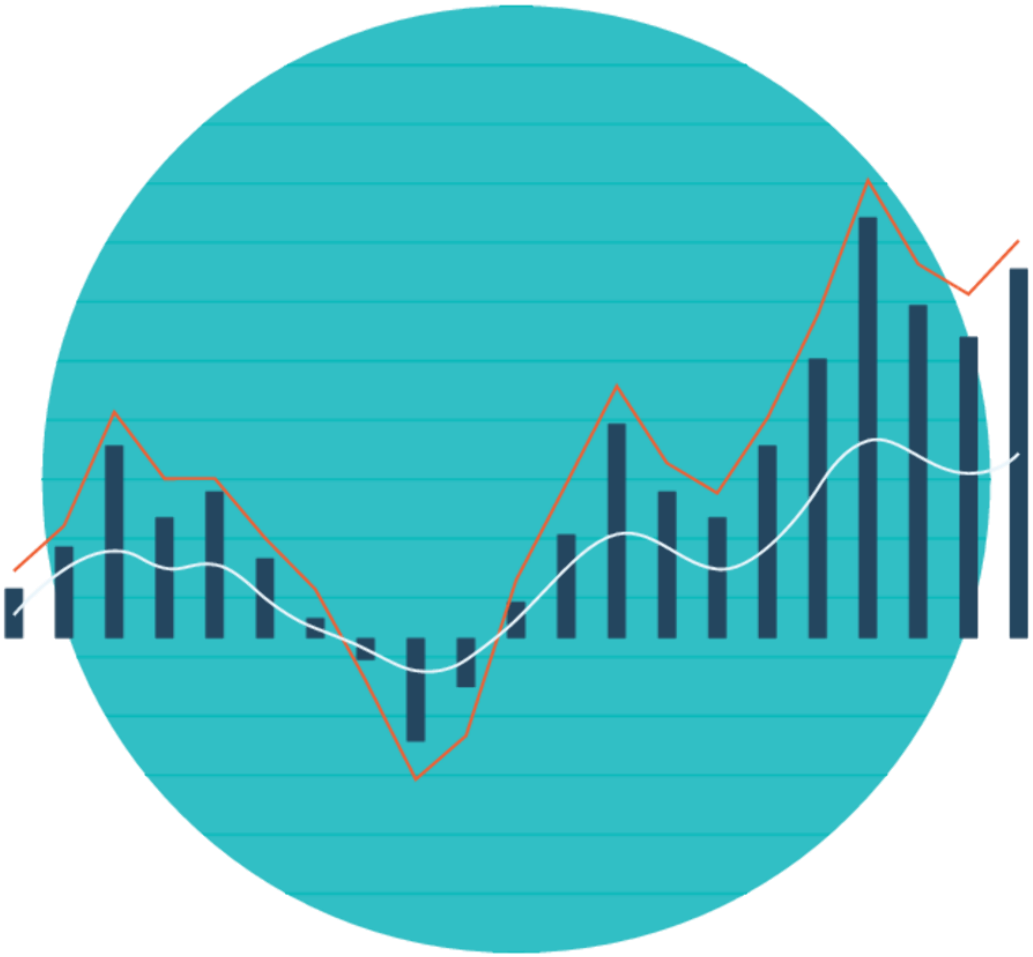
Deloitte.



Sin Tax Analysis: Alcohol

Estimation of price elasticities of demand for alcohol in the United Kingdom

David Whitaker
Deloitte LLP
August 2019

Abstract

Pressures on the NHS, demographic changes, further declines in North Sea oil and gas production, a social care system under strain, local councils needing financing support, calls to remedy the intergenerational divide. All these developments have in one thing in common—a likely need to raise more tax in future.

Governments of all political hues have always relied on so-called "sin taxes"—taxes on items with addictive or pollutive properties such as tobacco and alcohol—in order to both discourage consumption and raise more tax revenue. But there are now considerable policy challenges for these taxes which may significantly restrict their ability to raise more revenue in future. Lifestyle changes, manifested in falling smoking and drinking rates and the greater popularity of e-cigarettes, indicate that households have become more responsive to price rises and higher duties.

To provide evidence on whether households have become more responsive to price rises, this paper estimates the size of own and cross-price elasticities associated with the consumption of alcoholic beverages in the UK, building on previous work by Her Majesty's Revenue and Customs (HMRC). To estimate these elasticities, data from the Living Costs and Food Survey (LCF) from 2012 to 2016-17 has been used in conjunction with sample selection methods, in order to accommodate the large number of households who do not reporting consuming any alcohol.

In this study, new information available on the precise volumes of alcohol purchased through both the on-trade (e.g. bars and pubs) and off-trade (e.g. supermarkets) is exploited to estimate the income, own and cross-price elasticities of demand for alcohol. Elasticities are estimated for the four major categories of alcohol: beer, cider, wine and spirits. The income and own-price elasticity estimates for alcohol are found to be negative and statistically significant. The results are found to be stable when different model specifications and price estimation methodologies are applied.

The resulting elasticity estimates are in some cases higher than those from previous HMRC analysis, such as for wine and beer, indicating that households have become more responsive to price changes and suggesting that the revenue-raising potency of Alcohol Duty may have fallen.

Executive Summary

- Alcohol Duty has long provided a stable and growing source of revenues for governments of all hues and persuasions, and accrued £11.6 billion for the Exchequer in 2017-18. It's easy to see why—compared to other items, drinkers are more reluctant to cut back even when faced with higher prices. A substantial tax on alcohol also has the clear rationale of funding the spending needed to treat drinking-related illnesses and other associated costs to society.

- Recent trends show that drinking levels have fallen, both in the UK and across the OECD more generally. In 2005 the Office for National Statistical (ONS) estimate that 64% of adults aged 16 or over drank alcohol; as of 2017, this has fallen slightly to 57% of adults. There has also been a shift towards the purchase of alcohol in shops rather than in bars and pubs: Deloitte analysis also shows that the real expenditure per head on alcohol bought in shops and outlets in 2017 was around 50% higher than in 1988, despite a 19% rise in the adult population over the past thirty years.

- The composition of the alcohol market in the UK has also shown marked changes over the past twenty years, with a shift away from beer and towards wines and spirits. Clearance data from Her Majesty's Revenue and Customs (HMRC) show that while beer volumes were down 15% in 2017-18 compared to the level in 1999-00, spirits, wine and cider volumes were all up by 30%, 30% and 16% respectively. Over the same period, beer the share of Alcohol Duty contributed by beer has fallen from 44% to 30%.

- Governments of all persuasion and colours have increased Alcohol Duty to raise more revenue. Persistent above-inflation increases in duties, particularly on wine, have consequently led to the UK levying one of the highest tax burdens on alcohol among OECD countries. The current duty rate levied on a standard bottle of table wine is around 32% higher in real terms than the rate set in 1995. The latest OECD Consumption Tax Trends data show that the UK levies one of the highest overall tax burdens on alcohol in 2018, particularly on beer and wine.

- However, despite the expectation that duties will continue to rise, there are signs that Alcohol Duty may not offer the same level of potency in revenue-raising as in previous years. Beer, Spirits and Cider Duties are frozen in 2019-20, but are expected to increase at least in line with the Retail Price Index (RPI) thereafter. Even then, the Office for Budget Responsibility (OBR) forecast that real Alcohol Duty revenues will only grow slightly over the next five years—from £12.1 billion in 2019-20 to £12.9 billion in 2023-24.

- New Deloitte research using detailed and extensive ONS household data indicates that the responsiveness of households to prices is likely to have increased compared to previous HMRC estimates, and be a possible underlying cause for why Alcohol Duty cannot be expected to raise as much additional revenue in future. Household consumption is found to be particularly responsive to price increases for spirits sold in bars and pubs, as well as beer and cider sold for consumption at home.

- In one sense Alcohol Duty is likely to have helped achieve a policy objective in getting people to drink less while raising billions for the Exchequer, but the findings suggest that it's unlikely that a large amount of additional revenue can be raised from this source in future. So the question is—where does the Chancellor of the Exchequer turn now for the higher revenue that will be needed for long-term health and social care?

1. Background

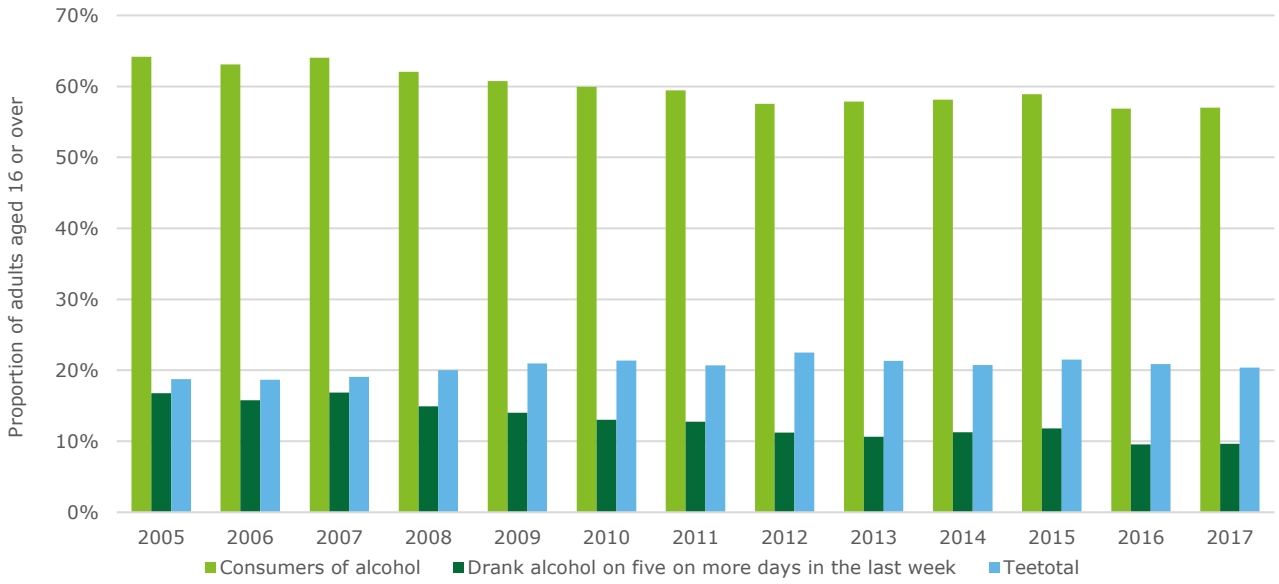
Alcohol Duties raised a total of £12.1 billion of revenues in 2017-18, or approximately 1.7% of the UK total tax and National Insurance Contributions (NICs); this contribution exceeded the revenue accrued from Tobacco Duty (£8.8 billion), Insurance Premium Tax (£5.9 billion) and Vehicle Excise Duty (£6.4 billion). The combination of household demand for alcohol products and the duties levied on these products thus results in a sizeable contribution to the UK Exchequer.

The market for alcohol can be disaggregated into 'on-trade' and 'off-trade'. The on-trade relates to the alcohol consumed on licensed premises, such as pubs, bars and restaurants. The off-trade refers to alcohol consumed off-premises, such as alcohol bought in shops to then be consumed at home. The objective of this study is to estimate the demand for alcohol consumed through both channels; in particular, it seeks to assess whether the responsiveness of households to price changes has increased in recent years when results are compared to previous HMRC studies.

1.1 Recent trends in alcohol consumption in the UK

The latest Office for National Statistics (ONS) Adult Drinking Habits in the UK publication[1] provides some insight into recent trends in alcohol consumption. Figure 1 below shows trends in three indicators over the period 2005 to 2017: the proportions of adults aged 16 and over who reported drank alcohol in the last week; the proportion reporting that they drank alcohol on five or more days in the last week; and those reporting that they do not drink alcohol at all (tee-total).

Figure 1: Recent trends in reported alcohol consumption, frequent alcohol consumption and teetotalism among adults aged 16 and over in Great Britain



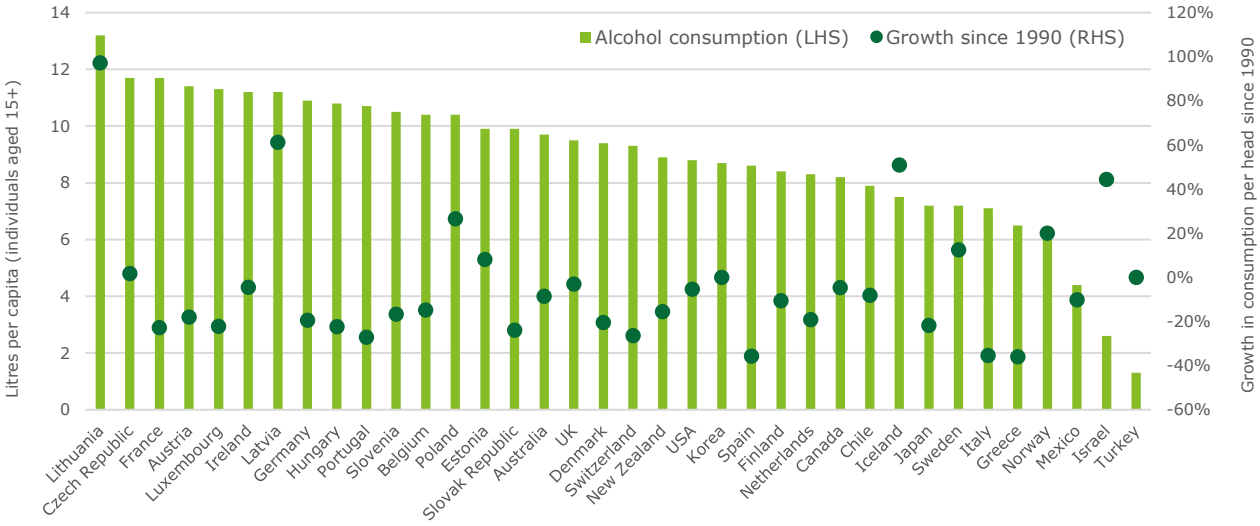
Note: Estimates in 2005 are based on a fiscal year rather than a calendar year. Source: ONS, Deloitte analysis

The proportion of adults reporting some recent alcohol consumption has declined slightly since 2005, falling from 64% to 57%; over the same period, the proportion of adults who do not drink rose slightly from 19% to 20%. The survey time series does however indicate a clear downward trend in the share of adults drinking frequently: this share fell from 17% to 10% over the period.

[1] ONS (2019). Adult Drinking habits in the UK: 2017. https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/drugusealcoholandsmoking/datasets/adultdrinkinghabits

The slight decline in UK alcohol consumption is consistent with consumption across the OECD. Figure 2 below shows alcohol consumption in OECD countries in 2016 expressed as litres of pure alcohol consumed per adult aged 15 or over.[2] In 2016, the average UK adult consumed 9.5 litres of alcohol, just above the OECD average of 8.9 litres. UK consumption per head declined by 3.1% between 1990 and 2016, close to the OECD average of -3.6%.

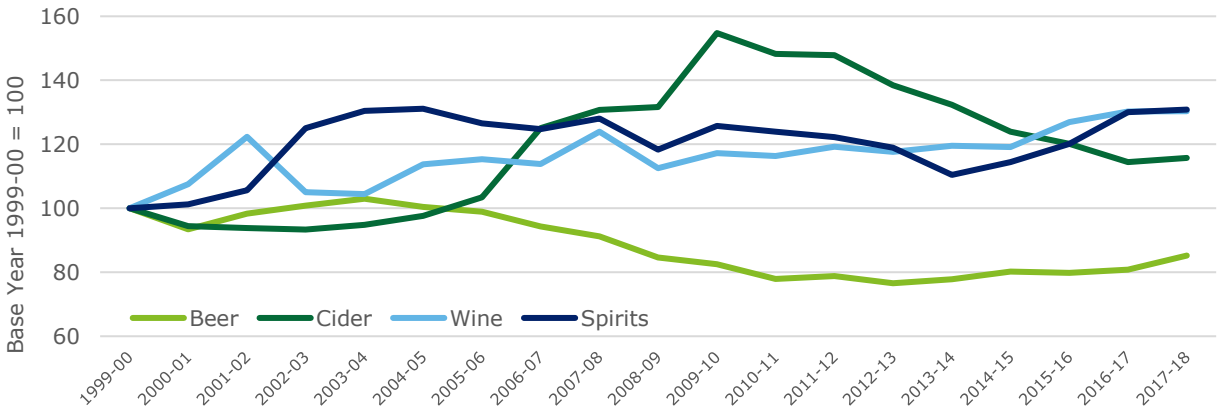
Figure 2: Alcohol consumption among OECD countries in 2016



Note: Estimates for 2015 shown if 2016 data unavailable. Source: OECD, Deloitte analysis

Trends in alcohol consumption are also reflected in clearance data: clearances are alcohol volumes that have been certified as UK Duty Paid (UKDP), enabling products to be released for consumption after duty has been paid to HMRC. Figure 3 below shows recent trends in clearances of the main categories of alcohol products: beer, cider, wine and spirits. There are some marked differences in clearance trends across the different alcohol categories. Beer clearances were in steady decline between 2003-04 and 2011-12, but have recovered slightly since then; however, clearances in 2017-18 were still around 15% lower than in 1999-00. By contrast, spirits and wine clearances have increased by around 30% since 1999-00.

Figure 3: Indexed HMRC alcohol clearances, base year 1999-00



Source: HMRC, Deloitte analysis

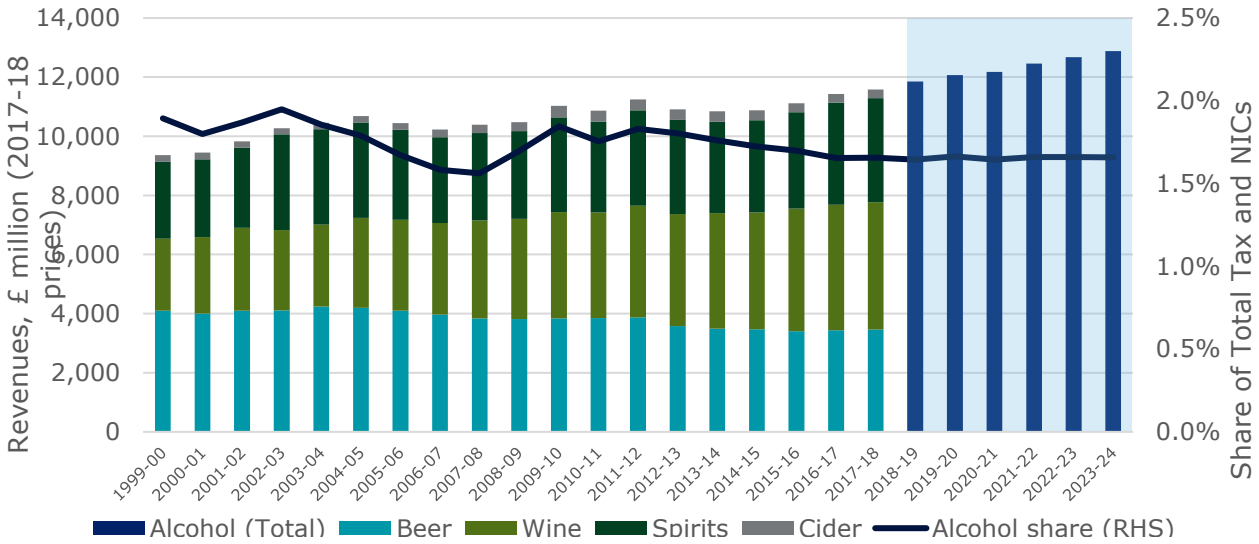
[2] OECD (2019). Non-Medical Determinants of Health: Alcohol consumption. http://stats.oecd.org/wbos/fileview2.aspx?IDFile=17d36de2-b4ae-409a-9968-a27c7f2857e4

1.2 Trends in Alcohol Duty rates and revenues

Alcohol Duty is an excise tax levied in the UK on beverages with alcoholic content, and comprises individual duties on beer, cider and perry, wine of fresh grape, made wine, and spirits. Duties does not depend on whether alcohol is sold in the on-trade or the off-trade, but the duty regimes do have different structures: Beer Duty is levied on the strength of products in terms of alcohol by volume (ABV); Cider Duty and Wine Duty is levied on the volume of product; and Spirits Duty is levied on the volume of pure alcohol. In addition, different rates apply within the different categories; in the case of beer, wine and cider, these relate to different alcohol strength bands, and different rates also apply within Beer Duty for different bands of overall volume produced.

Alcohol Duties have provided a consistent source of tax revenue for the Exchequer, both through the duties raised in themselves, and the Value-Added Tax (VAT) raised on top of the underlying price of products and duties applied. In 2017-18, Alcohol Duty revenues totalled £12.1 billion, or approximately 1.7% of the UK total tax and National Insurance Contributions (NICs); revenues are expected to continue to rise when expressed in real terms and as a share of total revenue. Figure 4 below shows historical trends in accrued Alcohol Duty revenues, with these revenues then expressed as a share of total tax and NICs. At Spring Statement 2019[3], the Office for Budget Responsibility (OBR) forecast for that revenues in real terms (in 2017-18 prices) will increase to around £12.9 billion by 2023-24, with the tax revenue share remaining steady at 1.7%.

Figure 4: Historical and forecasted trends in accrued Alcohol Duty revenues (£ million, 2017-18 prices, LHS), and expressed as a share of total tax and NICs (RHS)



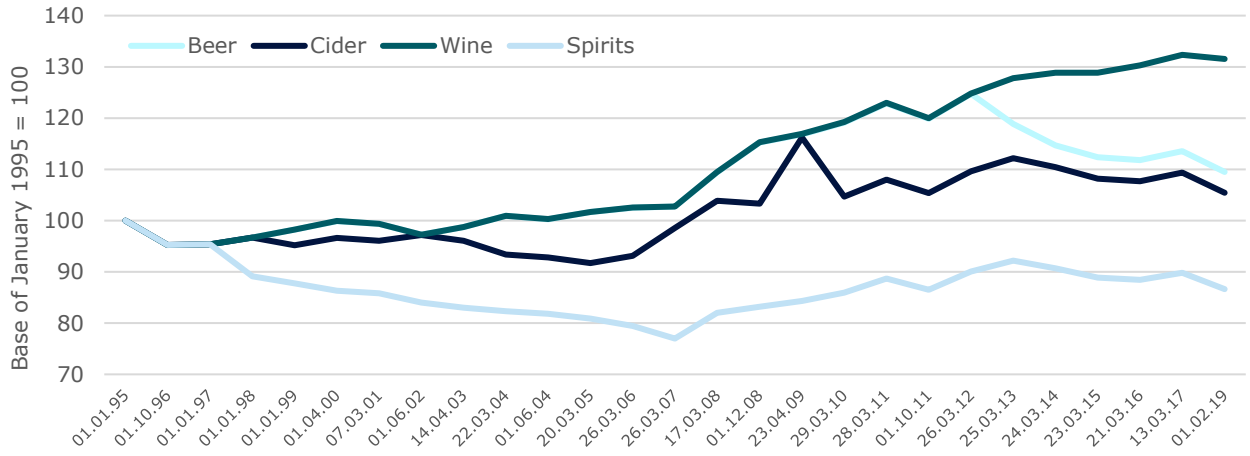
Note: ONS series MF6V and GCSU; shaded area indicates forecast period. Source: HMRC, OBR, ONS, Deloitte analysis.

While there has been a steady increase in real Alcohol Duty revenues, trends in duty rates have varied over time, with a considerably heavier duty burden imposed on wine and a falling burden on spirits. Figure 5 overleaf shows indexed real duty rates since January 1995, adjusted for inflation using 2017-18 prices, using the harmonised Spirits Duty rate and the more commonly applied rates for Beer, Cider and Wine.[4] The main Beer Duty and Cider Duty rates set on 1st February 2019 are around 9% and 5% higher respectively than in January 1995. In contrast, Spirits Duty is now around 13% lower after inflation across the same period.

[3] OBR (2018). Economic and fiscal outlook—March 2019. http://obr.uk/efo/economic-fiscal-outlook-march-2019/

[4] In Figure 3, the Beer Duty rate shown is the General Beer Duty Rate; the Cider Duty rate shown is the rate applying to those products with an ABV exceeding 1.2% but less than 6.9%; the Wine Duty rate shown is the rate applying to Still Wine with an ABV of over 5.5% and up to 15.5%.

Figure 5: Indexed selected real duty rates for Beer, Cider, Wine and Spirits, base year 1995



Source: ONS, HMRC, OBR, Deloitte analysis

The OECD compares the tax burden levied on alcohol and other excise products as part of its Consumption Tax Trends publication;[5] this publication provides a comparison of the different overall levels of taxation imposed across different general categories of alcoholic beverages across all OECD countries. Table 1 below shows duty rates in 2018 for a selection of countries and expressed in US dollars to enable a comparison. The UK imposes a relatively high tax burden across beer, wine and spirits in comparison to countries such as France, Germany and Italy.

Table 1: Taxation of alcoholic beverages for selected OECD countries in 2018, expressed in US dollars

Category	**Beer**	**Wine**	**Spirits**	**Value-Added Tax (VAT) rate**
Excise Tax by measure	**Per hectolitre per % Alcohol by Volume**	**Per hectolitre of product**	**Per hectolitre of absolute alcohol**	
Austria	5.62	0.00	1,348.31	20.0%
Belgium	5.63	84.17	3,362.69	21.0%
Czech Republic	3.42	0.00	1,218.47	21.0%
Denmark	8.49	175.91	2,272.73	25.0%
Finland	39.94	430.34	5,376.40	24.0%
France	8.34	4.25	1,956.22	20.0%
Germany	2.21	0.00	1,464.04	19.0%
Ireland	25.34	477.35	4,783.15	23.0%
Israel	64.17	0.00	2,340.00	17.0%
Italy	8.48	0.00	1,160.13	22.0%
Luxembourg	2.22	0.00	1,169.83	17.0%
Sweden	23.63	-	6,031.46	25.0%
United Kingdom	24.46	370.06	3,684.62	20.0%
United States	-	47.00	995.00	-

Note: Beer Duty rates reflect specific excise rates; Wine Duty rates reflect excises rates on regular-strength Still Wine; Spirits Duty rates reflect duties on all other alcoholic beverages. Source: OECD, Deloitte analysis

[5] OECD (2018). Consumption Tax Trends 2018. http://www.oecd.org/tax/consumption-tax-trends-19990979.htm

2. Literature Review

2.1 The demand for alcohol

This section briefly examines the more recent literature on alcohol demand in the UK. For brevity and given the nature of this study, there is a particular focus on those studies which have examined differences in UK demand for alcohol across both the on-trade and off-trade.

It is clear from the array of previous studies that the demand for alcohol in the UK is affected by a variety of factors, although prices and income are likely to be key influences. These other factors include the availability of alternative products, advertising and licensing restrictions, social norms, and personal characteristics and circumstances. For the price elasticity of demand, studies to date broadly suggest that the demand curve for alcohol slopes downward and that demand is still somewhat inelastic; however, elasticities are thought to vary by different alcohol categories and by consumption channel.

2.2 Previous HMRC studies focusing on alcohol demand in the United Kingdom

HMRC have previously undertaken studies which seek to estimate the size of price and income elasticities associated with demand for alcohol in the UK, providing valuable inputs into HMRC's costing and forecasting models. Two of their notable and more recent studies are Collis et al (2010) and Sousa (2014), which are the main studies referenced here. Prior HMRC estimates using different modelling, data approaches and earlier years of data are summarised in those studies and are not repeated here.

Collis et al (2010) estimate the price elasticity of demand for alcohol products in the UK, drawing upon data from the ONS Expenditure and Food Survey (EFS)[6] and its successor, the LCF. They estimate income, own-price and cross-price elasticities for five major categories of alcohol products: beer, wine, cider, spirits and Ready-To-Drinks (RTDs), both for on-trade and off-trade consumption. They use a Tobit model to accommodate the large number of zero entries for household alcohol consumption found in the EFS, effectively allowing for the distinguishing of teetotallers from those whose alcohol consumption is not recorded. They find that the price elasticities of demand for off-trade beer and cider, and on-trade spirits are the greatest in magnitude, and imply that demand for these alcohol products is actually price-elastic; cross-price elasticities are also found to be smaller in magnitude in comparison to own-price elasticities.

Sousa (2014) builds the analysis from Collis et al (2010) by using more up-to-date data from the Living Costs and Food Survey from 2007 to 2012, and by estimating a Heckman correction model. Like the choice of the Tobit model in Collis et al (2010), the Heckman correction model is chosen to avoid selection bias, but instead makes the implicit assumption that the decision to consume alcohol is independent of quantity consumed. Again, the own- and cross-price elasticities in both the on-trade and the off-trade are estimated for five major categories of alcohol: beer, wine, cider, spirits and RTD products. Spirits in the on-trade and beer and cider in the off-trade are found to be the most price-elastic types of alcohol, while RTDs in the on-trade and wine in both the on- and off-trade are found to be the least price-elastic categories of alcohol.

[6] The Expenditure and Food Survey (EFS) was a survey conducted by the ONS and the Department for Environment, Food and Rural Affairs (DEFRA) between 2001 and 2008. The EFS collected data about private household expenditure and food consumption in Great Britain. The EFS itself replaced the Family Expenditure Survey (FES) and National Food Survey (NFS), which were conducted between 1957 and 2001; the FES and NFS also previously provided information on household expenditure patterns and food consumption.

2.3 Other recent studies focusing on alcohol demand in the United Kingdom

Arnoult and Tiffin (2010) construct a complete model of food demand for UK households, focusing on alcohol consumption both at home and outside. They use data for 2005-06 from the EFS and apply a full demand system (Almost Ideal Demand System, AIDS[7]) to model alcohol demand in the UK. They estimate elasticities for nine groups of alcoholic drinks, four of which correspond to off-trade consumption, and five to on-trade consumption. In the majority of cases, demand for alcohol across different categories is found to be price inelastic; exceptions are off-trade alcopops and spirits, and on-trade spirits. They also find a high degree of substitutability within on-trade and off-trade consumption, as evidenced by the majority of cross-price elasticities being positive.

Meng et al (2014) also use the LCF to estimate price elasticities of alcohol demand; they estimate the own- and cross-price elasticities of off- and on-trade beer, cider, wine, spirits and RTDs in the UK. However, instead of using a cross-sectional framework, they apply a pseudo-panel approach over the years 2001-02 to 2009, constructing 72 subgroups delineated by birth year, gender and socioeconomic status. Demand for off-trade beer and cider is found to be the most elastic, with demand for off-trade spirits and on-trade RTDs found to be the least elastic.

Tomlinson and Branston (2014) estimate the long-run own-price, cross-price and income elasticities for beer consumed through the on-trade and off-trade in the UK. They estimate a standard demand function featuring advertising expenditure, prices and income, applying a double-log functional form and utilising pricing data obtained from the British Beer and Pub Association (BBPA). Their results indicate that beer consumers are indeed sensitive to price changes; on-trade beer and off-trade beer are also found to be close substitutes.

Pryce et al (2018) apply quantile regression methods to estimate the differential price and income elasticities across the drinking distribution and for both on-trade and off-trade alcohol, without disaggregating alcohol by category; they also examine how drinkers respond to price changes by varying the quality of alcohol consumed. They draw upon the EFS and LCF to provide data from 2001 to 2013 inclusive. Only household data for those households reporting alcohol consumption is used, with the presumption being that there is no price that would turn a drinker into a non-drinker (and vice versa) and so non-drinkers simply have different preferences to drinkers. Heavy drinkers are found to be much less responsive to price in terms of quantity, but that they are more likely to substitute with cheaper products when the price of alcohol increases.

Quirmbach et al (2018) estimate the demand for sugar-sweetened beverages (SSBs) in the UK, and examine the relationship between the purchase of SSBs, other non-alcoholic and alcoholic beverages, and their respective prices. Like Arnoult and Tiffin (2010) they use a partial demand model, adapted from the Almost Ideal Demand System, and draw upon Kantar Worldpanel sales data from January 2012 to December 2013. Their estimates for own-price elasticities indicate that demand for beer, cider and spirits is price-elastic. An increase in the price of high-sugar drinks leads to an increase in the purchase of lager, an increase in the price of medium-sugar drinks reduces purchases of alcoholic drinks, while an increase in the price of diet and low-sugar drinks increases purchases of beer, cider and wines.

Griffith, McConnell and Smith (2018) examine whether varying tax rates on different alcohol products in an optimal tax design setting can lead to welfare gains. They use detailed longitudinal data on alcohol purchases from Kantar Worldpanel, taken from a representative panel of British households over a minimum of 20 weeks in 2011, and for around 40 weeks per year, on average. Consistently heavy drinkers are found to systematically purchase a different mix of alcohol products than lighter drinkers; on average, they are found to buy stronger and cheaper varieties of alcoholic beverages. Heavier drinkers are also much more willing to switch between different alcohol products in response to price changes, and are less willing to switch away from alcohol altogether than lighter drinkers.

[7] The Almost Ideal Demand System (AIDS) is a consumer demand model first developed by Deaton and Muellbauer (1980); it expresses the share of a consumer's expenditure on a particular good as a function of prices and the related expenditures on other goods. This relationship can then be interpreted as a Marshallian or uncompensated demand function expressed in budget shares.

Table 2 below summarises the main results from the studies briefly discussed above, focusing in particular on the estimated own-price elasticities for the different alcohol categories; these provide a benchmark from which new estimates can be indirectly compared. While now shown in this table, income elasticities in both HMRC studies and for all alcohol categories are found to be positive, in line with the expectation that, as a normal good, demand for alcohol should rise in line with household income. The price elasticities for off-trade beer and cider are broadly greater in magnitude that those for wine and spirits.

Table 2: Recent estimates for own-price elasticities of alcohol products in the UK

Category	Channel	Alcohol	Beer	Cider	Wine	Spirits	RTDs
Collis et al (2010)	On	-	-0.77	-0.85	-0.46	-1.15	-0.91
	Off	-	-1.11	-1.34	-0.54	-0.90	-0.93
Arnoult and Tiffin (2010)	On	-	-0.92	-0.92	-0.74	-1.53	-
	Off	-	-0.95	-	-0.82	-1.22	-1.09
Sousa (2014)	On	-	-0.34	-0.49	-0.24	-1.25	-0.24
	Off	-	-0.74	-0.74	-0.08	-0.45	-0.52
Meng et al (2014)	On	-	-0.79	-0.59	-0.87	-0.89	-0.19
	Off	-	-0.98	-1.27	-0.38	-0.08	-0.59
Tomlinson and Branston (2014)	On	-	-1.68	-	-	-	-
	Off	-	-1.60	-	-	-	-
Pryce et al (2018)	On	-0.41	-	-	-	-	-
	Off	-0.66	-	-	-	-	-
Quirmbach et al (2018)	All	-	-1.12	-1.07	-0.97	-1.14	-

Note: Elasticities for Arnoult and Tiffin (2010) are taken from after correction for substitution and complementarity effects. Own-price elasticities from Sousa (2014) taken from quantity equation. Elasticity estimates rounded to two decimal places.

Source: various; please refer to study references.

3. Dataset

3.1 The Living Costs and Food Survey (LCF)

The data used in this analysis was exclusively sourced from the Living Costs and Food Survey (LCF). The LCF collects information on spending patterns and the cost of living that reflect household budgets. It is conducted jointly by the ONS and the Department for the Environment, Food and Rural Affairs (Defra) throughout the year, across the whole of the UK, and is the most significant survey on household spending in the UK. The LCF features responses from approximately 12,000 households each year, of which typically around 50% provide responses. Two modules have been used to construct the dataset: the main LCF survey and the Family Food Module; the latter records expenditures on different items and the quantities purchased.

3.2 Categorising alcohol using the LCF data

Household demand for four major alcohol categories is examined: Beer, Cider, Wine[8] and Spirits. Unfortunately, there is insufficient information available in the more recent LCF data to explicitly model demand for Ready to Drink (RTDs) products, as in previous studies. However, the consumption of RTDs, and other comparatively minor categories such as sparkling wine, are used as controls within the estimated models. It is also important to note that differences in quality across alcohol products have not been captured due to lack of granularity in the LCF data; however, it has been possible to capture quantities by product volume. Annex B provides further information on the chosen alcohol categories, their constituent products and volume measures.

3.3 Choice of time period for data in the analysis

The latest version of the LCF available in the UK Data Archive at the time of writing was the Living Costs and Food Survey, 2006-2017.[9] However, only data covering the period 2012 to 2016-17 inclusive has been used in this study. While ordinarily it would be advantageous to include data covering all available years, the survey variables which precisely capture the specific volumes of alcohol consumed through the on-trade for all the main alcohol categories were only firstly introduced in 2012. Prior to this, only the volume of beer consumed through the on-trade was captured through the LCF, with only the recorded number of drinks purchased captured.[10] It is therefore not possible to construct a consistent series across data prior to 2012 and thereafter. However, the resulting sample still exceeds 27,000 responses from households, providing an ample and sufficient amount of information to estimate UK household demand for alcohol.

3.4 The choice to use data in a cross-sectional framework

The data used in this study has been analysed using a pooled cross-sectional framework. While panel data would ordinarily be the best framework to conduct the analysis, the LCF is not a longitudinal dataset; in other words, it is comprised of data from randomly selected households each year, rather than data repeatedly gathered from the same households over time. A pseudo-panel approach could have been undertaken, with households were grouped by categories such as socioeconomic status, as in Meng et al (2010), but this is not explored further in this study.

3.5 Missing quantities of alcohol purchased

For off-trade consumption, in the vast majority of instances the precise quantity of alcohol purchased has been recorded in diary data. Where quantities are missing, these have been estimated by dividing expenditure by the average regional price—the estimation of prices is discussed further below. Similarly for on-trade consumption, there are a minority of diary entries where the recorded volumes of alcohol purchased away from home are missing. In order to estimate the volume purchased in these instances, the associated expenditure, number of drinks and average regional prices by volume have been used to infer the volume purchased.

[8] Here, the Wine category excludes sparkling wine (including champagne) and fortified wine, which are treated as separate categories.
[9] The LCF data can be found here: https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=7047
[10] The variables which capture the on-channel consumption of alcohol were only introduced into the LCF datasets in 2012. Between 2006 and 2011, prior to this, there were no only available LCF variables capturing precisely the quantity of drink purchased, in either millilitres or units.

3.6 Missing prices for non-drinking households

Another drawback of using the LCF is that alcohol product prices are naturally missing for those households which do not record expenditure on any alcohol; these households must still be included in the final dataset to avoid bias. Therefore, prices for these households are estimated using the averages of household responses where prices can be estimated. Following Sousa (2014), average prices are calculated based on the year, region and household size to reflect regional differences in prices and potential discounting when households buy larger quantities. In instances where this average is incalculable, the average based on the region and year is used instead. In the absence of any other data, this is considered to be a reasonable adjustment.

3.7 Adjustment of prices for inflation

All estimated alcohol prices have been adjusted for inflation using the monthly ONS Consumer Price Index[11] (CPI, ONS series D7BT) with the calendar year 2015 as the base period. This ensures consistency when estimating the elasticities measured using data across different years.

3.8 Descriptive statistics from the LCF dataset

The LCF dataset is balanced and nationally-representative. Table 3 below shows in each year the total number of households from whom survey responses were received, the average number of individuals across all households, and the average number of people in households who were eligible to buy and consume alcohol during the period (in this context, those aged 18 or over, as it is legal in the UK for these individuals to buy alcohol in a pub, off-licence, shop or elsewhere.)

Table 3: Total households, average size and average number in household of drinking age

	2012	2013	2014	2015q1	2015-16	2016-17
Total number of households	5,596	5,144	5,134	1,320	4,916	5,043
Average household size	2.36	2.36	2.36	2.36	2.36	2.37
Average Number in Household aged 18+	1.82	1.82	1.84	1.84	1.82	1.84

Note: figures subject to rounding. Source: LCF, Deloitte analysis

The number of households responding to the LCF has declined slightly in recent years, but fortunately the thousands of responses received over ten consecutive annual surveys still provides a rich dataset for use in the study. Further descriptive statistics covering other household and person-level variables used in this study, including household breakdowns by ethnicity, region and socioeconomic group are provided in Annex A.

Table 4 below shows trends in the income and expenditure variables used in the study, expressed as averages across the sampled LCF households, and adjusted for inflation. As might be expected, incomes and expenditure continue to grow over time. Average Weekly Expenditure is the preferred measure used, with a further rationale for this choice provided in the next section.

Table 4: Real average income and expenditure measures used in the study

	2012	2013	2014	2015q1	2015-16	2016-17
Average Weekly Expenditure (EFS)	£437	£446	£453	£435	£459	£472
Average Total Expenditure	£511	£512	£517	£490	£526	£537
Average Gross Weekly Income	£751	£738	£765	£762	£785	£801
Average Disposable Income	£622	£617	£643	£633	£659	£674

Note: figures subject to rounding. Source: LCF, Deloitte analysis

Table 5 below shows the proportions of households recording consumption of alcohol, different alcohol products and tobacco over the period considered. The proportion of households reporting

[11] ONS (2019). CPI INDEX 00: ALL ITEMS. https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/d7bt/mm23

expenditure on alcohol has remained fairly constant, although the proportion of households reporting expenditure on tobacco products has gradually declined, consistent with HMRC tobacco product clearances data and falling real Tobacco Duty revenues.

Within on-trade consumption, beer and wine are the most popular alcohol categories, with nearly a third of households responding to the LCF reporting some expenditure on beer. In contrast, the proportion of those households reporting some expenditure on a round of drinks has declined slightly. Within off-trade consumption, wine is more popular than beer, with around a third and quarter of households reporting expenditure on these categories respectively.

Table 5: Consumption of alcohol and tobacco by proportion of households

Alcohol and Tobacco	2012	2013	2014	2015q1	2015-16	2016-17	Full Sample	Frequency
Alcohol	53.2%	53.5%	54.0%	47.7%	54.2%	54.8%	53.6%	14,558
No Alcohol	46.8%	46.5%	46.0%	52.3%	45.8%	45.2%	46.4%	12,595
Tobacco	20.8%	20.2%	18.2%	15.2%	16.0%	16.6%	18.3%	4,960
On-trade								
Beer	31.5%	31.1%	31.8%	29.6%	31.8%	31.9%	31.5%	6,929
Cider	5.3%	6.0%	6.0%	5.7%	6.4%	6.5%	6.0%	1,328
Wine	17.7%	17.8%	19.1%	19.3%	18.9%	9.7%	16.2%	3,578
Spirits	9.2%	9.3%	9.4%	9.0%	10.8%	9.8%	9.7%	2,138
Sparkling Wine	1.4%	1.4%	0.5%	1.6%	2.0%	1.4%	1.3%	363
Fortified Wine	0.6%	0.3%	1.5%	-	0.3%	0.2%	0.6%	-
RTDs	1.1%	1.0%	0.6%	-	0.4%	0.9%	0.8%	-
Round of Drinks	4.7%	5.1%	0.9%	-	0.5%	0.9%	2.4%	-
Cocktails	1.9%	2.5%	2.4%	3.0%	2.8%	1.7%	2.3%	624
Off-trade								
Beer	22.8%	23.9%	24.3%	20.6%	24.8%	25.5%	24.1%	6,534
Cider	9.0%	11.1%	9.3%	7.3%	9.5%	8.3%	9.3%	2,533
Wine	33.8%	33.0%	33.1%	35.9%	32.9%	34.2%	33.5%	9,108
Spirits	14.8%	14.2%	15.4%	35.9%	15.5%	15.5%	16.1%	4.365
Sparkling Wine	3.3%	4.5%	5.6%	4.0%	6.9%	6.8%	5.3%	1,433
Fortified Wine	3.6%	3.5%	3.3%	2.0%	2.8%	2.8%	3.2%	857
RTDs	2.0%	11.1%	1.9%	-	1.5%	1.4%	3.4%	-

Note: figures subject to rounding; dashes indicate where data has been suppressed due to low frequency counts.

Source: LCF, Deloitte analysis

Tables 6 and 7 below provide an overview of the average prices as calculated using the LCF dataset. Prices are expressed using the Weighted Average Price (WAP)[12], expressed in both nominal and real terms and through the standard volumes typically provided in a serving.

As expected, nominal and real prices of products are increasing over time in line with higher Alcohol Duties, and are similar to the historical averages as estimated by Collis et al (2012) and Sousa (2014). There are some notable anomalies in the weighted prices for wine and spirits in the

[12] The Weighted Average Price (WAP) is the average price of prices after introducing weights for each observation. In this context, prices are weighted by recorded volumes of alcohol consumed. This is in contrast to the standard arithmetic mean, whereupon the simple average price would be calculated as the mean without volume weights.

first quarter of 2015; this is most likely due to seasonal effects and the much smaller sample size. There is a notable downward trend in both the nominal and real price of spirits purchased through both the on-trade and off-trade over the five year period, consistent with the real-terms decline in the Spirits Duty rate previously identified in Figure 4. Conversely and again in line with trends in Wine Duty, the weighted average price of wine has increased significantly.

Unfortunately, while more recent data incorporate within the LCF dataset now provides sufficient granularity for information on alcohol by volume—most notably for on-trade alcohol consumption—it does not allow us to use information on quality.

Table 6: Estimated WAP of different alcohol products, in nominal terms

Channel	Type	Serving	2012	2013	2014	2015q1	2015-16	2016-17	Sample
On	Beer	Pint (568 ml)	£2.94	£3.02	£3.12	£3.24	£3.29	£3.16	£3.11
	Cider	Pint (568 ml)	£3.15	£3.22	£3.31	£3.33	£3.33	£3.23	£3.25
	Wine	Glass (175 ml)	£3.07	£3.13	£3.31	£3.59	£3.61	£3.78	£3.38
	Spirits	Serving (25 ml)	£1.67	£1.74	£1.03	£2.38	£2.06	£2.36	£1.80
Off	Beer	Pint (568 ml)	£1.23	£1.22	£1.21	£1.25	£1.22	£1.36	£1.25
	Cider	Pint (568 ml)	£1.10	£1.17	£1.15	£1.13	£1.16	£1.38	£1.19
	Wine	Bottle (750ml)	£4.95	£5.05	£5.22	£6.60	£5.23	£5.31	£5.22
	Spirits	Bottle (700ml)	£11.89	£12.30	£12.43	£6.16	£12.21	£12.00	£11.87

Note: figures subject to rounding. Source: LCF, Deloitte analysis

Table 7: Estimated real WAP of different alcohol products, expressed in 2015 prices

Channel	Type	Serving	2012	2013	2014	2015q1	2015-16	2016-17	Sample
On	Beer	Pint (568 ml)	£2.82	£2.97	£3.12	£3.23	£3.29	£3.20	£3.08
	Cider	Pint (568 ml)	£3.02	£3.17	£3.30	£3.32	£3.33	£3.27	£3.22
	Wine	Glass (175 ml)	£2.95	£3.08	£3.31	£3.57	£3.62	£3.83	£3.36
	Spirits	Serving (25 ml)	£1.60	£1.72	£1.03	£2.36	£2.06	£2.39	£1.78
Off	Beer	Pint (568 ml)	£1.18	£1.20	£1.21	£1.25	£1.22	£1.38	£1.24
	Cider	Pint (568 ml)	£1.06	£1.15	£1.15	£1.12	£1.17	£1.40	£1.18
	Wine	Bottle (750ml)	£4.76	£4.98	£5.22	£6.56	£5.24	£5.37	£5.18
	Spirits	Bottle (700ml)	£11.42	£12.12	£12.42	£6.12	£12.22	£12.15	£11.77

Note: figures subject to rounding. Source: LCF, Deloitte analysis

4. Choice of Model, Specifications and Functional Form

4.1 The problem of zero observations and the choice of model

The choice of model applied in this study is largely influenced by large number of households reporting no expenditure on any alcohol products through the years covered in the sample. This is perhaps unsurprising as it would be expected that a significant minority of households do not drink alcohol, and the LCF diary data only covers a two-week period. The choice to not consume alcohol could be either due to products being too expensive, the influence of cultural and lifestyle factors on their preferences, under-reporting by households or perhaps simple measurement error. If non-consuming households were to be discarded from the sample, those remaining households who have consumed alcohol products will thus have been selected non-randomly, thereby introducing sample selection bias into any resulting elasticity estimates.

In the absence of these zero observations, the application of the Ordinary Least Squares (OLS) estimator would be appropriate, subject to the usual post-estimation tests for the normality of residuals, multicollinearity and heteroscedasticity. Use of the OLS estimator would also be appropriate if the characteristics of drinking and non-drinking households were believed to be similar, indicating a lack of selection bias. However, assuming that there is a basis for this bias existing, the OLS estimator would fail to take into account the sample selection bias discussed above, rendering it unsuitable to estimate elasticities. In other words, an OLS model would in effect be attempting to determine the influence of factors on the decision to drink alcohol as well as the impact of a change of prices on the quantity of alcohol consumed. Any approach must therefore attempt to circumvent this issue. Fortunately, a number of modelling approaches exist which are designed to deal with the problem of sample selection, but this analysis makes use of two tried-and-tested models: the Tobit Model and Heckman Correction Model.

4.2 The Tobit Model

The Tobit Model, first proposed by James Tobin in 1958, addresses the sample selection bias which arises when there is a large quantity of zero observations present—in this instance, with a large number of households reporting zero expenditure on alcohol products. Use of the OLS estimator here, when data points are censored at zero, would create biased model estimates.

In the Tobit model, there is a latent variable Q_i^*representing the quantity of a product demanded, which is dependent on P_i, the price of that product in addition to the prices of other products. The latent variable Q_i^* could actually be negative as in reality some households will not consume certain products for health or cultural reasons, or because the price is too high—with these households constrained by zero demand. This is referred to as a corner solution: some households will refuse to purchase a particular good regardless of the price of that good or other goods; conversely, some will purchase the good regardless. Taking this into account, there is a coefficient which determines the relationship between quantity and price, and an error term ε_i which captures random disturbances. The actual quantity demanded is equal to the latent quantity when demand is in excess of 0, and equal to 0 when not.

From the above, Q_i^* is the latent quantity demanded; X_i is the list of independent variables; β is the list of model coefficients associated with these variables; and the error term ε_i is assumed to be normally distributed. The stated quantity demanded Q_i is strictly non-negative.

$$Q_i^* = X_i\beta + \varepsilon_i$$

$$Q_i = \begin{cases} Q_i^*, if\ Q_i^* < 0 \\ 0\ \ , if\ Q_i^* \geq 0 \end{cases}$$

The estimator for β, β', is calculated by maximising the following log likelihood function below:

$$\ln(L(\beta)) = \sum_{y_i>0} \ln\left(\frac{1}{\sigma}\ \phi\ \left(\frac{y_i - X_i\beta}{\sigma}\right)\right) + \sum_{y_i=0}\left(1 - \Phi\left(\frac{X_i\beta}{\sigma}\right)\right)$$

The terms ϕ and Φ represent the density function and cumulative density function of the standard normal distribution; σ is the standard deviation. The first part of the log likelihood function above covers all non-zero observations and corresponds to the standard OLS regression; the second part covers zero-only observations and corresponds to a standard Probit model. The coefficients are then estimated using a Maximum Likelihood Estimation (MLE) approach with respect to β. For this analysis, the estimated Tobit model is then as follows:

$$Q_i^* = \alpha + \sum_{i=1}^{4} \beta_i P_i + \gamma_j X_j + \varepsilon_i$$

Here, P_i represents the range of prices for alcohol products, covering beer, cider, wine and spirits. The term X_j represents the control variables, or the list of other factors which are expected to influence both the decision to drink and the quantity of alcohol products purchased: household income, socio-economic status, owner-occupier status among others, as well as a linear time trend. The coefficients for β are interpreted as the effect on the uncensored, latent quantity demanded, rather than the actual observed quantity demanded.

4.3 The Heckman Correction Model

While the application of the Tobit Model attempts to address the likely presence of corner solutions among some household preferences for alcohol, it would seem unlikely that all of the zero observations of alcohol consumption result from standard corner solutions. In other words, it seems more likely that some households will choose to abstain from alcohol consumption, while some will separately face corner solutions. Hence a modelling framework which firstly determines whether a household chooses to consume alcohol, and then if so determines what quantity is consumed, would likely be more appropriate.

The Heckman Correction Model offers an alternative means to deal with the selection bias that would otherwise manifest by focusing on a non-random sample—in this context, focusing on the preferences for only households that drink alcohol. The Heckman Correction Model differs from the Tobit Model by applying a two-stage approach; the first stage involves estimating the probability of an individual or household having a non-zero response (in this case, reporting expenditure on alcohol or not), represented by a "participation" equation. The second stage, represented by a "quantity" equation, determines the factors which influence the quantity consumed and incorporates a transformation of the probabilities estimated in the participation equation. In effect, the inclusion of this transformation of probabilities solves the selection bias and is treated as another explanatory variable.

The Heckman model can be expressed as per the following two equations described below, the first representing the participation equation, the second the quantity equation. The first takes the form of a probit model, whereupon the dependent variable is constrained to be one or zero.

$$d_i = Z_i'\gamma + \varepsilon_i \ (1)$$

$$y_i = x_i'\beta + \delta\lambda_i + u_i \ (2)$$

For the participation equation (1), d_i equals to one if participation occurs, i.e. the households consumes alcohol, and zero if not. The term Z_i' represents a number of explanatory variables thought to influence this participation decision, such as the decision to consume similar products (for beer, cider, wine or spirits) or related products (such as tobacco) and ε_i is an error term.

For the quantity equation (2), y_i is the quantity of alcohol product consumed, x_i' is the list of factors which are thought to influence the level of consumption, and u_i is once again a normally-distributed error term capturing random disturbances. The term δ represents the inclusion of the sample selection bias, and is captured through a function of the inverse Mills ratio, calculated for every observation. If following computation the coefficient on λ is found to be indistinguishable from zero, there is no evidence of sample selection bias, and an OLS approach can be used instead. However, if the coefficient on λ is statistically different from zero, it must be reported alongside the other model coefficients.

As the quantity equation follows a Probit model, the overall estimation must use a MLE approach. The estimator for β, β', is generated by maximising the following log likelihood function shown below.

$$L = \prod_{y_i=0} 1 - \Phi\left(\frac{Z_i'\gamma}{\sigma_d}\right) \prod_{y_i>0} \Phi\left\{\left(Z_i'\gamma + \frac{\sigma_{dy}}{\sigma_y^2}(y_i - x_i'\beta)\right)\sqrt{\sigma_d^2 - \frac{\sigma_{dy}^2}{\sigma_y^2}}\right\} \times \frac{1}{\sigma_y}\phi\left(\frac{(y_i - x_i'\beta)}{\sigma_y}\right)$$

This log likelihood function must be solved either iteratively (using the Full Information Maximum Likelihood approach, FIML) or using a two-step alternative estimator (Limited Information Maximum Likelihood, LIML). The FIML approach is preferred as although it is computationally demanding, it is generally more efficient and has been found previously to perform better with larger datasets—as is the case here, as the compiled LCF dataset used to perform the analysis has over 27,000 data points compiled from six individual LCF surveys.

4.4 Choice of functional form

For the estimation of the Heckman correction model, the "double log" (or "log log") functional form has been used, resulting in an isoelastic demand model. An isoelastic demand system is linear in the logs of quantities and the logs of prices, meaning that the elasticity is constant along the demand curve. As the log difference between two values approximates a percentage change, this means that any resulting model coefficients can be directly interpreted as elasticity estimates. There are of course other functional forms which could have been estimated instead: fully linear, log-linear and linear-log; these forms imply that the price elasticity of demand is not constant; rather, it changes along the demand curve, depending on the level of quantity purchased and price. However, the linear-log form is used later in the analysis to test the robustness of the chosen model (see Section 5.3).

4.5 Choosing instruments for the Heckman Correction Model

One of the difficulties associated with the Heckman Correction Model approach is the high collinearity that can be observed between the inverse Mills ratio and the other explanatory variables included in the quantity equation; this multicollinearity can lead to inconsistent model coefficient estimates. As the participation and consumption equations share the same vector of predictors, the transformed predicted value in the first stage correlates strongly with the predictors in the second stage.

One typical solution to circumvent this issue is to include an additional set of variables which form part of the participation equation but not the quantity equation. Akin to instrumental variables, these predictors should influence the choice of participation but then have no relationship to the error term within the quantity equation. In other words and in this context, these additional variables should influence the decision to drink alcohol but not the quantity of alcohol consumed. Failure to include these exclusion restriction variables, using weak exclusion variables, or using exclusion variables that are themselves endogenous, will yield inconsistent and potentially biased estimates.

Fortunately, there are a number of candidate variables present within the LCF dataset which could be potentially used as instruments. In line with previous studies on alcohol consumption, they relate to factors driven by culture, health, and personal preferences. The most straightforward instrument to include is **whether the household consumes other types of alcohol products**, with the rationale for being that if a household consumes on-trade beer for instance, they are

likely to consume off-trade beer as well. The consumption of these other products are captured through dummy variables, and helps provides additional insight on whether households view consumption of different products as being related.

A number of potential instruments have been rejected for inclusion in the participation equation. **Religion** has not been chosen as an instrument, as the LCF dataset does not specifically contain information on household or individual religious beliefs, and it would therefore be necessary to proxy for this using some other household characteristic. Ordinarily, **pregnancy** would be a potentially useful instrument, given that alcohol consumption during pregnancy is strongly discouraged; however, alcohol consumption is recorded at household level, so unless a household consists solely of an expectant mother, it is impossible to distinguish changes in consumption at an individual level.

4.6 Choosing Control Variables for the Tobit and Heckman Correction Models

Alongside prices, a number of control variables have been included in the models to ensure that the effect of price changes is adequately isolated. Without at least some attempt to control for these other non-price factors, there is a high risk of omitted variable bias influencing the results—with the model coefficients for prices inadvertently and unhelpfully capturing the effects of other factors as well. In line with previous studies, a number of standard control variables have been included to account for differences in preferences. These include a **linear time trend**, **region**, **socioeconomic group** and **ethnicity**, with the first of these reflecting changing preferences over time which are not captured through the other variables. The others reflect likely differences in consumption preferences across regions, skill levels and ethnic groups.

Alongside prices, **income** is one of the most important factors driving both the decision to drink alcohol and the quantity of alcohol consumed. All other things being equal, higher incomes make alcohol consumption more affordable, with their consumption therefore expected to be a normal good. However, this relationship is unlikely to be linear, and this is reflected in the models by expressing this variable in logs, and in separate specifications including both income and income squared. However, **household expenditure** has been used as a proxy for income in the preferred model specifications, given that it is expected that there will be less measurement error by households (who might for instance confuse pre-tax and post-tax income, or solely consider "income" as being from employment with other income sources disregarded), and more consistency over time in expenditure versus income. However, other measures of expenditure and income have been used as part of robustness checks, discussed later in this paper.

However, simply using reported household income or expenditure does not reflect the resource or consumption requirements for households of different sizes. It is therefore necessary to adjust household income and expenditure by some measure of household size to ensure that any measure of affordability of alcohol products is comparable across households. This process is known as **equivalisation of income or expenditure**, for which there are a number of tried-and-tested approaches: assigning values to the first adult, subsequent adults and children ("OECD equivalence scale" and "OECD modified equivalence scale"); and taking the square root of the total household size ("square root scale"). The different methods are explain in further detail here;[13] for this analysis, the square root scale approach has been used.

It is also possible that **home ownership** has a depressing effect on alcohol consumption, and also acts as a proxy for economic stability; owner-occupier status is recorded within the LCF household-level data. Within the household, to control for the positive effect of a higher number of adults on levels of alcohol consumption, **the number of adults aged at or above the legal drinking age** have been included. This is measured as the recorded number of adults aged 18 or over in the household. The composition of households by different age groups, and potentially different preferences for drinking among different generations, has also been reflected by the inclusion of a control for those **households exclusively consisting of those aged 70 years old or more**.

[13] OECD (undated). What are Equivalence Scales? Technical Note. http://www.oecd.org/eco/growth/OECD-Note-EquivalenceScales.pdf

The **gender of the Household Reference Person (HRP)** has also been used to observe whether gender influences the decision to drink as well as alcohol consumption.

Finally, two additional control variables have been included, following Aristei and Pieroni (2008). The first is **expenditure on tobacco,** captured by a dummy variable. The rationale for including this particular control is that there is likely to be complementarity between smoking and drinking, as shown for example by Decker and Schwartz (2000) and Pierani and Tiezzi (2008). In addition, it might be expected that the presence of younger children in the household would have a downward impact on alcohol consumption; **the presence of any children aged 5 or under** in the household is also included as a dummy variable.

4.7 The regression equations

Table 8 below lists the variables used in the final model specifications, with the instruments listed included in the Heckman Correction model specifications. The variables included in the Tobit Model specifications are the same, with the exception of the instruments which are discarded. A constant value is also included in the model. The consumption of different alcohol category variables are interchangeable depending on the dependent variable; for example, the consumption of on-trade beer is not used as an instrument when the dependent variable is the quantity of on-trade beer consumed, in order to avoid multicollinearity.

Table 8: Variables used in the final specifications using the preferred model

Dependent Variable	Explanatory Variables	Instruments	Controls
Quantity of on-trade beer	Price of on-trade beer	Consumption of on-trade beer	Log equivalised real expenditure (or income)
Quantity of off-trade beer	Price of off-trade beer	Consumption of off-trade beer	Home ownership (owner-occupier status)
Quantity of on-trade cider	Price of on-trade cider	Consumption of on-trade cider	Number of people in household of smoking age
Quantity of off-trade cider	Price of off-trade cider	Consumption of off-trade cider	Households with members all aged 70 or over
Quantity of on-trade wine	Price of on-trade wine	Consumption of on-trade wine	Male House Reference Person
Quantity of off-trade wine	Price of off-trade wine	Consumption of off-trade wine	Smoking household (consumes tobacco)
Quantity of on-trade spirits	Price of on-trade spirits	Consumption of on-trade spirits	Children aged 5 or under
Quantity of off-trade spirits	Price of off-trade spirits	Consumption of off-trade spirits	Region
		Consumption of on-trade RTDs	Marital status
		Consumption of off-trade RTDs	Socio-economic group
		Consumption of on-trade fortified wine	Ethnicity
		Consumption of off-trade fortified wine	Linear Time Trend
		Consumption of on-trade sparkling wine	
		Consumption of off-trade sparkling wine	
		Consumption of round of drinks	
		Consumption of cocktails	

Source: LCF, Deloitte analysis

5. Model results

5.1 Main results using preferred modelling specification

The own-price and cross-price elasticities estimated using the quantity equation from the chosen Heckman Correction model are shown in Table 9 below as an elasticity matrix, using the preferred double-log functional form; the coefficients thus directly represent the estimated elasticities. The full set of results are set out in Annex C. The estimated own-price elasticities for each alcohol category are highly statistically significant; demand for all alcohol categories is also found to be price inelastic. The most elastic estimates are for off-trade cider, on-trade spirits and off-trade beer; the results suggest that, all other things being equal, a 1% increase in the real prices of these goods would reduce household demand by 1.0%, 0.9% and 0.8% respectively. The least elastic estimates are for off-trade wine and spirits. These own-price elasticities also appear to be higher than those previously estimated by Sousa (2014) and Collis et al (2010), even allowing for differences in approach; however, the results are broadly consistent.

A number of cross-price elasticities have also been estimated, which are broadly smaller in magnitude, not always positive and generally not of statistical significance. The associated coefficient estimates should not be directly interpreted as the impact of an increase of a price of one alcohol category on demand for another. This is because the modelling approach applied here analyses uncompensated or Marshallian demands, unavoidably incorporating both the income and substitution effects resulting from a price change.[14]

Table 9: Elasticity estimates using the preferred model specification, log-log functional form

	Quantity	**Beer**		**Cider**		**Wine**		**Spirits**	
Price		**On**	**Off**	**On**	**Off**	**On**	**Off**	**On**	**Off**
Beer	On	-0.45***	0.05	-0.192	-0.30**	-0.02	-0.09	-0.05	0.05
		(0.06)	(0.07)	(0.12)	(0.12)	(0.07)	(0.06)	(0.11)	(0.07)
	Off	-0.05	-0.81***	-0.12	-0.03	0.00	-0.07**	-0.06	-0.02
		(0.04)	(0.04)	(0.08)	(0.05)	(0.05)	(0.03)	(0.07)	(0.04)
Cider	On	-0.15**	-0.04	-0.42***	-0.06	0.01	0.11*	0.17	0.07
		(0.07)	(0.07)	(0.09)	(0.10)	(0.08)	(0.06)	(0.11)	(0.07)
	Off	-0.06	-0.05	-0.25***	-0.99***	-0.02	-0.07*	-0.03	-0.10**
		(0.04)	(0.04)	(0.07)	(0.04)	(0.05)	(0.04)	(0.07)	(0.04)
Wine	On	0.031	-0.01	-0.13	-0.05	-0.43***	-0.06	-0.03	0.02
		(0.05)	(0.06)	(0.09)	(0.08)	(0.05)	(0.05)	(0.09)	(0.06)
	Off	-0.014	0.02	0.03	0.03	0.09*	-0.22***	0.16**	0.09**
		(0.05)	(0.05)	(0.09)	(0.08)	(0.05)	(0.04)	(0.08)	(0.04)
Spirits	On	0.04	0.08*	0.02	-0.11	-0.03	-0.03	-0.92***	0.04
		(0.04)	(0.05)	(0.07)	(0.08)	(0.05)	(0.04)	(0.04)	(0.05)
	Off	0.02	0.03	0.14**	-0.01	0.07*	0.08***	0.01	-0.19***
		(0.04)	(0.03)	(0.07)	(0.05)	(0.04)	(0.03)	(0.06)	(0.03)

Note: own-price elasticities are highlighted; asterisks indicate significance level (*** p<0.01; ** p<0.05; * p<0.1) with standard errors shown in parentheses. Figures subject to rounding. Source: LCF, Deloitte analysis

[14] Following standard demand theory, an increase in the price of a good will have both an income and substitution effect. The substitution effect involves a consumer shifting consumption away from the higher-priced good to another; the income effect involves the consumer choosing a new set of goods following the reduction in their purchasing power. In the model estimated here, while a measure of the income effect is incorporated through the inclusion of the weekly expenditure variable, this effect cannot be stripped out to solely leave the substitution effect. The use of a Hicksian demand function, in which a consumer minimises their expenditure to achieve a certain desired level of utility, would enable the identification of the substitution effect in isolation, but this is not examined here.

5.3 Other results

The inclusion of the weekly household expenditure variable as a proxy for household income has enabled the estimation of an income elasticity for each alcohol category. Table 10 below sets out the estimated coefficients and associated standard errors taken from the preferred modelling specification again with the double-log functional form. In addition, estimates are also provided for models using both weekly expenditure and a quadratic term, to capture any non-linear income effects. The results for on-trade beer and off-trade spirits indicate that while an increase in expenditure (income) increases the quantity consumed, the rate of this increase falls as expenditure (income) increases. However, regardless of how weekly expenditure is included in the models, the own-price elasticities for each alcohol category appear to remain robust.

Table 10: Elasticity estimates with both weekly expenditure and a quadratic term

	Quantity	Beer		Cider		Wine		Spirits	
Model		**On**	**Off**	**On**	**Off**	**On**	**Off**	**On**	**Off**
Preferred Model	Weekly Expenditure	0.10***	0.06**	-0.04	0.08**	0.25***	0.16***	0.14***	0.13***
		(0.03)	(0.02)	(0.05)	(0.03)	(0.03)	(0.02)	(0.04)	(0.03)
	Own-price elasticity	-0.45***	-0.81***	-0.42***	-0.99***	-0.43***	-0.22***	-0.92***	-0.19***
		(0.06)	(0.04)	(0.09)	(0.04)	(0.05)	(0.04)	(0.04)	(0.03)
Preferred Model with quadratic for weekly expenditure	Weekly Expenditure	0.94***	-0.06	0.23	0.09	0.32	0.15	0.02	0.67***
		(0.18)	(0.17)	(0.33)	(0.23)	(0.20)	(0.14)	(0.31)	(0.18)
	Weekly Expenditure (sq.)	-0.42***	0.06	-0.14	-0.00	-0.03	0.06	0.06	-0.27***
		(0.09)	(0.08)	(0.17)	(0.12)	(0.10)	(0.07)	(0.15)	(0.09)
	Own-price elasticity	-0.46***	-0.81***	-0.42***	-0.99***	-0.43***	-0.22***	-0.92***	-0.20***
		(0.06)	(0.04)	(0.09)	(0.04)	(0.05)	(0.04)	(0.04)	(0.03)

Asterisks indicate significance level (*** p<0.01; ** p<0.05; * p<0.1), standard errors shown in parentheses. Figures subject to rounding. Source: LCF, Deloitte analysis

Table 11 below shows a selection of the other results from the preferred model specification which influence both the decision to consume alcohol and the quantity consumed; a full set of results can be found in Annex C. The results suggest that older households are found to be less likely to consume beer or cider, either through the on-trade or off-trade; households with a male Household Reference Person are more likely to consume beer and less likely to consume wine.

Table 11: Other results for control variables using the preferred model specification

	Quantity	Beer		Cider		Wine		Spirits	
Variable	**Channel**	**On**	**Off**	**On**	**Off**	**On**	**Off**	**On**	**Off**
Smoking Household	Participation	0.03	0.14***	-0.03	0.09***	-0.19***	-0.05**	0.11***	0.22***
		(0.02)	(0.02)	(0.04)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
	Quantity	0.21***	0.20***	0.20***	0.20***	0.13***	0.15***	0.20***	0.06**
		(0.03)	(0.03)	(0.06)	(0.04)	(0.04)	(0.03)	(0.05)	(0.03)
At least one child aged under 5	Participation	-0.16***	0.10***	-0.12**	-0.03	-0.13***	-0.11***	-0.05	-0.12***
		(0.03)	(0.03)	(0.05)	(0.04)	(0.04)	(0.03)	(0.04)	(0.03)
	Quantity	-0.12***	-0.07**	0.00	-0.05	-0.10**	-0.14***	-0.08	-0.05
		(0.04)	(0.03)	(0.08)	(0.05)	(0.04)	(0.03)	(0.07)	(0.04)
	Participation	-0.11***	-0.24***	-0.21***	-0.29***	0.01	-0.00	0.03	0.09**
		(0.03)	(0.03)	(0.06)	(0.05)	(0.04)	(0.03)	(0.05)	(0.03)

	Quantity	Beer		Cider		Wine		Spirits	
Variable	**Channel**	**On**	**Off**	**On**	**Off**	**On**	**Off**	**On**	**Off**
Household members all aged 70 +	Quantity	-0.23***	-0.08	-0.04	-0.24***	0.02	-0.11***	-0.13*	0.01
		(0.05)	(0.05)	(0.11)	(0.08)	(0.05)	(0.04)	(0.08)	(0.04)
Male HRP	Participation	0.35***	0.16***	0.01	0.06**	-0.15***	-0.07***	-0.06**	0.07***
		(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)
	Quantity	0.15***	0.03	0.05	0.08*	0.06**	0.03	0.02	0.06**
		(0.03)	(0.03)	(0.05)	(0.04)	(0.03)	(0.02)	(0.04)	(0.03)

Asterisks indicate significance level (*** p<0.01; ** p<0.05; * p<0.1), standard errors shown in parentheses. Figures subject to rounding. Source: LCF, Deloitte analysis

5.3 Robustness checks for the preferred model specification

Alongside results from the preferred model, Table 12 below shows the results of further robustness checks applied using different approaches: these include using alterative proxies for household income (total expenditure, total income and disposable income); applying a quarterly rather than annual model; and a different end year of 2015-16 for the data sample. For brevity, only the coefficients for the own-price elasticity and linear time trend estimates are shown. The results are found to be broadly stable in each case, with own-price elasticity coefficients remaining statistically significant and their magnitudes remaining broadly unchanged.

Table 12: Robustness checks for own-price elasticity estimates using different approaches

		Coefficient	Preferred Model	Quarterly Model	End-year 2015-16	Total Expenditure	Total Income	Disposable Income
Beer	On	Log-Price	-0.454***	-0.455***	-0.499***	-0.448***	-0.412***	-0.410***
		Time Trend	0.0158**	0.0158**	0.0158**	0.0158**	0.0140*	0.0137*
	Off	Log-Price	-0.811***	-0.811***	-0.802***	-0.809***	-0.796***	-0.796***
		Time Trend	-0.00960	-0.00960	-0.00960	-0.00953	-0.0102	-0.0103
Cider	On	Log-Price	-0.419***	-0.421***	-0.416***	-0.414***	-0.419***	-0.420***
		Time Trend	0.00437	0.00437	0.00437	0.00364	0.00403	0.00481
	Off	Log-Price	-0.989***	-0.989***	-1.011***	-0.989***	-0.986***	-0.986***
		Time Trend	0.00229	0.00229	0.00229	0.00273	0.00277	0.00254
Wine	On	Log-Price	-0.433***	-0.433***	-0.472***	-0.432***	-0.395***	-0.394***
		Time Trend	0.0140*	0.0140*	0.0140*	0.0151*	0.0145*	0.0142*
	Off	Log-Price	-0.216***	-0.217***	-0.209***	-0.214***	-0.192***	-0.191***
		Time Trend	-0.00794	-0.00794	-0.00794	-0.00759	-0.00840	-0.00877
Spirits	On	Log-Price	-0.922***	-0.921***	-0.948***	-0.921***	-0.920***	-0.918***
		Time Trend	0.0112	0.0112	0.0112	0.0111	0.0104	0.01000
	Off	Log-Price	-0.193***	-0.195***	-0.214***	-0.194***	-0.174***	-0.173***
		Time Trend	0.0175**	0.0175**	0.0175**	0.0179**	0.0178**	0.0177**

Asterisks indicate significance level (*** p<0.01; ** p<0.05; * p<0.1). Source: LCF, Deloitte analysis

5.4 Other modelling specifications

Other modelling specifications in order to test the robustness of the model coefficients for the different alcohol categories. These alternative specifications include Ordinary Least Squares (OLS) on both the full sample and a subsample of non-zero observations, and the aforementioned Tobit Model. In order to exploit the full data sample, the preferred Heckman model specification and the alternative specifications have been tested with the linear-log specification. Otherwise, in the case

of the Tobit model and the OLS model with full sample, the log transformation of the dependent variable would result in the loss of zero observations. Following convention, the elasticities have been estimated at the sample average.[15] The Full Information Maximum Likelihood (FIML) estimator is typically not as stable when using levels in the left-hand side of the equation, so the Heckman Model with two-step estimator has been used instead.

Table 13 overleaf shows the coefficient estimates for the own-price elasticities taken from the Heckman Correction model with the two-step estimator applied. As the dependent variable of the quantity of alcohol consumed is now in a linear format, as expected the resulting coefficients vary considerably from those using the double-log form.

Table 13: Elasticity estimates using the linear-log functional form, Heckman two-step estimator

	Quantity Beer			Cider		Wine		Spirits	
Price	**Channel**	**On**	**Off**	**On**	**Off**	**On**	**Off**	**On**	**Off**
Beer	On	-1.26***	-0.02	-5.22	-2.28	-0.25	-0.28	3.43	0.57
	Off	-0.13	-2.77***	-1.44	-0.38	0.33	-0.13	-0.98	-0.02
Cider	On	-0.62**	-0.31	-7.22***	-0.64	0.58	0.24	5.53**	0.95
	Off	-0.04	-0.16	-4.43**	-11.24***	-0.19	-0.37***	-0.80	-0.87**
Wine	On	0.07	0.06	-3.30	0.91	-2.98***	-0.07	3.78*	0.38
	Off	0.08	-0.16	1.93	0.96	0.50	-0.44***	0.43	0.96**
Spirits	On	0.02	0.36	-0.51	-2.29	-0.57	-0.09	-20.88***	-0.01
	Off	0.11	0.15	2.87	-0.43	0.14	0.16	0.92	-1.60***

Note: own-price elasticities are highlighted; asterisks indicate significance level (*** p<0.01; ** p<0.05; * p<0.1). Quantities and prices of beer and cider expressed per pint; quantities and prices of wine and spirits expressed per ml

Source: LCF, Deloitte analysis

As a first comparison, Table 14 below shows the coefficient estimates for the own-price elasticities taken from the OLS model using the full sample. While the estimates remain statistically significant, there are marked differences in the magnitude of the estimates when compared to those from the preferred model. In particular, demand for beer, wine and off-trade spirits is found to be much more elastic. These large differences, coupled with the evidence supporting the use of a Heckman Correction model detailed in Annex C, provide evidence that the use of an OLS model on the full data sample would result in biased elasticity estimates.

Table 14: Elasticity estimates using the linear-log functional form, OLS with full sample

	Quantity Beer			Cider		Wine		Spirits	
Price	**Channel**	**On**	**Off**	**On**	**Off**	**On**	**Off**	**On**	**Off**
Beer	On	-1.71***	-0.06	-0.71**	-0.07	1.36***	0.15	0.62*	0.03
	Off	-0.12*	-2.86***	-0.11	-0.33**	0.16**	-0.06	0.17	-0.12
Cider	On	-0.26**	-0.44***	-2.10***	0.11	0.47***	0.14	-0.18	0.28*
	Off	0.01	0.10	-0.44**	-3.52***	-0.11	-0.18***	-0.12	-0.18
Wine	On	-0.20*	-0.13	-0.77**	-0.3*	-3.96***	-0.31***	0.70**	0.20
	Off	0.05	-0.31***	-0.12	-0.49***	0.28**	-0.86***	0.28*	0.23
Spirits	On	-0.2**	0.12	-0.32*	-0.27**	0.14	0.00	-9.64***	-0.14
	Off	0.10*	-0.03	0.29**	-0.20	0.11	-0.08	0.09	-2.03***

Note: own-price elasticities are highlighted; asterisks indicate significance level (*** p<0.01; ** p<0.05; * p<0.1). Quantities and prices of beer and cider expressed per pint; quantities and prices of wine and spirits expressed per ml
Source: LCF, Deloitte analysis

As an alternative to running an OLS model on the full sample as above, Table 15 overleaf shows the coefficient estimates for the own-price elasticities taken from the OLS model using only non-zero observations. Again, the coefficients are of a significantly higher magnitude when compared to those from the preferred model, indicated that there is evidence of bias.

[15] When using a linear-log functional form, the own-price elasticity is conventionally estimated using the transformation of the own-price coefficient by dividing it by the quantity consumed; in this case, the quantity consumed is taken as the sample average.

Table 15: Elasticity estimates using the linear-log functional form, OLS with subsample

	Quantity Beer			Cider		Wine		Spirits	
Price	**Channel**	**On**	**Off**	**On**	**Off**	**On**	**Off**	**On**	**Off**
Beer	On	-1.60***	-0.04	-5.15*	-2.28	1.00**	-0.12	3.46*	0.56
	Off	-0.15	-3.12***	-1.25	-0.39	0.39	-0.13	-0.96	-0.10
Cider	On	-0.61**	-0.38	-8.17***	-0.64	1.16*	0.30	5.53***	1.01
	Off	-0.03	-0.15	-4.52***	-11.25***	-0.25	-0.4***	-0.74	-0.86*
Wine	On	-0.06	0.00	-3.73*	0.89	-4.34***	-0.27	3.84**	0.34
	Off	0.03	-0.25	1.48	0.93	0.48	-0.77***	0.43	1.08**
Spirits	On	-0.11	0.36	-0.84	-2.29*	-0.35	-0.08	-21.09***	-0.10
	Off	0.16	0.12	2.9*	-0.43	0.05	0.03	0.94	-2.18***

Note: own-price elasticities are highlighted; asterisks indicate significance level (*** p<0.01; ** p<0.05; * p<0.1). Quantities and prices of beer and cider expressed per pint; quantities and prices of wine and spirits expressed per ml

Source: LCF, Deloitte analysis

Finally, Table 16 below shows the coefficient estimates derived from the Tobit Model; once again, the estimates are of a much greater magnitude compared to those from the preferred model. This is perhaps unsurprising however as in this context the Heckman Correction and Tobit models are applying different assumptions regarding the consumption of alcohol. Here, the Tobit Model assumes that alcohol consumption is censored at zero, with zero consumption distinguished by the actual decision to not purchase alcohol versus instances where alcohol consumption has in fact not been recorded.

Table 16: Elasticity estimates using the linear-log functional form, Tobit Model

	Quantity Beer			Cider		Wine		Spirits	
Price	**Channel**	**On**	**Off**	**On**	**Off**	**On**	**Off**	**On**	**Off**
Beer	On	-3.35***	-0.16	-2.75	2.36	6.85***	0.56**	1.16	0.12
	Off	-0.34**	-6.26***	1.32	-3.05***	0.41	-0.16	1.02	-0.89**
Cider	On	-0.46	-1.06**	-16.46***	-1.75	2.94***	0.34	1.00	1.26*
	Off	-0.07	0.17	-3.94*	-10.84***	-0.49	-0.36**	2.77**	-0.56
Wine	On	-0.89***	-0.66**	-8.21***	-3.27**	-11.02***	-0.92***	1.85	0.32
	Off	-0.13	-1.16***	-3.86*	-6.64***	-0.01	-2.08***	1.45	0.74
Spirits	On	-0.66***	0.10	-3.53	-0.32	0.73	0.03	-25.55***	-0.81*
	Off	0.36**	-0.18	2.24	-2.52***	-0.09	-0.35***	1.04	-6.81***

Note: own-price elasticities are highlighted; asterisks indicate significance level (*** p<0.01; ** p<0.05; * p<0.1). Quantities and prices of beer and cider expressed per pint; quantities and prices of wine and spirits expressed per ml

Source: LCF, Deloitte analysis

Annex A: Further Descriptive Statistics

This annex sets out the descriptive statistics for the other variables used in the study not already outlined earlier in the paper. For the Region, Socioeconomic Group, Marital Status and Ethnicity variables, the reference category is shown emboldened, as it necessary to create a reference category for which the effects of the other categories can then be compared against.

Table A.1: Households by former Government Office Region (GORS) and other variables

Region	Proportion	Variable	Proportion
North East	5%	Consumers of alcoholic beverages	53.0%
North West and Merseyside	11%	With all members aged 70 or above	16.1%
Yorkshire and the Humber	9%	With at least one child aged under 5	33.6%
East Midlands	8%	Owner-occupiers (outright, mortgage)	12.4%
West Midlands	9%	Married or Civil Partnership	49.9%
East of England	10%	Co-habitee	10.6%
London	9%	Single	14.7%
South East	13%	Widowed	10.6%
South West	9%	Divorced, Separated or Former Civil Partner	14.3%
Wales	5%		
Scotland	9%		
Northern Ireland	5%		

Source: LCF, Deloitte analysis

Table A.2: Households by socioeconomic group and ethnicity by Reference Person (HRP)

Socioeconomic group	Proportion	Ethnicity	Proportion
Large employers and higher managerial	7%	White	73%
Higher Professional	13%	Mixed Multiple Ethnic	2%
Lower managerial and professional	17%	Asian or Asian British	2%
Intermediate occupations	6%	Black or Black British	1%
Small employers and own account workers	6%	Other Ethnic Group	1%
Lower supervisory and technical occupations	5%	Not Known	21%
Semi-routine occupations	7%		
Routine occupations	6%		
Never worked and long term unemployed	2%		
Students	1%		
Occupation not stated	1%		
Not classified	29%		

Source: LCF, Deloitte analysis

Annex B: Constructing the dataset using LCF data

This annex sets out information on how the dataset has been constructed using data taken from the LCF for the years 2012 to 2016-17 inclusive. Data has been collated from three sources within the LCF: the main household-level data, personal-level data, and raw household diary data.

B.1 Household and person-level LCF data

Information for individual households has been sourced and compiled from the main LCF household-level datasets, and have collectively been used to generate most of the control variables. Each household is attributed a case number within the LCF, which forms the basis of each observation. The household-level variables used are described in Tables B.1 and B.2 below. Separately, Table B.3 sets out the data taken from the from the LCF person-level variables for the Household Reference Person (HRP), which is then used to represent the overall household.

Table B.1: LCF household-level variables

LCF Code(s)	Variable	Description
A049	Household Size	Number of individuals in household
Year	Year	Yeah of survey
SampQtr	Sample Quarter	Calendar quarter in which household data collected
GORX	Government Office Region (GORS)	Region where the household is located
P600	Weekly total consumption expenditure	Weekly total consumption expenditure, EFS criteria
P550P	Total expenditure	Total expenditure, by adults and children (anonymised)
P344	Gross Household income	Gross normal weekly household income
P389	Disposable household income	Normal weekly disposable household income

Source: LCF, Deloitte analysis

Table B.2: Household-level variables derived using LCF household-level data

LCF Code(s)	Variable	Description
A043-A047	Number at drinking age	Number of individuals in household who are eligible to smoke, proxied by aged 18 or above
A047	Older household	Households in which all members are aged 70 or over
SexHRP	Sex of House Reference Person	Gender of HRP (Male or Female)
A121	Owner-occupier	Households which are outright owners of their main dwelling, or own with a mortgage
A040, A041	Children under 5	Households which have at least one child aged five or under living in the household
FS22	Smoking Household	Households reporting expenditure on tobacco

Source: LCF, Deloitte analysis

Table B.3: Household-level variables derived using LCF person-level data

LCF Code(s)	Variable	Description
A006	Marital status	Marital status of HRP, condensed into: Married or Civil Partnership; Co-habitee; Single; Widowed; and Divorced, Separated or Former Civil Partner
A121	Ethnicity	Ethnicity of HRP: White, Mixed Multiple Ethnic, Asian or Asian British, Black or Black British, and Other Ethnic Group
A094	Socioeconomic group	Socioeconomic group of HRP by 12 category grouping

Source: LCF, Deloitte analysis

B.2 Alcohol category data

Table B.4 below shows the various subcategories of alcohol product reported consumed while eating-out, and how these have been aggregated into the four main categories for which demand has been estimated. The remaining products—sparkling wine, fortified wine, RTDs, cocktails and rounds of drinks—are identified, but not aggregated and are included as controls in the models.

Table B.4: Identification and aggregation of on-trade alcohol categories within LCF diary data

Category	LCF Code(s)	Description	Serving	Assumed Volume
Beer	TYPEBEER	Bitter, Ale or Stout	Half Pint	284ml/0.5 pint
			Pint	568 ml/1 pint
			Bottle	500ml/0.88 pint
			Can	440ml/0.77 pint
			Not specified	Estimated
		Lager	Half Pint	284ml/0.5 pint
			Pint	568 ml/1 pint
			Bottle	500ml/0.88 pint
			Can	440ml/0.77 pint
			Not specified	Estimated
Cider	TYPECIDE	Cider	Half Pint	284ml/0.5 pint
			Pint	568 ml/pint
			Bottle	500ml/0.88 pint
			Can	440ml/0.77 pint
			Not specified	Estimated
Wine	TYPEWINE	Wine	Small Glass	125 ml
			Medium Glass	175 ml
			Large Glass	250 ml
			Not specified	Estimated
			Half bottle	375 ml
			Bottle	750 ml
Spirits	TYPESPIR	Spirits	Single Measure	25 ml
			Double Measure	50 ml
			Bottle	700 ml
			Not specified	Estimated

	TYPESPMX	Spirits with mixer	Glass with single measure	25 ml
			Glass with double measure	50 ml
			Bottle	700 ml
			Not specified	Estimated
	TYPELIQU	Liqueurs	Glass with single measure	25 ml
			Glass with double measure	50 ml
			Bottle	700 ml
			Not specified	Estimated
	TYPELQMX	Liqueurs with mixer	Glass with single measure	25 ml
			Glass with double measure	50 ml
			Bottle	700 ml
			Not specified	Estimated
Sparkling Wine	TYPECHAM	Other alcohol category variables, servings and volumes not captured. Round of drinks captured within the TYPEALC variable.		
Fortified Wine	TYPEFORT			
RTDs	TYPEAPOP			
Round of drinks	TYPEALC (12)			
Cocktails	TYPECKTL			

Note: Figures subject to rounding. Source: LCF, Deloitte analysis

Finally, Table B.5 below shows the various subcategories of alcohol product reported consumed through the off-trade (products purchased for home consumption), and again how these have been aggregated into the four main categories for which demand has been estimated.

Unlike the on-trade, LCF diary data provides information on the volumes and unit prices of consumed products through the MAFFQUAN and UNITCOST variables respectively. As discussed in the Dataset chapter of this paper, in instances where either information under the MAFFQUAN and UNITCOST variables is missing, values have been estimated using the average unit costs in each geographical region.

Table B.5: Identification and aggregation of off-trade alcohol categories within LCF diary data

Category	EFS Code(s)	Description
Beer	1.4.3.1.1	Beers including pale ale, stout, Guinness
	1.4.3.1.2	Lagers and continental beers
Cider	1.4.2.1.4	Ciders and Perry, including Babycham
Wine	1.4.2.1.1	Table wine including wine not specified
Spirits	1.4.1.1.1	Spirits e.g. gin, vodka, whiskey
	1.4.1.1.2	Liqueurs and cocktails e.g. Baileys, Daiquiri
	1.4.1.1.3	Spirits with mixer e.g. ready-to-drink gin and tonic
Sparkling Wine	1.4.2.1.2	Champagne and sparkling wines; wine with mixer e.g. Bucks Fizz
Fortified Wine	1.4.2.1.3	Fortified Wine—port, sherry, vermouth, Cinzano, Martini
Ready To Drinks (RTDs)	1.4.2.1.5	Alcopops, alcoholic soft drinks e.g. Bacardi Breezer, Smirnoff ice, Hooch

Source: LCF, Deloitte analysis

Annex C: Full Model Results

This annex sets out the full model results from the preferred modelling specification. Results from the participation equation are shown first, followed by the quantity equation. Point estimates and their associated standard errors are shown, with the latter in parentheses.

Table C.1: Regression outputs from the participation equation using the preferred specification

Log Price and Income	**Beer (On)**	**Beer (Off)**	**Cider (On)**	**Cider (Off)**	**Wine (On)**	**Wine (Off)**	**Spirits (On)**	**Spirits (Off)**
Beer (On)	-0.700***	0.0232	-0.0252	0.153*	0.582***	0.105*	-0.0378	-0.0677
	(0.0740)	(0.0597)	(0.0762)	(0.0847)	(0.0696)	(0.0603)	(0.0677)	(0.0669)
Beer (Off)	0.0231	-0.679***	0.0441	-0.00181	0.0162	0.0877***	0.0357	-0.0184
	(0.0329)	(0.0423)	(0.0487)	(0.0414)	(0.0384)	(0.0313)	(0.0436)	(0.0349)
Cider (On)	-0.0136	-0.152***	-0.314***	-0.0334	0.257***	0.0211	-0.0308	0.0766
	(0.0598)	(0.0585)	(0.109)	(0.0758)	(0.0688)	(0.0553)	(0.0732)	(0.0618)
Cider (Off)	-0.0413	0.0702**	-0.0458	-0.202***	-0.0369	-0.0317	0.127***	-0.0107
	(0.0356)	(0.0349)	(0.0498)	(0.0553)	(0.0420)	(0.0331)	(0.0482)	(0.0372)
Wine (On)	-0.000557	-0.0403	-0.0915	-0.0436	-0.941***	-0.0599	0.136**	0.0948*
	(0.0505)	(0.0481)	(0.0678)	(0.0642)	(0.0627)	(0.0468)	(0.0585)	(0.0526)
Wine (Off)	-0.0198	-0.0824**	-0.0723	-0.130**	0.0176	-0.440***	0.0495	0.0907**
	(0.0425)	(0.0406)	(0.0626)	(0.0508)	(0.0446)	(0.0479)	(0.0529)	(0.0427)
Spirits (On)	-0.0726*	0.00402	0.0117	0.0129	0.183***	0.00447	-0.418***	-0.0488
	(0.0399)	(0.0376)	(0.0508)	(0.0501)	(0.0468)	(0.0356)	(0.0501)	(0.0404)
Spirits (Off)	0.0711**	0.0203	0.0393	-0.0408	-0.0147	-0.00596	0.0258	-0.542***
	(0.0302)	(0.0295)	(0.0444)	(0.0381)	(0.0352)	(0.0285)	(0.0379)	(0.0374)
Log real weekly expenditure	0.318***	0.0954***	0.170***	0.00879	0.597***	0.352***	0.323***	0.222***
	(0.0174)	(0.0178)	(0.0265)	(0.0238)	(0.0212)	(0.0168)	(0.0237)	(0.0188)
Instruments	**Beer (On)**	**Beer (Off)**	**Cider (On)**	**Cider (Off)**	**Wine (On)**	**Wine (Off)**	**Spirits (On)**	**Spirits (Off)**
Consumption of Beer: On	-	0.457***	0.680***	-0.0247	0.697***	0.0892***	0.874***	-0.0317
	-	(0.0208)	(0.0329)	(0.0295)	(0.0239)	(0.0201)	(0.0280)	(0.0238)
Consumption of Beer: Off	0.468***	-	-0.120***	0.359***	-0.0391	0.399***	-0.084***	0.262***
	(0.0209)	-	(0.0321)	(0.0272)	(0.0242)	(0.0198)	(0.0286)	(0.0231)
Consumption of Cider: On	0.764***	-0.132***	-	0.684***	0.162***	-0.0477	0.385***	0.0234
	(0.0399)	(0.0365)	-	(0.0417)	(0.0387)	(0.0354)	(0.0406)	(0.0395)
Consumption of Cider: Off	-0.0388	0.414***	0.668***	-	-0.0639*	0.226***	-0.0903**	0.204***
	(0.0333)	(0.0311)	(0.0394)	-	(0.0381)	(0.0309)	(0.0436)	(0.0340)
Consumption of Wine: On	0.705***	-0.0497*	0.165***	-0.0825**	-	0.474***	0.335***	0.0684**
	(0.0256)	(0.0254)	(0.0353)	(0.0352)	-	(0.0237)	(0.0311)	(0.0271)
Consumption of Wine: Off	0.0828***	0.386***	-0.0230	0.204***	0.455***	-	-0.0442	0.485***
	(0.0200)	(0.0197)	(0.0307)	(0.0271)	(0.0220)	-	(0.0275)	(0.0211)
Consumption of Sparkling Wine: On	0.401***	-0.134*	-0.00717	0.0239	0.714***	0.0121	0.275***	-0.0101
	(0.0842)	(0.0708)	(0.0904)	(0.0972)	(0.0757)	(0.0712)	(0.0828)	(0.0767)
Consumption of Sparkling Wine: Off	-0.0463	0.287***	-0.0613	0.135***	0.142***	0.461***	0.0691	0.209***
	(0.0396)	(0.0369)	(0.0566)	(0.0472)	(0.0402)	(0.0375)	(0.0477)	(0.0390)
Consumption of Fortified Wine: On	0.272**	-0.0126	0.211*	-0.0294	0.592***	-0.0348	0.695***	0.0683
	(0.127)	(0.114)	(0.126)	(0.152)	(0.120)	(0.108)	(0.112)	(0.117)
Consumption of Fortified Wine: Off	-0.0315	0.221***	-0.0906	0.132**	0.134***	0.365***	-0.0727	0.617***
	(0.0497)	(0.0484)	(0.0763)	(0.0643)	(0.0515)	(0.0469)	(0.0672)	(0.0473)
Consumption of Spirits: On	0.961***	-0.090***	0.365***	-0.0915**	0.374***	-0.085***	-	0.204***
	(0.0323)	(0.0306)	(0.0379)	(0.0417)	(0.0316)	(0.0295)	-	(0.0324)
Consumption of Spirits: Off	-0.0312	0.288***	0.00446	0.200***	0.0934***	0.516***	0.199***	-
	(0.0251)	(0.0239)	(0.0359)	(0.0312)	(0.0267)	(0.0226)	(0.0310)	-
Consumption of RTDs: On	0.635***	-0.0708	0.420***	-0.0159	-0.0688	-0.0343	0.646***	0.00189
	(0.111)	(0.0923)	(0.103)	(0.128)	(0.103)	(0.0892)	(0.101)	(0.0995)
Consumption of RTDs: Off	-0.142***	0.260***	0.0552	1.931***	-0.0339	0.0166	0.0934	0.0866
	(0.0535)	(0.0500)	(0.0629)	(0.0507)	(0.0588)	(0.0491)	(0.0662)	(0.0533)
Consumption of Round of drinks	0.182***	0.137**	0.0186	-0.0125	0.170***	-0.0418	0.0785	0.139**
	(0.0594)	(0.0548)	(0.0777)	(0.0722)	(0.0574)	(0.0542)	(0.0689)	(0.0595)
Consumption of Cocktails	0.258***	-0.159***	0.346***	-0.0693	0.519***	-0.138**	0.577***	0.139**
	(0.0675)	(0.0594)	(0.0649)	(0.0778)	(0.0598)	(0.0547)	(0.0604)	(0.0596)
Controls	**Beer (On)**	**Beer (Off)**	**Cider (On)**	**Cider (Off)**	**Wine (On)**	**Wine (Off)**	**Spirits (On)**	**Spirits (Off)**
Male Household Reference Person	0.345***	0.164***	0.00700	0.0577**	-0.148***	-0.071***	-0.0600**	0.0736***
	(0.0215)	(0.0215)	(0.0318)	(0.0282)	(0.0242)	(0.0197)	(0.0276)	(0.0231)
Number in household at drinking age or above	0.0261	0.0878***	0.151***	0.0524**	-0.0849***	-0.00984	0.222***	0.0375**
	(0.0176)	(0.0162)	(0.0217)	(0.0206)	(0.0198)	(0.0162)	(0.0192)	(0.0174)
Household members all aged 70 or over	-0.110***	-0.242***	-0.205***	-0.286***	0.0149	-0.00416	0.0301	0.0869**
	(0.0315)	(0.0349)	(0.0592)	(0.0508)	(0.0381)	(0.0302)	(0.0476)	(0.0348)

Standard errors in parentheses; asterisks indicate significance level (*** p<0.01; ** p<0.05; * p<0.1)

Controls (continued)	Beer (On)	Beer (Off)	Cider (On)	Cider (Off)	Wine (On)	Wine (Off)	Spirits (On)	Spirits (Off)
Smoking Household	0.0302	0.144***	-0.0321	0.0870***	-0.185***	-0.0473**	0.109***	0.220***
	(0.0240)	(0.0234)	(0.0367)	(0.0306)	(0.0296)	(0.0228)	(0.0314)	(0.0253)
Owner-Occupier (mortgage or outright)	0.0736***	0.0803***	0.0341	0.0394	0.109***	0.133***	0.0580**	-0.0228
	(0.0212)	(0.0208)	(0.0309)	(0.0277)	(0.0248)	(0.0200)	(0.0281)	(0.0233)
Household with at least one child aged under 5	-0.162***	0.0962***	-0.116**	-0.0348	-0.131***	-0.112***	-0.0475	-0.124***
	(0.0291)	(0.0276)	(0.0462)	(0.0375)	(0.0369)	(0.0276)	(0.0419)	(0.0330)
Marital: Co-habitee	0.0225	0.0979***	0.252***	0.00392	-0.0939***	-0.0467*	0.144***	-0.0192
	(0.0296)	(0.0286)	(0.0402)	(0.0376)	(0.0350)	(0.0283)	(0.0380)	(0.0324)
Marital: Single	-0.143***	-0.153***	0.163***	-0.0501	-0.135***	-0.290***	0.393***	-0.0584
	(0.0366)	(0.0360)	(0.0523)	(0.0472)	(0.0423)	(0.0339)	(0.0445)	(0.0390)
Marital: Widowed	-0.234***	-0.233***	-0.0264	-0.0267	-0.121**	-0.189***	0.132**	-0.0169
	(0.0432)	(0.0455)	(0.0737)	(0.0609)	(0.0490)	(0.0386)	(0.0611)	(0.0446)
Marital: Divorced, Separated	-0.156***	-0.153***	0.104*	-0.0357	-0.204***	-0.108***	0.241***	-0.0287
	(0.0360)	(0.0360)	(0.0535)	(0.0469)	(0.0425)	(0.0328)	(0.0464)	(0.0383)
Higher Professional	-0.0154	0.0846**	-0.0421	0.0864	-0.0691	0.0627*	0.0417	0.00951
	(0.0401)	(0.0403)	(0.0585)	(0.0547)	(0.0476)	(0.0374)	(0.0551)	(0.0443)
Lower managerial and professional	-0.0340	0.0353	-0.0481	0.181***	0.0770	0.0211	0.178***	0.0759*
	(0.0418)	(0.0413)	(0.0600)	(0.0557)	(0.0479)	(0.0388)	(0.0558)	(0.0456)
Intermediate occupations	-0.0501	0.104**	-0.0230	0.189***	0.0311	-0.0306	0.245***	0.104*
	(0.0502)	(0.0498)	(0.0726)	(0.0658)	(0.0581)	(0.0468)	(0.0663)	(0.0553)
Small employers and own account workers	-0.0682	-0.00598	-0.0794	0.0495	0.0769	-0.0889*	0.130*	0.134**
	(0.0525)	(0.0525)	(0.0781)	(0.0722)	(0.0604)	(0.0495)	(0.0719)	(0.0570)
Lower supervisory and technical occupations	-0.00320	0.0386	-0.0938	0.194***	-0.0293	-0.122**	0.192***	0.156***
	(0.0546)	(0.0543)	(0.0816)	(0.0726)	(0.0660)	(0.0520)	(0.0741)	(0.0598)
Semi-routine occupations	-0.198***	0.0393	-0.0660	0.122*	-0.0302	-0.172***	0.186***	0.160***
	(0.0516)	(0.0507)	(0.0778)	(0.0680)	(0.0620)	(0.0481)	(0.0710)	(0.0550)
Routine occupations	-0.142***	0.0959*	-0.0438	0.230***	-0.178***	-0.310***	0.225***	0.141**
	(0.0528)	(0.0519)	(0.0779)	(0.0677)	(0.0681)	(0.0508)	(0.0723)	(0.0577)
Never worked and long-term unemployed	-0.0202	0.0386	-0.385*	0.226*	-0.412**	-0.445***	-0.118	0.107
	(0.0936)	(0.0903)	(0.198)	(0.119)	(0.197)	(0.104)	(0.164)	(0.103)
Students	-0.174*	-0.0286	0.0320	0.256**	-0.153	-0.0281	0.265**	0.128
	(0.0974)	(0.0932)	(0.122)	(0.104)	(0.107)	(0.0858)	(0.107)	(0.0894)
Occupation not stated	-0.378**	-0.135	-0.267	0.169	-0.0851	-0.216	0.136	-0.0802
	(0.177)	(0.165)	(0.268)	(0.191)	(0.188)	(0.149)	(0.217)	(0.189)
Not classified	-0.00127	-0.0628	-0.154**	-0.0462	0.110**	-0.0891**	0.0886	0.175***
	(0.0414)	(0.0428)	(0.0643)	(0.0585)	(0.0501)	(0.0388)	(0.0584)	(0.0451)
Not stated	0.0167	0.00654	-0.0277	-0.0268	-0.0238	-0.0282	-0.0421	0.0232
	(0.0231)	(0.0227)	(0.0331)	(0.0300)	(0.0267)	(0.0221)	(0.0303)	(0.0250)
Mixed Multiple Ethnic	-0.265**	-0.0269	-0.0820	-0.133	-0.141	-0.125	-0.101	-0.108
	(0.124)	(0.117)	(0.196)	(0.153)	(0.156)	(0.109)	(0.178)	(0.136)
Asian or Asian British	-0.458***	-0.491***	-0.768***	-0.497***	-0.479***	-0.545***	-0.316***	-0.156**
	(0.0594)	(0.0628)	(0.166)	(0.106)	(0.0843)	(0.0595)	(0.0945)	(0.0680)
Black African, Black Caribbean, Black British	-0.776***	-0.124	-0.195	-0.159	-0.296**	-0.221***	-0.100	-0.0833
	(0.125)	(0.0884)	(0.161)	(0.119)	(0.128)	(0.0823)	(0.137)	(0.0964)
Other ethnic group	-0.380***	-0.299***	-1.085***	-0.207	-0.193	-0.292***	-0.173	-0.168
	(0.105)	(0.108)	(0.378)	(0.136)	(0.136)	(0.100)	(0.153)	(0.121)
North East	0.0317	-0.118**	0.0782	0.116	-0.155**	-0.0965*	-0.109	0.0937
	(0.0593)	(0.0589)	(0.0885)	(0.0797)	(0.0711)	(0.0574)	(0.0785)	(0.0641)
North West and Merseyside	0.0306	-0.0112	-0.0798	0.108*	-0.00187	0.0287	-0.0743	0.0753
	(0.0471)	(0.0463)	(0.0746)	(0.0656)	(0.0531)	(0.0437)	(0.0608)	(0.0503)
Yorkshire and the Humber	0.159***	-0.00957	-0.0151	0.140**	-0.169***	-0.0969**	-0.160**	0.0765
	(0.0485)	(0.0484)	(0.0764)	(0.0669)	(0.0568)	(0.0463)	(0.0653)	(0.0527)
East Midlands	0.144***	-0.0200	0.0269	0.172**	-0.136**	-0.0817*	-0.196***	0.0740
	(0.0496)	(0.0495)	(0.0780)	(0.0685)	(0.0579)	(0.0474)	(0.0665)	(0.0535)
West Midlands	0.0102	-0.0489	0.0799	0.164**	-0.0546	-0.0595	-0.0974	0.0945*
	(0.0485)	(0.0476)	(0.0737)	(0.0659)	(0.0546)	(0.0455)	(0.0635)	(0.0514)
Eastern England	-0.0176	0.00633	-0.0467	0.0811	0.0247	-0.0300	-0.133**	-0.0441
	(0.0450)	(0.0450)	(0.0719)	(0.0641)	(0.0505)	(0.0425)	(0.0594)	(0.0492)
South East	0.0366	0.0334	0.0287	0.127**	-0.0960**	-0.0407	-0.133**	-0.0518
	(0.0427)	(0.0424)	(0.0668)	(0.0601)	(0.0479)	(0.0400)	(0.0561)	(0.0467)
South West	0.00821	-0.0721	0.314***	0.236***	-0.135**	0.0507	-0.0717	-0.0171
	(0.0467)	(0.0468)	(0.0688)	(0.0630)	(0.0525)	(0.0432)	(0.0612)	(0.0503)
Wales	-0.0922	-0.191***	0.122	0.198**	-0.121*	0.0225	-0.139*	-0.0540
	(0.0592)	(0.0587)	(0.0894)	(0.0776)	(0.0683)	(0.0541)	(0.0800)	(0.0644)
Scotland	-0.285***	-0.0644	-0.204**	0.128*	-0.0932*	0.0135	0.207***	0.217***
	(0.0502)	(0.0491)	(0.0828)	(0.0684)	(0.0566)	(0.0457)	(0.0611)	(0.0515)
Northern Ireland	-0.190***	-0.143**	-0.0864	-0.0648	-0.00377	-0.0453	0.106	0.111*
	(0.0595)	(0.0583)	(0.0975)	(0.0854)	(0.0664)	(0.0543)	(0.0758)	(0.0621)
Linear Time Trend	0.00698	0.0121**	0.0211**	0.0295***	-0.0502***	-0.0140**	0.0399***	0.0240***
	(0.00606)	(0.00603)	(0.00896)	(0.00835)	(0.00699)	(0.00572)	(0.00805)	(0.00659)
Constant	1.336**	-2.012***	-1.414*	-3.210***	-9.023***	-3.255***	-2.964***	-2.713***
	(0.562)	(0.508)	(0.830)	(0.686)	(0.589)	(0.496)	(0.617)	(0.552)
Observations	27,143	27,143	27,143	27,143	27,143	27,143	27,143	27,143

Standard errors in parentheses; asterisks indicate significance level (*** p<0.01; ** p<0.05; * p<0.1)

Table C.2: Regression outputs from the quantity equation using the preferred specification

Log Price and Income	**Beer (On)**	**Beer (Off)**	**Cider (On)**	**Cider (Off)**	**Wine (On)**	**Wine (Off)**	**Spirits (On)**	**Spirits (Off)**
Beer (On)	-0.454***	0.0494	-0.192	-0.298**	-0.0180	-0.0866	-0.0461	0.0495
	(0.0580)	(0.0683)	(0.118)	(0.117)	(0.0742)	(0.0637)	(0.105)	(0.0718)
Beer (Off)	-0.0542	-0.811***	-0.122	-0.0323	0.00237	-0.0748**	-0.0588	-0.0203
	(0.0379)	(0.0356)	(0.0781)	(0.0527)	(0.0451)	(0.0334)	(0.0669)	(0.0361)
Cider (On)	-0.151**	-0.0448	-0.419***	-0.0586	0.00559	0.110*	0.174	0.0733
	(0.0703)	(0.0719)	(0.0863)	(0.0964)	(0.0808)	(0.0629)	(0.107)	(0.0698)
Cider (Off)	-0.0604	-0.0496	-0.245***	-0.989***	-0.0238	-0.0701*	-0.0346	-0.102**
	(0.0434)	(0.0418)	(0.0737)	(0.0399)	(0.0471)	(0.0364)	(0.0713)	(0.0425)
Wine (On)	0.0312	-0.00759	-0.127	-0.0507	-0.433***	-0.0553	-0.0279	0.0174
	(0.0499)	(0.0575)	(0.0888)	(0.0805)	(0.0466)	(0.0460)	(0.0869)	(0.0552)
Wine (Off)	-0.0139	0.0156	0.0307	0.0346	0.0935*	-0.216***	0.160**	0.0859**
	(0.0496)	(0.0494)	(0.0930)	(0.0778)	(0.0506)	(0.0366)	(0.0767)	(0.0428)
Spirits (On)	0.0399	0.0784*	0.0200	-0.112	-0.0260	-0.0279	-0.922***	0.0402
	(0.0406)	(0.0454)	(0.0740)	(0.0798)	(0.0502)	(0.0418)	(0.0382)	(0.0481)
Spirits (Off)	0.0164	0.0294	0.140**	-0.00537	0.0688*	0.0769***	0.0112	-0.193***
	(0.0366)	(0.0343)	(0.0652)	(0.0487)	(0.0401)	(0.0290)	(0.0575)	(0.0347)
Log equivalised weekly expenditure	0.0979***	0.0579**	-0.0436	0.0828**	0.248***	0.161***	0.137***	0.127***
	(0.0256)	(0.0236)	(0.0464)	(0.0336)	(0.0332)	(0.0214)	(0.0434)	(0.0269)
Controls	**Beer (On)**	**Beer (Off)**	**Cider (On)**	**Cider (Off)**	**Wine (On)**	**Wine (Off)**	**Spirits (On)**	**Spirits (Off)**
Male Household Reference Person	0.151***	0.0314	0.0525	0.0761*	0.0612**	0.0258	0.0244	0.0584**
	(0.0274)	(0.0266)	(0.0502)	(0.0399)	(0.0311)	(0.0227)	(0.0422)	(0.0266)
Number in household at drinking age or above	0.0664***	0.0412**	0.0994***	0.0310	0.0373*	-0.0382**	0.137***	-0.0359*
	(0.0202)	(0.0207)	(0.0340)	(0.0263)	(0.0221)	(0.0179)	(0.0293)	(0.0194)
Household members all aged 70 or over	-0.234***	-0.0776	-0.0427	-0.236***	0.0204	-0.108***	-0.131*	0.0123
	(0.0465)	(0.0512)	(0.108)	(0.0831)	(0.0506)	(0.0364)	(0.0764)	(0.0385)
Smoking Household	0.207***	0.203***	0.200***	0.198***	0.130***	0.148***	0.155***	0.0649**
	(0.0316)	(0.0295)	(0.0615)	(0.0443)	(0.0399)	(0.0271)	(0.0507)	(0.0296)
Owner-Occupier (outright or mortgage)	-0.0265	0.0304	0.0690	0.0727**	-0.0174	-0.0239	0.0753*	0.0581**
	(0.0258)	(0.0252)	(0.0488)	(0.0367)	(0.0294)	(0.0223)	(0.0419)	(0.0265)
At least one child aged under 5	-0.124***	-0.0739**	0.00336	-0.0458	-0.0951**	-0.140***	-0.0756	-0.0460
	(0.0360)	(0.0325)	(0.0751)	(0.0489)	(0.0435)	(0.0308)	(0.0660)	(0.0396)
Co-habitee	0.143***	-0.000120	0.136**	0.0444	0.0467	-0.132***	0.115**	-0.0639*
	(0.0351)	(0.0329)	(0.0605)	(0.0524)	(0.0415)	(0.0308)	(0.0567)	(0.0369)
Single	0.203***	-0.113**	0.243***	-0.0353	0.0264	-0.179***	0.230***	-0.0302
	(0.0468)	(0.0475)	(0.0826)	(0.0658)	(0.0529)	(0.0400)	(0.0664)	(0.0470)
Widowed	0.0427	-0.0581	-0.0389	0.0149	-0.0829	-0.188***	0.262**	-0.0485
	(0.0641)	(0.0706)	(0.121)	(0.0939)	(0.0640)	(0.0457)	(0.104)	(0.0514)
Divorced, Separated or Former Civil Partner	0.118**	0.0108	0.132	0.0578	0.0449	-0.175***	0.138*	-0.0392
	(0.0468)	(0.0477)	(0.0922)	(0.0662)	(0.0528)	(0.0371)	(0.0727)	(0.0470)
Higher Professional	-0.149***	-0.000999	-0.00644	-0.157*	-0.0762	-0.0442	0.0423	-0.0425
	(0.0489)	(0.0518)	(0.0895)	(0.0884)	(0.0548)	(0.0413)	(0.0793)	(0.0578)
Lower managerial and professional	-0.130***	-0.0532	-0.111	-0.115	-0.0528	-0.0447	0.0544	-0.0202
	(0.0502)	(0.0526)	(0.0887)	(0.0872)	(0.0544)	(0.0422)	(0.0798)	(0.0586)
Intermediate occupations	-0.105*	-0.0615	0.0354	-0.225**	-0.0622	-0.0596	0.0763	-0.108*
	(0.0605)	(0.0620)	(0.116)	(0.101)	(0.0686)	(0.0510)	(0.0972)	(0.0653)
Small employers and own account workers	-0.108*	0.0265	-0.106	-0.134	-0.102	0.0441	0.131	-0.0263
	(0.0654)	(0.0670)	(0.115)	(0.108)	(0.0716)	(0.0563)	(0.111)	(0.0687)
Lower supervisory and technical occupations	-0.133**	0.0884	-0.0957	0.00418	-0.0899	-0.107*	0.180	0.0139
	(0.0673)	(0.0667)	(0.127)	(0.108)	(0.0762)	(0.0579)	(0.114)	(0.0741)
Semi-routine occupations	-0.0370	-0.0258	0.0190	-0.221**	0.0751	-0.168***	0.0986	0.0864
	(0.0691)	(0.0672)	(0.125)	(0.105)	(0.0798)	(0.0542)	(0.104)	(0.0712)
Routine occupations	0.0284	0.0760	0.125	0.0154	0.0553	-0.0806	0.202*	-0.0277
	(0.0712)	(0.0672)	(0.134)	(0.106)	(0.0867)	(0.0614)	(0.112)	(0.0713)
Never worked and long-term unemployed	-0.120	0.108	-0.212	0.00715	0.173	0.211	-0.139	0.172
	(0.162)	(0.149)	(0.371)	(0.169)	(0.310)	(0.152)	(0.264)	(0.115)
Students	-0.335***	-0.0685	-0.299*	-0.258*	-0.135	-0.333***	0.00669	-0.0773
	(0.104)	(0.112)	(0.162)	(0.143)	(0.124)	(0.0932)	(0.156)	(0.101)
Occupation not stated	-0.217	-0.0598	0.103	-0.266	-0.337*	0.121	-0.372	-0.157
	(0.297)	(0.204)	(0.315)	(0.319)	(0.203)	(0.221)	(0.354)	(0.221)
Not classified	0.0212	0.00628	-0.159	-0.186*	-0.139**	0.0854*	-0.0282	0.160***
	(0.0552)	(0.0581)	(0.111)	(0.0995)	(0.0594)	(0.0451)	(0.0892)	(0.0578)
Not stated	0.0292	-0.0221	-0.113**	0.0709*	-0.0368	-0.00715	-0.0584	0.0157
	(0.0270)	(0.0264)	(0.0510)	(0.0420)	(0.0310)	(0.0240)	(0.0447)	(0.0288)

Standard errors in parentheses; asterisks indicate significance level (*** p<0.01; ** p<0.05; * p<0.1)

Controls (continued)	Beer (On)	Beer (Off)	Cider (On)	Cider (Off)	Wine (On)	Wine (Off)	Spirits (On)	Spirits (Off)
Mixed Multiple Ethnic	-0.0219	-0.453***	0.0671	0.175	0.115	0.270**	0.304	0.00618
	(0.151)	(0.162)	(0.198)	(0.278)	(0.174)	(0.124)	(0.311)	(0.166)
Asian or Asian British	-0.0239	0.0343	0.155	-0.217	-0.0572	-0.0757	0.0499	0.160*
	(0.0934)	(0.0961)	(0.300)	(0.224)	(0.139)	(0.0856)	(0.199)	(0.0963)
Black African, Black Caribbean, Black British	0.00613	-0.333**	-0.273	-0.315*	-0.113	-0.335***	0.137	-0.240*
	(0.143)	(0.139)	(0.278)	(0.188)	(0.191)	(0.0947)	(0.241)	(0.140)
Other ethnic group	-0.0281	0.0854	0.188	0.0743	-0.381**	-0.231**	-0.802***	-0.0469
	(0.168)	(0.132)	(0.191)	(0.257)	(0.174)	(0.118)	(0.218)	(0.152)
North East	0.150**	0.168**	0.0566	0.0957	-0.0127	0.0487	-0.0435	0.0515
	(0.0742)	(0.0716)	(0.131)	(0.116)	(0.0845)	(0.0627)	(0.107)	(0.0727)
North West and Merseyside	-0.0607	0.170***	-0.0132	0.119	-0.197***	0.0183	0.00714	0.0573
	(0.0581)	(0.0571)	(0.113)	(0.0955)	(0.0628)	(0.0483)	(0.0894)	(0.0576)
Yorkshire and the Humber	0.0665	0.148**	0.0816	0.109	-0.0457	0.0442	-0.0605	-0.000189
	(0.0594)	(0.0596)	(0.119)	(0.0984)	(0.0686)	(0.0535)	(0.0974)	(0.0588)
East Midlands	-0.135**	0.0348	-0.0538	0.140	-0.176**	0.0546	-0.243***	0.0644
	(0.0603)	(0.0619)	(0.112)	(0.1000)	(0.0704)	(0.0542)	(0.0934)	(0.0617)
West Midlands	-0.0349	0.0695	-0.0667	0.181*	-0.137**	0.0169	-0.124	0.0465
	(0.0594)	(0.0606)	(0.113)	(0.0954)	(0.0669)	(0.0510)	(0.0951)	(0.0611)
Eastern England	-0.173***	-0.00492	-0.160	0.101	-0.179***	0.0346	-0.255***	0.0111
	(0.0551)	(0.0558)	(0.107)	(0.0935)	(0.0609)	(0.0479)	(0.0862)	(0.0577)
South East	-0.269***	0.0226	-0.0745	0.102	-0.182***	0.0662	-0.153*	0.0411
	(0.0515)	(0.0525)	(0.1000)	(0.0880)	(0.0571)	(0.0448)	(0.0816)	(0.0551)
South West	-0.122**	-0.00180	0.0732	0.180*	-0.292***	0.0282	-0.107	-0.0149
	(0.0573)	(0.0580)	(0.102)	(0.0923)	(0.0633)	(0.0478)	(0.0899)	(0.0599)
Wales	-0.0650	0.120*	-0.137	0.0967	-0.133	-0.0553	-0.220*	-0.0293
	(0.0744)	(0.0719)	(0.126)	(0.111)	(0.0857)	(0.0600)	(0.125)	(0.0712)
Scotland	-0.0232	0.0710	-0.0615	0.200*	-0.138**	-0.00291	0.127	0.0960
	(0.0642)	(0.0611)	(0.124)	(0.104)	(0.0674)	(0.0522)	(0.0886)	(0.0596)
Northern Ireland	0.0849	0.292***	0.163	0.285**	-0.187**	0.0754	0.245**	0.0894
	(0.0770)	(0.0711)	(0.150)	(0.118)	(0.0815)	(0.0597)	(0.113)	(0.0657)
Linear Time Trend	0.0158**	-0.00960	0.00437	0.00229	0.0140*	-0.00794	0.0112	0.0175**
	(0.00715)	(0.00714)	(0.0134)	(0.0113)	(0.00841)	(0.00632)	(0.0115)	(0.00761)
Constant	4.222***	6.714***	4.081***	8.075***	5.832***	6.910***	4.845***	5.596***
	(0.561)	(0.602)	(0.869)	(0.922)	(0.742)	(0.556)	(0.929)	(0.620)
atan(rho)	-0.401***	-0.346***	-0.289***	-0.0647*	-0.497***	-0.540***	-0.140***	-0.315***
	(0.0275)	(0.0457)	(0.0603)	(0.0346)	(0.0422)	(0.0311)	(0.0532)	(0.0597)
log(sigma)	0.0696***	-0.0766***	-0.116***	-0.169***	-0.0999***	-0.0431***	-0.0621***	-0.267***
	(0.00801)	(0.0124)	(0.0219)	(0.0145)	(0.0140)	(0.0103)	(0.0148)	(0.0181)
Inverse Mills Ratio	-0.408***	-0.309***	-0.250***	-0.054	-0.416***	-0.472***	-0.131***	-0.233***
LR Test of independence	-0.408***	57.44***	-0.250***	-0.054	-0.416***	-0.472***	-0.131***	-0.233***
Observations	27,143	27,143	27,143	27,143	27,143	27,143	27,143	27,143

Standard errors in parentheses; asterisks indicate significance level (*** p<0.01; ** p<0.05; * p<0.1)

References

Study Number 7047—Living Costs and Food Survey, 2006—2017: Secure Access. Department for Environment, Food and Rural Affairs, Office for National Statistics (2018). Living Costs and Food Survey, 2006-2017: Secure Access. [Data collection]. 10th Edition. UK Data Service. SN: 7047, http://doi.org/10.5255/UKDA-SN-7047-10

Arnoult, M.H. and Tiffin, J.R., 2010. Minimum Pricing of Alcohol and its Impact on Consumption in the UK (No. 352-2016-18044).

Aristei, D. and Pieroni, L., 2008. A double-hurdle approach to modelling tobacco consumption in Italy. Applied Economics, 40(19), pp.2463-2476.

Collis, J., Grayson, A. and Johal, S., 2010. Econometric analysis of alcohol consumption in the UK. London: HM Revenue & Customs.

Deaton, A. and Muellbauer, J., 1980. An almost ideal demand system. The American economic review, 70(3), pp.312-326.

Decker, S.L. and Schwartz, A.E., 2000. Cigarettes and alcohol: substitutes or complements? (No. w7535). National bureau of economic research.

Griffith, R., O'Connell, M. and Smith, K., 2019. Tax design in the alcohol market. Journal of Public Economics, 172, pp.20-35.

Heckman, J.J., 1979. Sample selection bias as a specification error. Econometrica: Journal of the econometric society, pp.153-161.

Holmes, J., Meng, Y., Meier, P.S., Brennan, A., Angus, C., Campbell-Burton, A., Guo, Y., Hill-McManus, D. and Purshouse, R.C., 2014. Effects of minimum unit pricing for alcohol on different income and socioeconomic groups: a modelling study. The Lancet, 383(9929), pp.1655-1664.

Meng, Y., Brennan, A., Purshouse, R., Hill-McManus, D., Angus, C., Holmes, J. and Meier, P.S., 2014. Estimation of own and cross price elasticities of alcohol demand in the UK—a pseudo-panel approach using the Living Costs and Food Survey 2001–2009. Journal of health economics, 34, pp.96-103.

Pierani, P. and Tiezzi, S., 2009. Addiction and interaction between alcohol and tobacco consumption. Empirical Economics, 37(1), pp.1-23.

Pryce, R., Hollingsworth, B. and Walker, I., 2018. Alcohol quantity and quality price elasticities: quantile regression estimates. The European Journal of Health Economics, pp.1-16.

Quirmbach, D., Cornelsen, L., Jebb, S.A., Marteau, T. and Smith, R., 2018. Effect of increasing the price of sugar-sweetened beverages on alcoholic beverage purchases: an economic analysis of sales data.

Sousa, J., 2014. Estimation of price elasticities of demand for alcohol in the United Kingdom. London: Her Majesty's Revenue and Customs.

Tobin, J., 1958. Estimation of relationships for limited dependent variables. Econometrica: journal of the Econometric Society, pp.24-36.

Tomlinson, P.R. and Branston, J.R., 2014. The demand for UK beer: estimates of the long-run on- and off-trade beer price elasticities. Applied Economics Letters, 21(3), pp.209-214.

Deloitte.