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Alcohol tax pass-through across the product and price range: do retailers treat cheap alcohol differently?

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ABSTRACT

Aims: Effective use of alcohol duty to reduce consumption and harm partly depends on retailers passing duty increases on to consumers via price increases; also known as 'pass-through'. The aim of this analysis is to provide evidence of UK excise duty and sales tax (VAT) pass-through rates for alcohol products, at different price points.

Setting: March 2008 to August 2011, UK

Design and measurement: Panel data quantile regression estimating the effects of three duty changes, two VAT changes and one combined duty and VAT change on UK alcohol prices, using product-level supermarket price data for 254 alcohol products available weekly. Products were analysed in four categories: beers, ciders/ready to drink (RTDs), spirits and wines.

Findings: Within all four categories there exists considerable heterogeneity in the level of duty pass-through for cheaper versus expensive products. Price increases for the cheapest 15 per cent of products fall below duty rises (under-shifting) while products sold above the median price are over-shifted (price increases are higher than duty increases). The level of under-shifting is greatest for beer (0.85 [0.79, 0.92]) and spirits (0.86 [0.83, 0.89]). Under-shifting affects approximately 57% of total beer sales and 30% of total spirits sales.

Conclusions: Our results show lower pass-through of duty increases for cheaper products (lowest 15 percentiles) and over-shifting for expensive products (prices above the median). This is likely to impact negatively on tax policy effectiveness. High risk groups, including heavy drinkers and particularly low income heavy drinkers, favour cheaper alcohol and under-shifting is likely to produce smaller consumption reductions among these groups.

Keywords Alcohol pass-through; alcohol excise duty; alcohol taxation; alcohol tax policy; alcohol prices; quantile regression.

INTRODUCTION

Alcohol misuse and associated disease, injury and death are of great concern for policy makers and health authorities. Globally, alcohol is estimated to be responsible for approximately 4% of deaths and 4.7% of injuries and diseases [1]. Price controls, and particularly taxation in the form of excise duties, have been shown to impact on alcohol consumption and related harm [2, 3].

The effectiveness of excise duty increases in reducing alcohol consumption and harm depends on a number of factors including the price elasticities of alcoholic products and on whether retailers fully pass on duty increases to consumers in the form of increased prices. Drawing on the assumption of tax incidence theory [4, 5], as a baseline case, many studies assume that taxes will be fully passed through to consumers such that a 1% increase in taxation is followed by a 1% increase in the proportion of prices accounted for by tax. However, in practice there could be under-shifting or over-shifting, such that the change in prices following duty changes are, respectively, lower or higher than the expected 1:1 relationship [6].

To date, there are few empirical studies focusing on tax pass-through. Two UK studies investigate tax pass-through of alcoholic products adopting a time series mean regression-based approach using aggregated price data for specific product categories (e.g. average price of a pint of beer) as a dependent variable and changes in excise duty as a covariate [7, 8]. In 2011, Hunt et al. [7] related changes in prices to changes in excise duty for both on- and off-trade products. The average rate at which tax is passed through to consumers within each beverage category varied; with full shifting or over-shifting in the on-trade and substantial under-shifting by large off-trade retailers. Similarly, in 1992, Baker and Brechling [8] employed time series averaged quarterly data to investigate the impact on alcohol (beers,

wines and spirits), tobacco and petrol prices of changes in excise duties. The authors conclude that while wines are over-shifted on average, a hypothesis of full pass-through for beers, spirits and petrol could not be rejected. Two US studies found evidence of duty over-shifting [9, 10], with the rate of over-shift varying by product type, brand and premise type. A Danish study of tax pass-through of both alcohol and non-alcoholic products found over-shifting in the event of tax increases and under-shifting for tax cuts [11]. Finally, a recent UK study found evidence of differential tax pass-through across tobacco products at different price points, with tax under-shifts for lower priced products [12].

In recent UK political debates about the merits of alcohol minimum unit pricing versus taxation, questions have been raised about whether retailers are choosing to absorb, or not fully pass-through, tax increases, in particular for very cheap supermarket alcohol [13]. This issue is crucial for understanding the effect of duty interventions on alcohol-related harm, as heavy drinkers have been shown to buy cheaper alcohol than moderate drinkers [14].

The present work forms a part of a wider alcohol policy research programme where one strand is to estimate the likely effects of different taxation options compared to minimum unit pricing. For this, we needed to develop a detailed understanding of how tax changes impact on prices on all points of the price distribution, for all alcohol beverage types. The work was made possible through collaboration with researchers who had, over several years, collected weekly supermarket price data, including for alcohol. In this article we add to the tax pass-through evidence base by examining whether, within different beverage types, there are differential tax shifting strategies for lower priced versus more expensive alcoholic products. We also estimate the proportion of sales affected by under- and over-shifting.

METHOD

Data

Price and product data

Our product-level panel dataset captures weekly prices for products, including alcohol, sold in major UK supermarkets with products recorded at single item or Stock Keeping Unit (SKU) level. Data is available on weekly price transitions for 254 alcoholic products and these represent every alcoholic product for which prices were available consistently and recorded by the authors from mysupermarket.co.uk, an online UK supermarket price comparison web-site, each week from March 2008 to August 2011 (178 weeks). That time period covers four episodes of excise duty changes, two value added tax (VAT, UK sales tax charged as a percentage of price) changes and one simultaneous change of both duty and VAT. The data cover four major supermarkets; Asda, Ocado (an online retailer in partnership with the grocery chain Waitrose), Sainsbury's and Tesco, and these retailers account for around half of all UK off-trade alcohol sales. They include higher (Ocado), middle (Sainsbury's) and lower (Asda, Tesco) price supermarkets. Each operates national pricing policies, such that prices from one retailer apply across all their UK supermarkets (irrespective of size) and online shops. However, not all products are necessarily available in all of their stores (e.g. due to store size differences).

The following product information was available for analyses: price, size of product (e.g. 4x 500ml), product name and 8 broad and 55 narrow beverage categories. Unit content of each product was calculated using alcohol by volume (ABV) data for the product obtained from internet searches (1 unit=8g/10ml ethanol). For this analysis the data were recoded into 4 categories: beers, ciders/ready-to-drink (RTDs), spirits and wines. This was done to increase the number of products in each category and align more closely with the categories used when applying excise duties. Further, the aggregation of products into four categories controls for noise observed in individual product price changes. Noise is considerable due to

the substantial use of short-run price promotions in UK supermarkets. Cider and RTDs are merged into one category as the alcoholic volume contained within these products are roughly the same [15] and this is also how they are marketed by parts of the industry (e.g. http://www.webcitation.org/6Lf4z8VX4). RTDs are taxed as spirits but as they make up less than 1% of total pure off-trade alcohol sold in the UK (AC Nielsen 2009, http://www.webcitation.org/6Lf5ICbgG), we assume that products falling under the cider/RTDs category are taxed at cider rates.

Sales Volumes

Since our dataset does not capture sales volume, we link price distributions for each of the four beverage categories to data provided by AC Nielsen. This describes the volume of off-trade sales in litres of ethanol in England and Wales across the price distribution of each beverage category.

Tax events

The date and magnitude of the duty events are listed in Table 1 with the taxation method for each beverage provided in the footnote. The duty events are largely increases, correspond to weeks 1, 38, 59, 107 and 159 in the data and are referred to as duty events 0 to 4 hereafter. VAT was reduced from 17.5% to 15% on 1st December 2008 (week 38), increased to 17.5% on 1st January 2010 (week 95) and increased again to 20% on 4th January 2011 (week 147).

<Table 1>

Variables

Let x_i denote the baseline average price per unit of product i, after deducting VAT, calculated over the period from week 1 to week 37. We calculate the expected price per unit of each product i (x_{it}^*) following a duty change at time t where we assume full pass-through by adding an incremental change in pence per unit of product i following duty change at time t (Δ_{it}) to the baseline average unit price (x_i) and then multiply by the VAT rate in the time interval. The calculation is as follows:

$$\begin{cases} x_{it}^* = 1.15(x_i + \Delta_{it=38}), & 38 \le t < 59 \\ x_{it}^* = 1.15(x_i + \Delta_{it=38} + \Delta_{it=59}), & 59 \le t < 95 \\ x_{it}^* = 1.175(x_i + \Delta_{it=38} + \Delta_{it=59}), & 95 \le t < 107 \\ x_{it}^* = 1.175(x_i + \Delta_{it=38} + \Delta_{it=59} + \Delta_{it=107}), & 107 \le t < 147 \\ x_{it}^* = 1.20(x_i + \Delta_{it=38} + \Delta_{it=59} + \Delta_{it=107}), & 147 \le t < 159 \\ x_{it}^* = 1.20(x_i + \Delta_{it=38} + \Delta_{it=59} + \Delta_{it=107} + \Delta_{it=159}), & t \ge 159 \end{cases} \quad (1)$$

For each product in a given category, the parameter Δ_{it} is calculated as the per unit difference between previous duty and current duty. A numerical and pictorial illustration of the evolution of expected and observed unit prices for four example products is shown in Table 2 and Figure 1. The figures demonstrate that retail prices on individual items can be volatile because of promotion pricing with regular prices punctuated by deep temporary price reductions as well as price changes driven by changing demand, cost and competitive conditions.

<<Table 2 >>

<<Figure 1 >>

Panel data quantile regression

In this article, the price data are not treated as a time series in order to exploit the panel structure of the data and allow calculated expected prices of each product to be included as a covariate. To model tax pass-through we instead adopt a quantile panel regression approach [16, 17]. This technique provides flexibility for modelling the entire distribution of the dependent variable given a set of independent variables. Rather than just focusing on the mean, as in classical mean regression, quantile regression focuses on quantiles which refer to defined points in the distribution. For example the 0.5 quantile is the median and 0.1 is the 10^{th} percentile of the distribution. Hence, this methodology provides a framework for investigating differential pass-through for price points (i.e. quantiles) in the price distribution. Further, since quantile regression does not impose assumptions of normality of error terms and constant variance it is superior to the mean regression as it can capture features such as skewness and heterogeneity which are inherently embedded in price data. More detailed explanation of quantile regression is provided in the online supporting material.

Since the period of analysis is relatively short and prices are recorded on a weekly basis, we do not adjust for inflation in our analysis but we include results for inflation-adjusted prices as a sensitivity analysis.

Tax pass-through is estimated in three separate models which progressively disaggregate the tax events such that Model I analyses all events jointly, Model II estimates separate pass-through levels for different types of tax events and Model III estimates pass-through levels for each individual tax event.

Model I

The model is structured such that for each of the four beverage categories observed prices, y_{it}, are regressed on the expected prices, x_{it}^{*}, and the resultant estimated coefficients for each beverage category indicate the magnitude of pass-through at a particular quantile

level. For our analysis we use quantiles $\theta \in \{0.05, 0.15, ..., 0.45, 0.50, 0.55, 0.65,\ldots, 0.95\}$ corresponding to different points of the price distribution.

If tax changes are fully passed through across the price distribution then, for all quantiles, the estimated coefficient of a given category should equal one. If the coefficient is less than or more than one, this corresponds to under-shifting and over-shifting respectively. Mathematical formulation of the model is shown in equation (S1) (supporting material).

Model II

Since the period of analysis captures both separate and simultaneous duty and VAT changes, we further extend Model I to account for (a) duty, (b) VAT and (c) both duty and VAT changes as three separate intervention types. In this way, the output of the model will contain 12 coefficients for each quantile indicating pass-through for all four beverage categories and each of the three tax options. Mathematical formulation of the model is shown in equation (S2) (supporting material).

Model III

This model estimates pass-through for all four beverage categories following each of the tax changes separately giving a total of 24 (6 tax changes and 4 categories) coefficients for each quantile. Mathematical formulation of the model is shown in equation (S3) (supporting material).

RESULTS

Table 3 displays the number of products in each beverage category and the absolute

price per unit over the entire period of analysis (weeks 38 to 178) for the upper bound of each quantile (θ) range. It also shows the proportion of off-trade sales for each beverage category which occur within different bands of the price distribution, where price distribution refers to the range of different unit prices paid for all products falling in one of the four beverage categories. The unit prices of cider/RTDs and spirits are the most dispersed of the four categories with very low prices at the lower end (θ = 0.05: 22 pence per unit) of the price distribution and very high prices (θ = 0.95: 104 pence per unit) at the top end. The price distributions for beers and wines are much more compacted. A large proportion of sales are generated from cheaper products. For instance, 38% of beer sales and 28% of cider/RTDs sales are at prices which are in the bottom 5% of the price distribution. Similarly, for spirits and wines, approximately 31% and 28% of respective sales are generated from products whose prices are in the bottom 15% of the price distribution.

< Table 3>

Beverage-specific pass through estimates for Model I (across all tax events), are shown in Figure 2. For all beverage categories there is over-shifting (i.e. pass-through greater than one) for products in the upper three quartiles of the price distribution. However, for beers, ciders/RTDs and spirits, there is also under-shifting (i.e. pass-through is less than 1) for products at the cheapest end of the price distribution. For beers and ciders/RTDs, under-shifting is seen for the cheapest 5% of products and for spirits under-shifting extends to the cheapest 25% of products. For wines, the hypothesis of under-shifting cannot be rejected at either the 5% or 15% quantile levels. The results suggest tax rises lead to price increases in the cheapest 5% of products which are 15% lower than full pass-through for beer and spirits and 11% lower than full pass-through for cider/RTDs. For all beverage categories, the magnitude of over-shifting increases for higher priced products and over-shifting is particularly pronounced for wine where, for example, the median priced product sees price increases 11% larger than would occur with full pass-through.

Tabulated quantile regression coefficients obtained from fitting this model together with their bootstrapped standard errors are presented in Table S1 (supporting material). All coefficients in the model are significant to at least 1% significance level.

<Figure 2 >

Model II estimates separate pass-through rates for duty, VAT and simultaneous duty and VAT events. Results of this model are presented in Figure S1 and Table S2 (supporting material). The results show that estimates for duty-specific and VAT-specific events closely resemble those for the aggregate pass-through in Model I; with spirits followed by beers and ciders/RTDs having the most pronounced under-shifting and wines being the most over-shifted category. For simultaneous VAT and duty events, over-shifting appears to begin higher in the price distribution than in the aggregate model.

Model III estimates pass-through rates for each duty and VAT change separately and results are shown in Figure S2 (supporting material). The same pattern of under-shifting low-priced products and over-shifting high-priced products is seen across all tax events; however, the magnitude of these effects varies across events. There is more over-shifting and less under-shifting in later tax events, suggesting variation is related to temporal processes rather than the size of tax increases.

Volume of sales

In order to examine the proportion of total sales affected by under- and over-shifting, we employ off-trade sales volume data and pricing obtained from AC Nielsen for England and Wales for year 2009. The data capture sales volumes (in litres of pure alcohol) across price per unit distributions of all four beverage categories in our analysis.

The AC Nielsen data on sales volumes across the price distribution allow estimation of the proportion of products sold which are under-shifted and over-shifted. Linking the calculated pass-through values (Figure 2, Table S1) together with price and sales volumes presented in Table 3, it follows that, approximately 68% of beer sales are for under-shifted products and these are sold for less than 40p per unit. The proportion of products under-shifted is smaller but still substantial for spirits (38%) and cider/RTDs (30%).

For beers, approximately 17% of sales are generated from over-shifted products sold above 50p per unit and 15% of sales are from full pass-through products sold at 40p to 50p. For ciders/RTDs 65% of sales are from over-shifted products (>26p per unit) with about 5% of sales fully shifted (22p to 26p). For spirits, approximately 45% of the sales are generated from over-shifted products (>39p per unit) and 17% from fully passed-through products. Wines are the most over-shifted category with over 70% of total sales generated from over-shifted products and 28% from under-shifted products (<37p per unit) although the hypothesis of full pass-through cannot be rejected for these products.

Sensitivity analysis

We undertook a number of sensitivity analyses which (1) control for alcohol content by including ABV measure of each product as an explanatory variable, (2) focus on duty-specific pass-through by deducting VAT from all prices, (3) adjust prices for inflation using the all-item monthly retail price index smoothed into a weekly index, (4) investigate the influence of large temporary price promotions on pass-through by 'adjusting' large price discounts, and (5) fits Model I to different quarters to account for seasonality. Methodological detail and results for these sensitivity analyses alongside information on which of Models I to III they were applied to are presented in Figures S3 to S9 and Tables

S3 and S4 (supporting material). In all cases, the findings do not substantively affect our conclusions from the base case analyses.

DISCUSSION

This study provides the most in-depth investigation to date of UK retailers' pricing strategies following alcohol tax changes. Using a panel data quantile regression of weekly pricing data from major supermarkets, we estimate pass-through of excise duty and sales tax on alcoholic products sold at different price points. Further, we used sales volumes at different intervals of the price distribution to indicate the proportion of sales of each beverage type which are under-shifted, fully passed through or over-shifted.

We find evidence of significant heterogeneity in tax pass-through across the price distribution. In particular, we observe a clear contrast in pass-through for cheap versus expensive products, with the former being under-shifted and the latter over-shifted. Duty pass-through ranges from 78% (lower priced beers) to 124% (higher priced cider/RTDs). This differential pass-through is visible to varying degrees across all beverage categories and appears to persist for different magnitudes of duty change. In terms of sales volumes, approximately two-thirds of beers and one third of ciders/RTDs and spirits are under-shifted while one-sixth of beers, two-thirds of wines and ciders/RTDS and over half of spirits are over-shifted. By comparing pass-through for a series of tax changes, our results indicate that retailers may not always apply the same approach and other factors, such as previous pass-through, wider economic conditions or prices of other products, may be influencing decisions on the magnitude of pass-through. Beers were under-shifted to the greatest degree and this may reflect retailers attempting to mitigate the impact of tax increases on a key product category for promotional activity and pricing competition. In contrast, under-shifting of wines was less common, potentially reflecting retailers' ability to conceal price

increases as customers tend to buy different wines at a particular price point rather than being loyal to specific brands.

The main strengths of the paper lie in the use of quantile regression together with a longitudinal panel of product-level price transitions which permits a comprehensive understanding of pass-through for different parts of the price distribution. We also link price point-specific pass-through estimates to sales volumes which allows quantification of the proportion of products being under- or over-shifted. An important limitation is our data only cover four of the UK's major supermarkets who account for approximately half of UK off-trade alcohol sales (http://www.webcitation.org/6Lf5ICbgG). We have no data on the UK's 4th largest supermarket chain, Morrison's, budget supermarket chains such as Aldi and Lidl and other, often independent, off-trade retailers. The latter in particular sell fewer products and have less bargaining power with their supply chain than major supermarkets and, therefore, may have less scope for avoiding full pass-through. As our sales volume data do capture a wider sample of shops and supermarkets, the derived price/sales distributions are not a perfect match for our estimates of pass-through.

It is difficult to compare our results with previous analyses which have not estimated pass-through across the price distribution. However, the magnitude of our calculated pass-through values are comparable to those of Baker and Bechling [8] in which beer and wine were found to be over-shifted and spirits under-shifted. Similarly, our results capture specific products pass-through estimates presented by Hunt et al. [7].

Our results show tax increases do lead to price increases across the price distribution and thus support evidence that duty increases are effective in reducing consumption [2]; however, additional measures may be required to ensure such policies are well-targeted. Heavier drinkers and particularly heavy drinkers with lower incomes are at greatest risk of harm from their drinking and tend to purchase cheaper alcohol [18]. As duty increases are not fully passed through to cheaper products, additional price-based interventions such as

minimum pricing or restrictions on promotional offers may restrict retailers' capacities to engage in price competition on low-cost alcohol. In turn, this may afford policymakers greater influence over the full price distribution and particularly the lower end which is associated with harmful drinking.

Beneficial extensions to this work may include investigating the role of other factors such as package sizes, differential tactics between retailers' own brands and major brands, differential strategies between retailers and cross-product pass-through such that wine duty increases are passed onto beer products. Further data allowing examination of whether price increases on non-alcoholic products subsidise under-shifting would also be valuable. These analyses would all require a larger dataset covering a wider range of products.

Conclusion

The effectiveness of employing alcohol taxation as a tool for controlling alcohol consumption is well documented in the literature. However, from a public health perspective, the success of this intervention relies heavily on the pass-through of duty from retailers to consumers in the form of increased prices. Our findings demonstrate that, across four beverage categories, tax increases lead to lower than expected price increases for cheaper products and higher than expected price increases for more expensive products. In order to off-set the under-shifting of cheaper products a duty rise could be implemented in conjunction with other interventions, such as minimum unit pricing. This may maximise public health benefits by ensuring greater effects on the alcohol disproportionately purchased by high risk drinkers.

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Supporting information

Additional Supporting Information may be found in the online version of this article.

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Table 1 Changes in UK alcohol excise duty between March 2008 and March 2011

Event	Mar 08	Dec 08			Apr 09			Mar 10			Mar 11		
Category	Duty	Duty	ΔDuty	%Δ	Duty	ΔDuty	%Δ	Duty	ΔDuty	%Δ	Duty	ΔDuty	%Δ
Beers[a]	14.96	16.15	1.19	+7.95	16.47	0.32	+1.98	17.32	0.85	+5.16	18.57	1.25	+7.22
Ciders[b]	28.9	31.21	2.31	+7.99	31.83	0.62	+1.99	36.01	4.18	+13.13	35.87	-0.14	-0.39
Ciders[c]	43.37	46.83	3.46	+7.99	47.77	0.94	+2.01	54.04	6.27	+13.13	53.84	-0.2	-0.37
Spirits[d]	21.35	22.2	0.85	+3.98	22.64	0.44	+1.98	23.8	1.16	+5.12	25.52	1.72	+7.23
Wines[e]	194.8	209.82	15.54	+8.00	214.02	4.2	+2.00	225	10.98	+5.13	241.23	16.23	+7.21
Wines[f]	259.2	279.74	20.72	+8.00	285.33	5.59	+2.00	299.97	14.64	+5.13	321.61	21.64	+7.21

[a] £ per hectolitre per cent of alcohol. The UK high and low strength beer duty bands were introduced in October 2011 so beer is modelled as a single duty band here.
[b] Ciders/RTDs ≤ 7.5% abv - £ per hectolitre of product.
[c] Ciders/RTDs > 7.5% abv - £ per hectolitre of product.
[d] £ per litre of pure alcohol.
[e] Wines ≤ 15% abv - £ per hectolitre of product.
[f] Wines > 15% abv - £ per hectolitre of product.

Table 2 Illustration of tax difference calculation Δ_{it} using four example products

	Beer	Cider/RTDs	Spirits	Wine
	4 ×568ml	4 ×275ml	500ml	750ml
ABV (%)	5	5	35	13.5
Units	11.36	5.5	17.5	10.13
Base prices x_i (pence per unit)	43.57	66.08	79.49	44.38
$\Delta_{it,E_{1\leq t<E_2}}$	1.19	0.46	0.85	1.15
x_{it}^* (post VAT and duty)	51.47	76.52	92.39	52.36
$\Delta_{it,E_{2\leq t<E_3}}$	0.32	0.12	0.44	0.31
x_{it}^* (post duty)	51.84	76.66	92.90	52.72
x_{it}^* (post VAT)	52.97	78.33	94.92	53.86
$\Delta_{it,E_{3\leq t<E_4}}$	0.85	0.84	1.16	0.81
x_{it}^* (post duty)	53.97	79.31	96.28	54.81
x_{it}^* (post VAT)	55.12	81.00	98.33	55.98
$\Delta_{it,\geq E_4}$	1.25	-0.03	1.72	1.2
x_{it}^* (post duty)	56.62	80.96	100.39	57.42

Note that $\Delta_{it,E_{1\leq t<E_2}}$denotes the expected duty change (pence per unit) of product i following event 1 until the week before event 2. For instance, the table shows that following event 1 the expected duty change of 4 X 568ml of beer with ABV 5% is 1.19 pence per unit and thus for all time periods up until the week before event 2 this product will have an expected unit price of 51.47p [1.15 (43.57 + 1.19)]. Similarly, following duty event 2 the expected price will increase by 0.32p to 51.84p [1.15 (43.57 + 1.19 + 0.32)]. In between duty events 2 and 3 there is a VAT change from 15% to 17.5% and thus the expected price in this interval is 52.97p [1.175 (43.57 + 1.19 + 0.32)] and following the third event the expected price is 53.97p [1.175 (43.57 + 1.19 + 0.32 + 0.85)]. Before the fourth event, VAT is increased from 17.5% to 20% and thus expected price in this period is 55.12p [1.20 (43.57+1.19+0.32+0.85)]. Finally, following the fourth duty event the expected price is 56.6p [1.20 (43.57 + 1.19 + 0.32 + 0.85 + 1.25)]. Note that, between two consecutive events the expected price of each product is constant.

Table 3 Quantiles of prices (pence per unit)

Quantile price band[1]	Beers		Ciders/RTDs		Spirits		Wines	
	Price per unit (pence)[2]	% sold in price band[3]	Price per unit (pence)	% sold in price band	Price per unit (pence)	% sold in price band	Price per unit (pence)	% sold in price band
$\theta \leq 0.05$	36	38.07	22	28.22	29	16.27	31	9.48
$0.05 < \theta \leq 0.15$	45	29.16	26	5.77	34	15.2	37	18.71
$0.15 < \theta \leq 0.25$	50	13.82	31	6.39	39	16.4	41	13.11
$0.25 < \theta \leq 0.35$	53	6.66	52	28.21	47	22.68	46	15.6
$0.35 < \theta \leq 0.45$	57	4.82	64	3.32	53	9.00	49	12.28
$0.45 < \theta \leq 0.50$	59	0.67	72	3.45	57	0.40	50	1.16
$0.50 < \theta \leq 0.55$	61	1.72	76	2.00	60	0.39	53	7.49
$0.55 < \theta \leq 0.65$	64	0.79	85	4.15	71	2.80	59	6.61
$0.65 < \theta \leq 0.75$	67	0.73	87	0.69	80	2.26	64	4.32
$0.75 < \theta \leq 0.85$	71	0.88	91	2.03	92	2.97	74	4.39
$0.85 < \theta \leq 0.95$	82	2.49	104	6.22	109	4.32	85	5.09
$\theta > 0.95$	N/A[4]	0.19	N/A	9.53	N/A	7.32	N/A	1.76
Number of Products	70		39		103		42	

[1] Price distribution for a specific category captures the unit prices of all products falling within the category.
[2] Price per unit refers to the upper bound of each quantile price band.
[3] The AC Nielsen data is publicly available from http://www.webcitation.org/6N9wCH3vU where for 2009 the total sales volume, (million litres of pure alcohol) are 76.00 (beers), 9.43 (ciders/RTDs), 60.58 (spirits) and 22.50 (wines).
[4] Since the price per unit (pence) are calculated for upper bound quantiles (0.05, 0.15, …,0.95) N/A denotes not applicable.

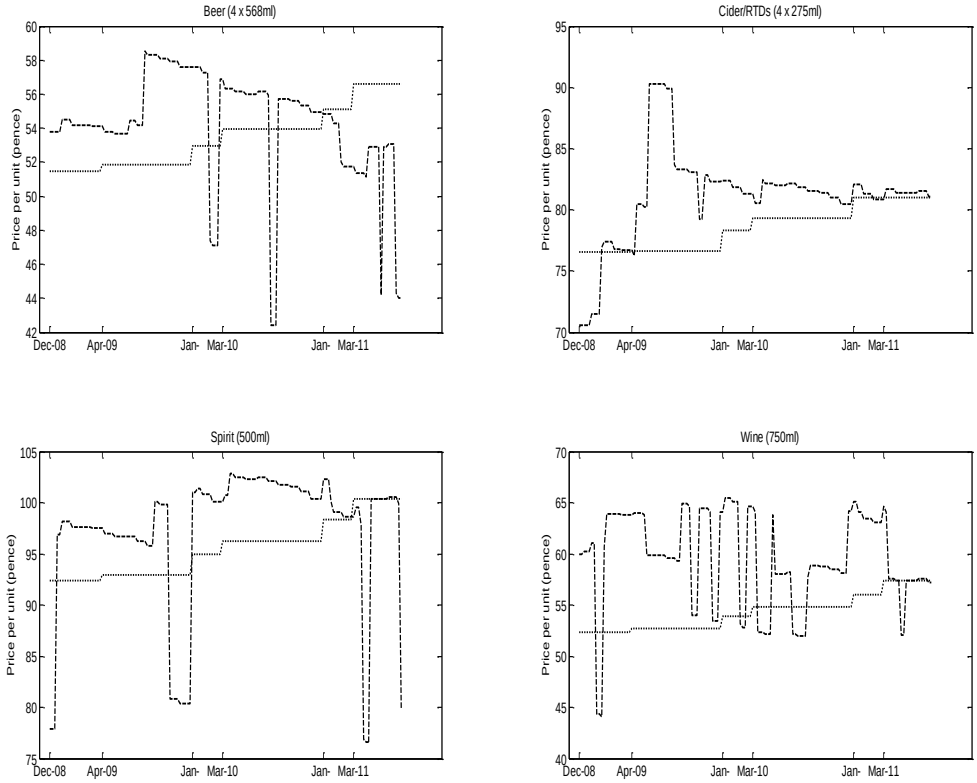

Figure 1 Expected prices illustration, expected (dotted) observed (dashed).

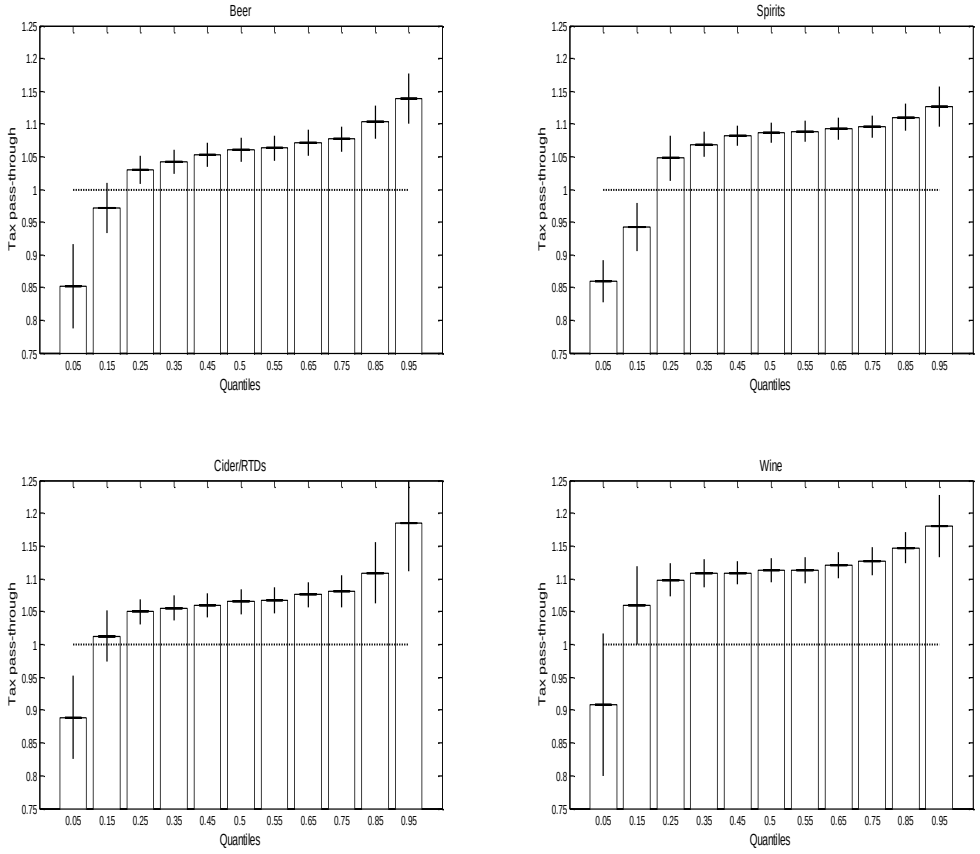

Figure 2 Model I - duty and VAT inclusive tax pass-through together with 95% confidence intervals.

Model I estimates aggregate pass-through across all tax events (duty, VAT and a combination of duty and VAT). This model can be viewed as a benchmark of expected pass-through following either duty, VAT or a combination of the two.

Price distribution for a specific category captures the unit prices of all products falling within the category.