9 depicts the differential changes between the logarithmic real price per litre of levy-exempt beverages and soft drinks. As all coefficients are statistically insignificant, it can be assumed that there was no difference in price changes of levy-exempt beverages and soft drinks. This shows that the parallel trends assumption for treatment and control group holds. Overall, the event study also indicates that the soft drink tax probably does not have a statistically significant impact on the soft drink prices,

[26] Hereafter prices is used as synonym.

as the coefficients remain statistically insignificant after the tax came into effect.

As logarithmic percentage interpretations can be twofold at first sight in difference-in-differences analyses, I also provide an overview of average absolute prices before and after the tax implementation in Table 8. The overview shows that soft drink prices as well as prices of levy-exempt beverages in general decreased over my entire observational period between 2013 to 2023. Whilst the average soft drink price was £3.85 in the pre-tax period, soft drinks on average only costed £3.17 post tax, a total decrease of 68 pence. The same trend is also observable for levy-exempt beverages. To further test whether and to what extent this price change is attributable to the introduction of the soft drink tax, or whether these declines are a general trend of economic downturn, I conduct a difference-in-differences analysis.

Table 8: Average Absolute Prices

#	Soft Drink Prices	Levy-Exempt Beverages
Mean Price per Litre before tax (£ 2018)	3.85	1.34
Mean Price per Litre after tax (£ 2018)	3.17	1.09
Difference in Prices	-0.68	-0.25
Change in %	-17.7	-18.5

Note. Author's own overview based on price data retrieved from Office for National Statistics (2024b). The table shows the mean real price per litre in absolute values before (2013-2017) and after the tax (2018-2023) was implemented for treatment (soft drinks) and control group (levy-exempt beverages) separately. The change in average price is depicted in percent.

The results of my price regression analysis are reported in Table 9. I first regress the soft drink tax event solely on my dependent variable logarithmic real price per litre (see Column (1)). The difference-in-differences estimator indicates that the tax leads to a positive change in soft drink prices relative to the change in prices of levy exempt beverages. However, this effect is not statistically significant. When controlling for confounding variables, as well as for region and shop fixed effects, I estimate a statistically significant positive effect on price changes (see Column (2)). As I know that prices of soft drinks declined over the complete observational period, I revise the interpretation of the difference-in-differences estimator. As its coefficient depicts the difference in price changes between the treatment group compared to the control group, a positive coefficient either indicates that prices increased more or declined less in the treatment group than in the control group. In my case, I find that, despite the overall declining trend of beverage prices in the UK, the soft drink tax led to a 6%[27] less decline in prices of soft drinks compared to prices of levy-exempt drinks. Put differently, even though the tax did not lead to significant price increases, it slowed down the general falling trend of soft drink prices. It can be said that, although the consumer did not visibly bear the soft drink tax burden in the form of higher product prices, I argue that they were still constrained by the tax, as soft drink prices would have declined even faster without the tax.

To quantify how much of the tax burden was passed onto the consumer, a pass through rate is estimated. However, as emphasised by Stacey et al. (2019), pass through rates can only be retrieved from regression analyses for uniform tax rates. For tiered tax rates, such as the UK soft drink tax, based on the sugar content and the applicable tax threshold, the pass-through rate could be calculated for each specific product. However, as my data does not provide nutritional information, I am not able to calculate the actual pass-through rate of the UK soft drink tax. However, I estimate the change in absolute prices, provided in Table 8, for comprehension purposes only. While Table 8 shows that soft drink prices (-17.7%) declined slightly less than levy exempt beverage prices (-18.5%), this does not depict the true causal effect of the soft drink tax. My difference-in-differences analysis, which controls for other influences on prices, finds that soft drink prices declined on average 6% less due to the soft drink tax and relative to levy-exempt beverage prices.

While declining prices seem counterintuitive at first, this trend could be caused by a general decline in demand for certain beverages, which might lead to significant promotions and herewith price decreases. Putting this into context, one of the few studies in this field, which also analyses the price effects of the UK soft drink tax, yields similar results. Using additional data on sugar content, Scarborough et al. (2020) differentiate between the two tax levies (i.e. the lower levy threshold has a tax rate of 18 pence per litre and the higher levy threshold of 24 pence per litre). They find that prices of soft drinks from the lower levy tier decreased by 10.7 pence, holding a tax pass-through rate of -59%. However, they also find that prices in the higher levy tier increased by 7.5 pence on average, equivalent to a pass-through rate of the tax onto consumers of 31%. They also identify an overall declining price trend for beverages in the control group, which costed 1.5 pence less 50 days post tax implementation.

Overall, my price results indicate that the UK soft drink tax decelerated the falling trend of soft drink prices. Whilst the general decrease in beverage prices is another research topic for itself, I argue that the beverage market is quite competitive, with a few large manufacturers predominating the market (see Figure 1). Thus, retail prices have to be kept as low as possible (e.g. by offering price promotions), in order for beverage companies to remain competitive. In view of the UK soft drink tax introduction, manufacturers were not able to hold soft drink prices as competitive as the prices of other levy-exempt beverages. This could be attributable to the new tax burden, which soft drink manufacturers partially passed onto consumers, in the form of fewer price promotions, compared to what they would have offered consumers, if the tax

[27] Again, for comprehension purposes, the percentage change is calculated as follows: $(e^{0,058} - 1) * 100 = 5.97\%$.

Table 9: Price Regression

Log(Price)	(1)	(2)
Treatment*Tax	0.036	0.058***
	(0.037)	(0.022)
Treatment	0.700***	0.535***
	(0.099)	(0.043)
Tax	-0.223***	-0.134***
	(0.020)	(0.017)
Unemployment Rate		0.063***
		(0.010)
GDP		0.000***
		(0.000)
Total Population		0.000**
		(0.000)
Volume		-0.994***
		(0.035)
Region FE	No	Yes
Shop Type FE	No	Yes
Observations	31,957	31,957
Adjusted R^2	0.142	0.587

Note. Author's own estimations. Column (1) depicts the coefficient estimates of regressing the tax event on logarithmic real price per litre (i.e. constant 2018 pounds). The fully specified model in Column (2) additionally controls for $Unemployment\ Rate$, GDP, $Total\ Population$, $Volume$, as well as region and shop type (i.e. chains with more than 10 shops or independent stores) fixed effects. Standard errors are heteroskedasticity-robust and clustered at shop code level (i.e. unique shop identifier, indicating from which shop the product prices were collected from). Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

would have not been implemented (see declining trend in soft drink prices before the tax).

An alternative explanation is that manufacturers did not have to pass the soft drink tax onto consumers, if they had reformulated their soft drinks early enough to bypass the levy. Scarborough et al. (2020) found that one year after the UK soft drink tax implementation, sugar in taxable soft drinks[28] was reduced by 2.13 grams per 100 millilitres on average. They observe that one year after the tax, 30.7% of the soft drinks that were tax liable (i.e. had a sugar content of 5 g per 100 ml or more), moved below the 5 g sugar threshold. This underlines that, in line with the UK soft drink tax objective, manufacturers substantially decreased the sugar levels in their products. Overall, I suggest that further analyses on the price effects associated with the UK soft drink tax need to be conducted to ensure more transparent results.

5. Robustness Checks

I test the validity of my price and employment regression results by performing a variety of adjustments to my main model specifications (Equations (1) – (3)). Results can be derived from Tables A2 to A4 in the Annex. The tests are described in detail below. The first two checks are applied uniformly to all model specifications (Equations (1) - (3)). Robustness check three is applied uniformly to all employment analyses (Equations (1) - (2)). Hereafter, specific checks for price and employment analyses are conducted, adapting to the needs of the respective datasets.

1) Covid-19 Pandemic

The Covid-19 pandemic significantly impacted economies worldwide, and herewith not only affected employment but also prices due to high inflation. Thus, I re-run all regression analyses, limiting my observational period from 2013 to 2020, to account for the Covid crisis as confounding error (in employment and price estimates). All results are robust to this change (see Column (1) in Tables A2 - A4).

2) Tax Announcement Effect

As the UK soft drink tax was announced in 2016, two years before its actual implementation, soft drink manu-

[28] Referred to as intervention drinks in Scarborough et al. (2020).

facturers might have already adjusted their product prices or employment levels to compensate the anticipated future costs of the tax. This behaviour, also known as the Ashenfelter Dip, could distort regression results when the treatment group significantly changes their behaviour in the pre-tax period (Lee, 2016). Therefore, I use the tax announcement as regressor. I discover that only my macroeconomic soft drink analysis yields the same results as in the main specification. Results from my macroeconomic beverage industry analysis remain positive but become insignificant (see Column (7) in Table A3). Positive microeconomic employment estimates, which were insignificant before, become significant. This indicates that the announcement of the soft drink tax-induced increases in employment of soft drink companies, compared to alcoholic beverage companies. As this significant effect in the pre-tax period could distort my main microeconomic regression estimates (Table 5), results have to be treated with caution. My price estimates, which were significantly positive in the adjusted specification (Table 9), become insignificantly negative (see Column (2) in Table A4). Overall, this indicates that the announcement of the UK soft drink tax had no effect on soft drink prices.

3) Separate Estimations of Fixed Effects and Lagged Model Specifications

Angrist and Pischke (2009) emphasise that fixed effects regressions together with lagged dependent variables must be applied with caution due to their different assumptions. Thus, as suggested by the authors, I estimate each model separately. I apply this robustness check exclusively to my employment analyses, as no lagged variables are included in my price analysis due to the missing panel component of the data. The macroeconomic results remain robust. In Table A4, the microeconomic results remain positive when the lagged dependent variable is excluded (see Column (3)) but become insignificantly negative when excluding fixed effects (see Column (4)). However, I argue that the results of my main model specification (see Columns (1) and (2) in Table 5) are likely to be valid due to the subsequent reason. Angrist and Pischke (2009) postulate that separate estimations of fixed effects and lagged dependent models serve as a bracket in which the true causal effect lies. When the lagged dependent model specification is correct, but a fixed effects model is incorrectly applied, this leads to an overestimation of the actual effect (upper bound). Vice versa, if a lagged dependent model is incorrectly applied instead of the correct fixed effects model, this leads to an underestimation of the causal effect (lower bound) (Angrist & Pischke, 2009). Thus, my fixed effects estimation (see Column (3) in Table A2) is the upper bound and the lagged dependent variable model the lower bound (see Column (4) in Table A2), in which the true causal effect of my main model specification lies (see Column (2) in Table 5).

4) Employment Analyses 2016 to 2023

Furthermore, I control for the change in methodology of the Business Register and Employment Survey, from which my macroeconomic employment data is obtained. Whilst data between 2009 to 2015 only encompasses VAT registered businesses in Great Britain, data from 2016 to 2023 additionally includes smaller firms with less than 20 employees (i.e. Pay As You Earn [PAYE] businesses) (Office for National Statistics, 2017). To control for this inconsistency, I exclude all observations before 2016 in my macroeconomic employment analyses and find that my results are still robust (see Columns (5) and (10) in Table A3).

5) UK Primary Sales Market

My microeconomic employment analysis only includes businesses for which the UK is at least their third biggest sales market. I tighten this restriction in the robustness analysis to encompass only companies with the UK as primary sales market. I herewith exclude the largest multinationals, namely Coca-Cola Europacific Partners and Diageo. Again, my regression results are robust (see Column (5) in Table A2).

6) Missing Pre-Tax Data

In my microeconomic employment analysis, I control for the missing pre-tax data of companies. Hence, I exclude Artisinal Spirits, Adnams, Gusbourne and Distil from my analysis, and find that my initial results are valid (see Column (6) in Table A2).

For my price analysis I also exclude items with insufficient pre-tax observations. Thus, I exclude all cola drinks (item IDs 212011, 21025 and 21026), a bottle of mixer (item ID 212022) and a water bottle (item ID 21025). My initial results are also robust to this test (see Column (3) in Table A4).

7) "Pseudo" Panel Data

Lastly, to control for potential autocorrelation in my repeated cross-sectional price dataset, I construct an artificial ("pseudo") panel structure. I compute the average price of each item per period, resulting in 143 unique item-year observations. This robustness check yields similar results as my initial price regression (see Column (3) in Table A4).

6. Conclusion

This paper analyses the medium-term effects of the UK soft drink tax on employment and price levels. I find that neither consumers nor employees had to bear the cost of the soft drink tax visibly. However, despite the overall falling trend in beverage prices, consumers of soft drinks were minimally constrained by the tax, as they experienced a 6% less decline in soft drink prices (relative to levy-exempt beverages) than they would have without the tax implementation. Whilst the

tax had no significant impact on employment in the soft drink industry, I observe significant employment increases in the entire beverage industry. I postulate that alcoholic beverage manufacturers increased their staffing for product innovation purposes (e.g. low sugary non-alcoholic drinks), to attract soft drink consumers with their more competitive prices than those of their tax burdened competitors.

By using five years post-tax data, my study offers novel insights on the more manifested structural changes in the beverage sector, which has not been accounted in the numerous short-term studies before. I herewith provide evidence for policymakers and the UK government, showing that the soft drink tax did not come at the cost of employees and only minimally burdened consumers. Based on my results, the government can revise and adapt the policy to further incentivise reformulation and herewith unburden the consumer.

My study is limited in the following ways. Due to missing nutritional information, I was not able to distinguish the effect of the soft drink tax on lower levy and higher levy tier drinks. Hence, I also could not quantify the pass-through rate of the tax. Thus, I was also unable to identify as to how much firms are burdened with the tax or bypass it by reducing sugar in soft drinks just below the threshold (i.e. bunching). Another limitation is that I could not account for autocorrelation in prices, hence price estimates have to be interpretated with caution. Lastly, due to the lack of an adequate geographical control group, I was not able to control for potential spillover effects of the tax (e.g. shifts of employment from the soft drink industry into alcoholic beverage manufacturing industry).

As my study and the few other studies in this field diverge largely in estimations, I encourage further price analyses to arrive at a common understanding on the tax incidence of consumers. Also, further research on the general pricing structure in the UK beverage market needs to be conducted, to comprehend the unusual trend of the overall decline in beverage prices.

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