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Original Research

The early impact of the UK's new alcohol taxation system on product strength and price: an exploratory comparative descriptive study

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ABSTRACT

Objectives: We explored the early impact of changes to the UK alcohol tax system, implemented in August 2023, on the strength and price of alcoholic products available for sale on the website of the largest supermarket in England.

Study design: Our comparative descriptive study using longitudinal brand-level data was not preregistered and should be considered exploratory.

Methods: Data were collected weekly (May to October 2023) using automated web scraping tools. Outcomes were product strength (% alcohol by volume [ABV]) and price (per 10 mL of pure alcohol and per litre of product). We undertook paired *t*-tests, two-sample Kolmogorov–Smirnov tests, and quantile regression to compare outcomes before and after the tax changes. Beer, cider, spirits, and ready-to-drinks (RTDs) were analysed separately.

Results: There was a reduction in the mean strength of beer, driven by manufacturers reformulating a small number of weaker beers, moving them into a lower tax band (<3.5%ABV). The mean price per 10 mL of alcohol and per litre of product was significantly higher after the new tax system for beer, cider, and spirits and significantly lower for RTDs. Increases in the price of beer tended to occur across the entire distribution, whereas increases in the price of cider occurred among more expensive products.

Conclusions: Changes to product strength tended to occur among weaker products near the new lowest tax band, suggesting tax bands may be a potential stimulus for change. Reformulation of stronger products would have better public health potential. Longer term monitoring, including data on purchasing/consumption, is required.

Introduction

Increasing the tax on alcohol to increase price is one of the most cost-effective approaches for preventing and reducing alcohol-related harm.[1–4] The basic assumption is that tax increases translate to price increases, which decrease consumption and harm since consumption is price elastic. The reverse is also true. This assumption is supported by reviews and meta-analyses of over 1000 studies.[5–7]

Internationally, the scale and structure of alcohol taxation are varied, with alcohol usually being taxed on one or more of three different bases: the volume of product (unitary taxation), the volume of alcohol (volumetric taxation) or the value of the product (ad-valorem taxation).[8–10] Regarding the relative effectiveness of these approaches for improving public health, the evidence is strongest for volumetric taxation. For example, modelling studies in Australia[11,12] and the United Kingdom[13,14] found moving to volumetric taxation was more effective for reducing alcohol consumption and cost-saving in comparison to the existing, hybrid systems. Volumetric taxation means the tax levied on each millilitre of alcohol is equivalent; therefore, a 15% alcohol by volume (ABV) wine will pay more tax than a 12% bottle. In contrast, under a unitary system, both wines would attract the same duty, so tax paid per millilitre of alcohol decreases as product strength increases. Under ad-valorem systems, there is no direct link between strength and tax.

The European Union (EU) requires that spirits are taxed on a volumetric basis, as is generally the case for beer, whereas wines and ciders must be taxed on a unitary basis.[15] EU Member States may levy additional ad-valorem taxes on top. While minimum tax rates are specified for beer and spirits, there is no minimum rate for

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wine. Under these EU regulatory requirements, before August 2023, the UK alcohol tax system contained inconsistencies, with variations in rates across products with equivalent alcohol content.[16] Most notably, tax on beer increased or held steady with the strength of the product (on a per millilitre of alcohol basis); however, this was not true for cider and wine. Following the UK's exit from the EU and a Government consultation, the Treasury designed a new alcohol tax system, implementing the changes in August 2023 (changes to wine are fully implemented in February 2025).[17–19] The new approach is volumetric taxation, and for the first time, there are lower tax rates for alcohol sold in the on-trade. The changes to the tax system are given in Appendix 1. All products are now taxed according to a standardised series of four bands based on alcoholic strength:

- lowest band: >1.2% to <3.5%ABV;
- second band: ≥3.5% to <8.5%ABV;
- third band: ≥8.5% to ≤22%ABV; and
- highest band: >22%ABV.

All products in the lowest, third, and highest bands pay the same rate of tax. In the second band, different tax rates apply to different products. Wine and spirits pay a common rate, whereas beers pay a lower rate, and ciders pay a lower rate again (about half that of beers). In addition to structural changes, in the Spring Budget 2023, the Government announced increases in alcohol taxes in line with Retail Price Index (RPI). This means two changes occurred simultaneously – the move to volumetric taxation and an increase in tax rates in line with inflation. The Government have committed to evaluating the impact of the tax changes by August 2026.[18] In this article, we explore the early impact of changes to alcohol taxes on the strength and price of products available for sale in one major retailer in England 3 months after implementation.

The impact of tax changes on tax paid

Under the new tax system, products across the entire distribution are affected differently as set out in Appendix 1.

- On a per litre of alcohol basis, spirits >22%ABV have had a tax increase of £2.90, whereas spirits ≤22%ABV but ≥8.5%ABV have had a tax cut of £0.24, and spirits-based ready-to-drinks (RTDs) between 3.5%ABV and <8.5%ABV have had a more pronounced cut of £3.97.
- On a per 10 mL of alcohol basis, beers up to 2.7%ABV have had small tax increases, whereas products between 2.8%ABV and 3.4%ABV have had a tax cut, largely due to the decision to increase the upper end of the lowest tax band from 2.8%ABV to 3.5%ABV.
- Per 10 mL of alcohol beers, between 3.5%ABV and 7.4%ABV have had a tax increase, whereas stronger beers between 7.5%ABV and 8.4%ABV have had a tax decrease related to the decision to increase the upper end of the third tax band from 7.5%ABV to 8.5% ABV.
- On a per 10 mL alcohol basis, ciders ≤4.1%ABV have had a tax cut with larger decreases given to weaker products, whereas ciders between 4.2%ABV to 8.4%ABV have had a tax increase, with larger increases given to stronger products <6.9%ABV.

Given these differences, there might be different changes to products across different parts of the distribution. For example, although the strength-based approach to taxation likely provides a financial incentive for producers to lower the strength of products, it is possible that there might be more focused changes for products that are closer to the new tax bands as the reduction in tax achieved from moving from 3.5%ABV to 3.4%ABV (which takes a product from the second to lowest tax band) is greater than the same absolute reduction in strength from 3.6%ABV to 3.5%ABV (since both strengths are in the second tax band).

Methods

Design

The analysis plan for this study was not preregistered, and the findings should be considered exploratory. STATAv15 was used for all analyses.

Data and variables

Data about alcoholic products were extracted from the website of the UK's largest supermarket using the automated Web Scraper tool[20] on a weekly basis between May 3, 2023, and October 25, 2023 (26 weeks). Web Scraper is a software tool for extracting data from publicly available websites and has been used to extract product prices in the Philippines (1) and piloted for use in the United Kingdom to estimate the Consumer Price Index (2). We refer readers who are interested in the approach and application of web scraping to the following: (3–5). Web scraping data from one major retailer has its advantages in that analysis on changes in product prices can be undertaken quickly, almost in real time, but clearly comes at the cost of being a comprehensive study across the entire market. The extracted data included the product name (brand), type (beer, cider, wine, spirit, RTD), serving size (volume in centilitre or millilitre), strength (%ABV) and price (£GBP). Price data refer to England and not the United Kingdom (noting Scotland and Wales have a minimum unit price on alcohol).[21] We converted serving sizes to millilitre and calculated the price per 10 mL of pure alcohol (one UK unit = 10 mL of pure alcohol), and the price per litre of product. If a product had a price promotion, we calculated price using this. Prices include value-added tax (set at 20% in the United Kingdom). We excluded products ≤1.2%ABV, which do not pay tax and removed alcoholic gifts, which were typically priced much higher (such as bottles sold alongside glasses). In our data, the same brand sold in different serving sizes is counted as distinct products (e.g. the same brand vodka sold as 350 mL, 500 mL and 1 L would count as three products).

To compare product strength and price before and after the introduction of the new tax system, we established a linked data set. To do this, we identified all products available for sale in the first 4 weeks of data collection (corresponding to May 2023 and herein the 'before' data). If the same product (brand and serving size) was available across weeks 1–4, we selected data from the earliest week. These products were then linked to their most recent observation in the last 4 weeks of data (corresponding to October 2023 and herein the 'after' data). In practice, more than 97% of 'before' data were obtained from the first week of data collection, and over 95% of 'after' data were obtained from the last week. The linked data are therefore a longitudinal brand-level data set. The advantage of using linked data is that it can directly identify changes in the %ABV and price of products. A disadvantage is that it excludes products that changed serving size across the period (e.g. from a multipack of six 500 mL servings to six 330 mL servings) and products that were unavailable either because they were out of stock or newly launched later in the time series.

Statistical analyses

Our primary outcomes of interest were product strength (% ABV), price per 10 mL of pure alcohol, and price per litre of product for beer, cider, spirits, and RTDs. Because the changes to wine

taxation are not fully implemented until 2025, we excluded wines. We undertook three statistical approaches to comparing these outcomes before and after the introduction of the new tax system, running separate analysis for beer, cider, spirits, and RTDs.

First, we undertook paired sample *t*-tests to explore whether the before and after data differ at the mean. Because products across the entire distribution are affected differently by the tax changes (e.g. spirits >22%ABV have had the largest tax increases of all products, whereas spirits <22% have had a tax cut, which is more pronounced for spirits-based RTDs <8.5%), before and after distributions might become more positively or negatively skewed depending on how products in that part of the distribution are affected. Explicitly, distributions may not differ only by their means but also (or even only) by their lower or upper parts. Therefore, statistical tests focusing only on detecting changes in the mean may overlook important distribution changes, which is why we chose to undertake additional analyses.

To compare the distributions of the outcomes before and after the tax changes, we used a two-sample Kolmogorov–Smirnov (KS) test, which compares differences between two empirical cumulative density functions (ECDFs) without needing to specify a common distribution.[22] Although our data are observed over time, in this analysis, the accumulated variable under analysis is the probability distribution and not time itself. Because we were interested not only in whether there was a difference, but where values were different, we compared distributions by multiple testing across ECDF values using the distcomp routine in STATAv15 (herein called the multiple testing across distributions approach).[23] For a detailed overview of the underlying method, see Goldman and Kaplan 2018.[24] Briefly, this approach identifies the ranges over which two distributions are significantly different, controlling the family-wise error rate (FWER). The method is qualitatively but not quantitatively related to KS and maintains even sensitivity across the continuum, addressing the problem KS tests have regarding poor power to detect deviations in distribution tails.[25] However, if a data set has substantial ties (the same value observed in both samples), the properties of the test can change substantially.[23,24] This is an important consideration for product strength, because although %ABV can exist on a continuum, in practice, some amount of discreteness exists. This is particularly true for spirits, which most commonly take the values 37.5%ABV or 40.0%ABV. Simulations suggest when there are ties, the method becomes conservative, controlling the FWER at a level even lower.[23,24] For this reason, we encourage readers to engage with the graphical representations of the ECDFs and not just associated *P*-values.

Finally, we compared the outcomes of interest using simultaneous quantile regression models to estimate the time effects (before and after the new tax system) for the 20th, 50th, and 75th percentile. Quantile regression estimates the dependent variable at different points on its distribution simultaneously, for example, at the 50th quantile. Analyses were carried out using the sqreg command in STATAv15, which produces bootstrapped errors (using 20 bootstraps in the estimation process). To examine whether the magnitude of the changes differed significantly between different percentiles of the product distribution, postestimation Wald tests were conducted using the test command. We did not undertake quantile regression for the %ABV distributions, given the very small number of changes that occurred.

Results

The impact of the new tax system on product strength (%ABV)

Our linked data included 279 beers, 192 spirits, 80 ciders, and 67 RTDs. The mean %ABV of products available before and after the introduction of the new tax system is given in Table 1. The mean %ABV of beers was significantly lower after the new tax system, driven by a reduction in the %ABV of 13 beers (mean difference [MD] = 0.01, standard deviation [SD] = 0.06, $P = 0.001$). The mean reduction in strength of these 13 beers was 0.25%ABV, ranging from 0.1%ABV to 0.5%ABV. Of the 13 beers with a lower %ABV after the tax changes, six reduced their strength from just above the upper threshold of the lowest tax band (<3.5%ABV) to below, making them eligible for a lower tax rate. One beer at the stronger end of the spectrum reduced its %ABV from 8.5%ABV to 8.4%ABV, which put it in a lower tax band. The mean %ABV of 189 spirits was also significantly lower after the new tax system (MD = 0.05, SD = 0.32, $P = 0.038$). Three gins and two rums had a mean reduction in %ABV of 1.8%, ranging from 0.5%ABV to 2.5%ABV. There was a tendency towards a reduction in the average strength of ciders, noting four products reduced their strength and one increased strength (from 6.8%ABV to 7.0%ABV). None of the 67 RTDs changed their strength. The ECDFs of %ABV before and after the tax changes can be seen in Appendix 2.

Table 1
The results of paired sample *t*-tests, two-sample KS tests and multiple testing across distributions comparing outcomes before and after the introduction of the new alcohol tax system.

Product	Before, mean (SD)	After, mean (SD)	Mean difference (SD)	*P*	Combined KS tests, D (*P*)	Rejected ranges
Strength (%ABV)						
Beer	**5.07 (1.12)**	**5.06 (1.13)**	**0.01 (0.06)**	**0.001**	0.03 (1.000)	None
Cider	4.73 (1.09)	4.69 (1.09)	0.04 (0.18)	0.079	0.04 (1.000)	None
Spirits	**39.58 (3.02)**	**39.54 (3.04)**	**0.05 (0.32)**	**0.038**	0.02 (1.000)	None
RTDs	4.78 (0.58)	4.78 (0.58)	–	–	0.00 (1.000)	None
Price per 10 mL of pure alcohol (pence)						
Beer	**0.98 (0.85)**	**1.03 (0.88)**	**−0.05 (0.10)**	**<0.0001**	0.07 (0.470)	None
Cider	**0.89 (0.69)**	**0.96 (0.76)**	**−0.08 (0.09)**	**<0.0001**	**0.24 (0.022)**	None
Spirits	**1.23 (0.51)**	**1.30 (0.52)**	**−0.06 (0.19)**	**<0.0001**	0.12 (0.138)	None
RTDs	**3.83 (2.26)**	**3.72 (2.25)**	**0.11 (0.20)**	**<0.0001**	0.15 (0.444)	None
Price per litre of product (GBP£)						
Beer	**3.76 (1.42)**	**3.96 (1.43)**	**−0.20 (0.39)**	**<0.0001**	**0.17 (0.001)**	**2.78–2.84** **2.88–2.98** **3.00–3.02** **3.27–3.41**
Cider	**3.11 (0.77)**	**3.35 (0.82)**	**−0.24 (0.26)**	**<0.0001**	**0.48 (<0.001)**	**3.79–3.93**
Spirits	**34.70 (13.17)**	**36.35 (13.07)**	**−1.66 (5.40)**	**<0.0001**	0.12 (0.110)	None
RTDs	**6.02 (1.28)**	**5.84 (1.28)**	**0.18 (0.50)**	**0.0042**	0.18 (0.233)	None

ABV, alcohol by volume; KS, Kolmogorov–Smirnov; RTDs, ready-to-drinks; SD, standard deviation.
There were 279 beers, 192 spirits, 80 ciders, and 67 RTDs. No RTDs changed their %ABV after the introduction of the new tax system. Bold values indicate statistical significance at the 0.05 level.

The impact of the new tax system on the price per 10 mL of pure alcohol

The mean price per 10 mL of pure alcohol was significantly higher after the introduction of the new tax system for beers, ciders, and spirits and significantly lower for RTDs (noting RTDs were the only category where all products had a tax decrease; Table 1). Of products with a higher mean price after the tax changes, the difference in means was largest for cider, followed by spirits, then beer. The two-sample KS tests revealed a significant difference between the before and after distributions for cider, with the before distribution having statistically smaller values than the after distribution (D = 0.24, $P = 0.011$). QQ plots and ECDFs are given in Figs. 1 and 2, respectively. The difference in the price per 10 mL alcohol after the tax changes is shown in Appendix 3.

The simultaneous quantile regression analysis is presented in Table 2. The coefficients represent the change in the price per 10 mL of product after the tax changes at the corresponding percentile of the price distribution. For beer, the price per 10 mL of alcohol was significantly higher at the modelled 75th percentile of the distribution, and the price per litre of beer at both the 25th and 50th percentiles increased by £0.25 and at the 75th percentile increased by £0.31. We note that the coefficients for RTDs are negative. The results of the postestimation Wald significance tests comparing the magnitude of change across different percentiles are given in Appendix 4.

Fig. 3 shows the price paid per 10 mL of alcohol before and after the tax changes. For cider, despite some upward movement after the tax changes, the price per 10 mL of alcohol decreases as product strength increases. This suggests that the pricing structure of cider has not moved to a system expected under a volumetric approach to taxation in the very short term, where the price per 10 L of alcohol would increase as product strength increases. The results for the price per litre of product are given in Appendix 5.

Discussion

This study aimed to understand the early impact of the changes to the UK alcohol taxation system introduced in August 2023. We present data on the strength and price of products comparing data from 3 months before the changes (May 2023) to data from 3 months after the changes (October 2023). The analysis included products available for sale in England, taken from the website of the UK's largest supermarket. The advantage of our approach using automated web scraping tools is that analysis can be undertaken quickly, almost in real time; however, this clearly comes at the cost of being a comprehensive study across the entire retail market.

Compared with the previous taxation system for cider, the shift to a volumetric approach theoretically creates a stronger financial incentive for producers to lower the strength of their products and pay less tax. Although this incentive pre-existed for beers and spirits, the recent RPI increases may have strengthened this. We observed a reduction in the mean strength of beer, largely driven by changes in some of the weakest beers around 3.5%ABV, which reduced their %ABV to be within the lower tax band. There was one example of a stronger beer shifting from 8.5%ABV to 8.4%ABV (again putting the product in a lower tax band), but changes in the stronger end of the distribution were not occurring at large scale in

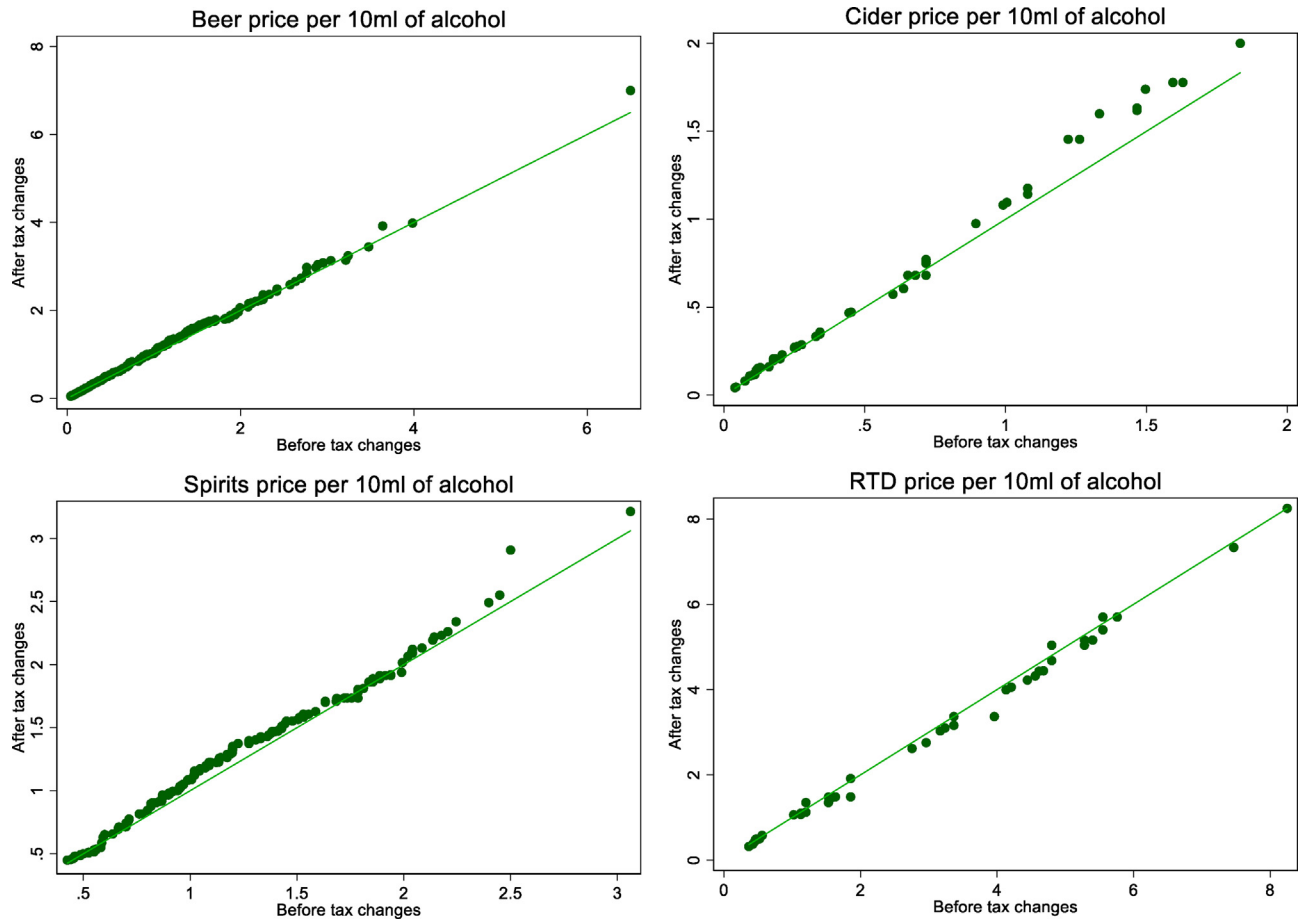

Fig. 1. QQ plots of price per 10 mL of alcohol before and after the new tax system by product type.

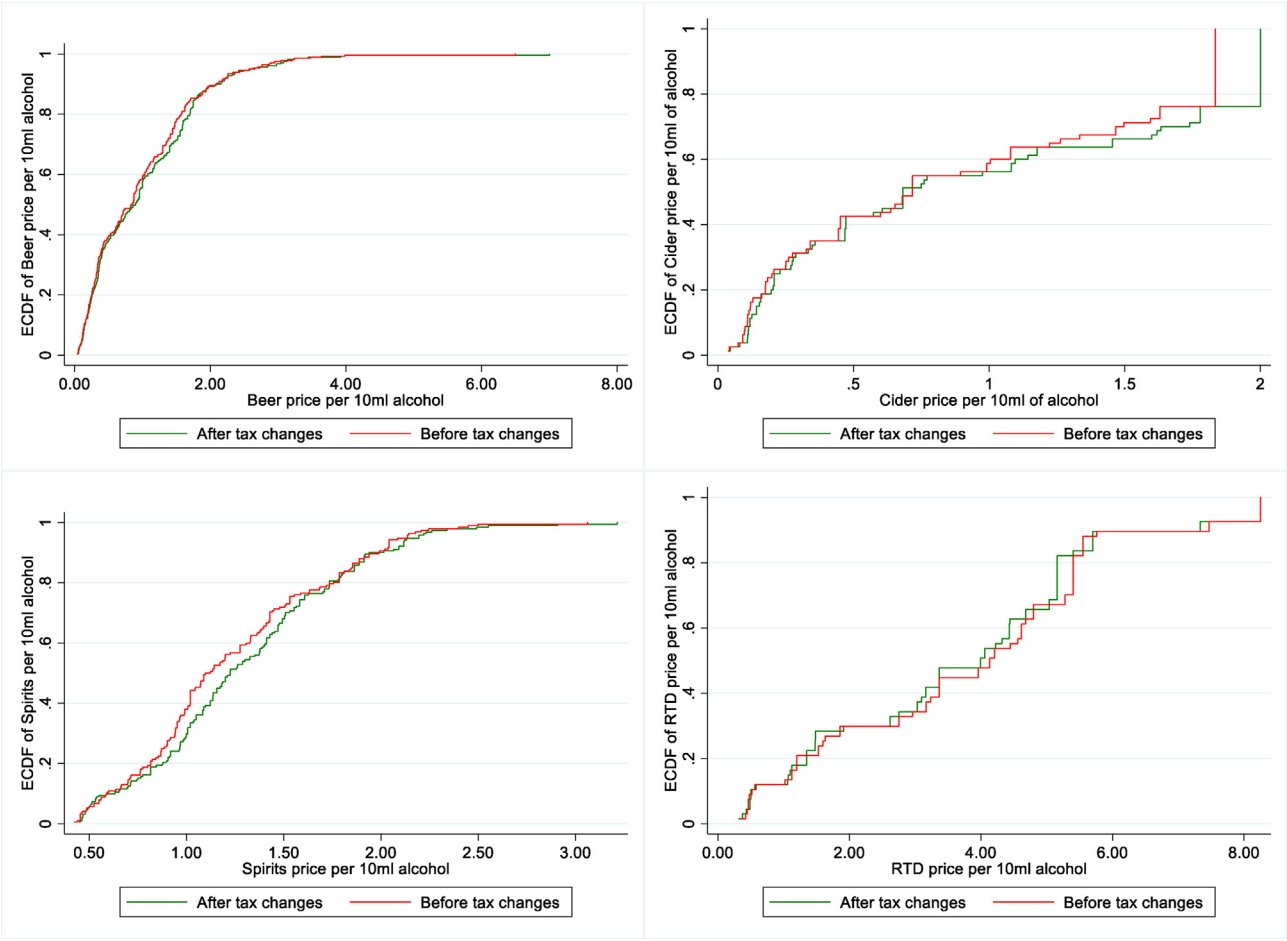

Fig. 2. Empirical cumulative distribution function of price per 10 mL of pure alcohol before and after the tax changes by product type.

Table 2
Results of simultaneous quantile regression.

Product	Percentile	Coefficient	Bootstrap SE	95% CI	T	*P* relating to time
Price per 10 mL of alcohol (pence)						
Beer	25	0.03	0.03	−0.03, 0.10	1.03	0.305
	50	0.06	0.10	−0.15, 0.26	0.54	0.591
	75	**0.15**	**0.06**	**0.02, 0.27**	**2.27**	**0.024**
Cider	25	0.02	0.14	−0.25, 0.27	0.16	0.870
	50	−0.04	0.23	−0.48, 0.01	−0.16	0.874
	75	0.15	0.26	−0.36, 0.64	0.57	0.567
Spirits	25	0.08	0.06	−0.03, 0.19	1.45	0.149
	50	0.10	0.06	−0.02, 0.23	1.61	0.109
	75	0.08	0.88	−0.10, 0.25	0.87	0.385
RTDs	25	−0.12	0.86	−1.83, 1.59	−0.14	0.889
	50	−0.13	0.63	−1.38, 1.10	−0.22	0.827
	75	−0.24	0.27	−0.77, 0.29	−0.90	0.369
Price per litre of product (GBP£)						
Beer	25	**0.25**	**0.05**	**0.16, 0.34**	**5.54**	**<0.001**
	50	**0.25**	**0.04**	**0.17, 0.33**	**6.38**	**<0.001**
	75	**0.31**	**0.15**	**0.02, 0.61**	**2.09**	**0.037**
Cider	25	0.14	0.30	−0.44, 0.73	0.48	0.632
	50	−0.07	0.19	−0.44, 0.31	−0.36	0.722
	75	**0.33**	**8.64**	**0.33, 0.33**	**3.90**	**<0.001**
Spirits	25	0.71	0.90	−1.06, 2.49	0.79	0.430
	50	2.75	2.97	−3.09, 8.59	0.93	0.355
	75	2.14	3.53	−4.80, 9.09	0.61	0.544
RTDs	25	0.00	0.32	−0.64, 0.64	0.00	1.000
	50	−0.20	0.30	−0.79, 0.39	−0.67	0.506
	75	−0.30	0.28	−0.85, 0.25	−1.08	0.283

CI, confidence interval; RTD, ready-to-drinks; SE, standard error.
There were 279 beers, 192 spirits, 80 ciders, and 67 RTDs. Bold values indicate statistical significance at the 0.05 level.

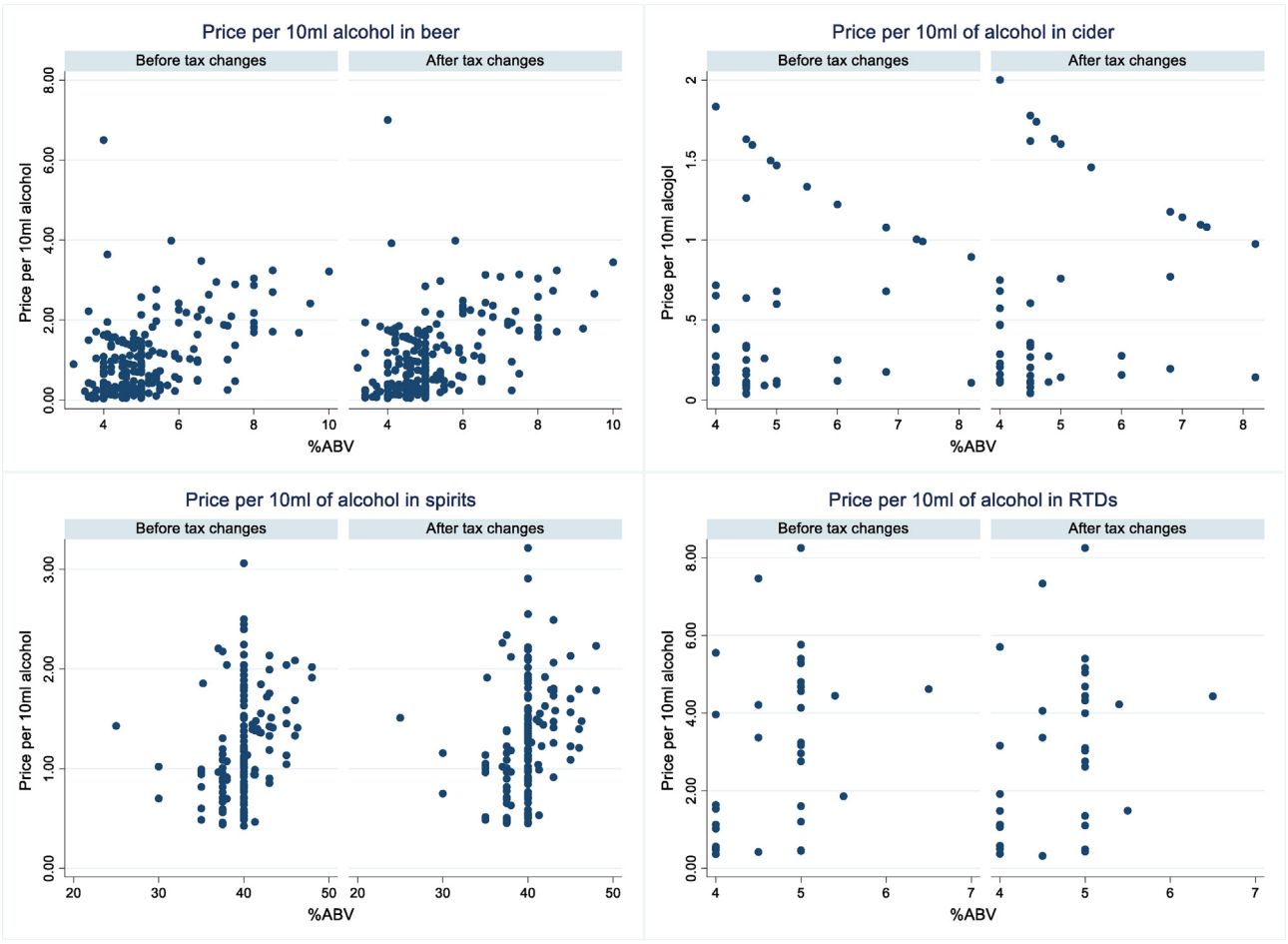

Fig. 3. The price paid per 10 mL of alcohol before and after the tax changes by type of product.

this short window of time our data cover. From a public health perspective, the priority should be to reduce the strength of the strongest products, which are often purchased at low cost and consumed by heavy daily drinkers who are most at risk of alcohol-related harm.[26–28] Our data suggest that tax bands might incentivise reformulation, and designing a tax system that prevents strong cheap alcohols could be a major part of the harm reduction effort. If the upper end of the new tax band (currently 8.5%ABV) were shifted downwards to the previous upper end (7.5%ABV; or even lower), it is possible that this might encourage reformulation of the strongest products and have greater public health potential. More comprehensive research of the entire market, ideally including a longer time frame, is required to fully understand the reformulation of products in relation to the taxation changes. That we saw less reformulation for cider might relate to the fact that under the new system, cider pays roughly half the duty of beer. From an epidemiological perspective, a 5% pint of beer has the equivalent risk of a 5% pint of cider, so there is no clear public health rationale for taxing these products differently. In addition, from a revenue-generating perspective, there is no clear rationale. The impact of moving to a system where cider and beer of the same strength are taxed more similarly should be explored.

We saw significantly higher prices of spirits, beers, and ciders following the tax changes and significantly lower prices of RTDs. That the price of RTDs decreased over the period might suggest that any observed changes in price are not wholly explained by inflation since inflation is unlikely to be drastically different for RTDs compared with other products (notwithstanding some differences in production and distribution costs). However, we accept that other factors, such as one-off annual effects, seasonal patterns, and other influences (such as the cost-of-living crisis), may have influenced our results.

Our data can provide insight into the early impact of changes to alcohol taxation on products and, by using automated web scraping tools, have a major advantage that it can do so in almost real time. Nonetheless, we note several limitations. First, our data are on products not sales. Although it is helpful to understand changes to products, clearly, the public health impact of any changes will most strongly relate to the most purchased and consumed products. Future work should focus on ascertaining the impact of the tax changes on sales/consumption. Second, we only began web scraping in May 2023, three months before the tax changes. Although we collected data on a weekly basis, we lacked sufficient 'pre' data to undertake more complex time series approaches.[29] Since consultation about the tax changes began in 2020 and were implemented in August 2023, our data may have missed changes that occurred between announcement and implementation. For example, we are aware of media reports of products reformulating their strength downward before our data collection began.[30] Our use of linked data also means that newly launched or out-of-stock products and products that changed their serving size would be excluded. Finally, two major changes occurred to the tax system

simultaneously – the move to volumetric taxation and a large increase in tax in line with RPI, and it is difficult to separate the effects of these in our analysis.

Our study provides an empirical and exploratory assessment of the early impact of the changes to the UK's alcohol tax system on the price and strength of products in England over a very short period. Although we did not see wide-scale changes to product strength, we did identify a small number of products, which lowered their strength, mostly occurring among the weakest products. Changes to price are more nuanced but might suggest that, in the very short term, the price per 10 mL of cider decreases with increasing strength, which does not reflect the volumetric approach to taxation. Longer term monitoring is required, with a particular focus on changes in purchasing/consumption.

Author statements

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Ethical approval

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Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2024.04.005.

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