Technical Appendix for the Sheffield Alcohol Policy Model Version 2.5 for England

Alan Brennan, Yang Meng, John Holmes, Daniel Hill-McManus, Colin Angus, Robin Purshouse, Tony Stone, & Petra Meier

CONTENTS

Index of Tables

Index of Figures

1 EXECUTIVE SUMMARY

This technical appendix covers the detailed methods used in the Sheffield Alcohol Policy Model version 2.5 (SAPM2.5) to examine policy impact for the population of England.

This document provides details of methods, data and evidence used. It covers:

- An overview of the SAPM approach
- Discussion of issues relating to the quantification of alcohol consumption in England
- How data is used on alcohol consumption from the General Lifestyle Survey (GLF, formerly GHS)
- How data is used on prices paid from the Living Costs and Food survey (LCF, formerly EFS) is used together with information from market research companies on sales prices of different types of product
- How we have estimated price elasticities of demand for beer, cider, wine, spirit, ready-to-drink in both off-trade and on-trade
- The approach used to modelling the relationship between consumption and harm including the use of evidence on risk functions relating harms to mean consumption and levels of peak consumption
- The evidence and modelling used to model health harms including hospitalisation and mortality for 47 different alcohol related conditions
- The evidence and modelling used to model crime harms
- The evidence and modelling used to model work absence
- The approach used and specific assumptions of sensitivity analyses
- Specific assumptions and evidence used to analyse the 2013 proposed below cost selling policy of the UK government
- A wider general discussion on the framework used for the modelling

For readers who are already familiar with the details of earlier versions of the model, this version 2.5 builds on work previously published in 2009 using the Sheffield Alcohol Policy Model version 2.0 (SAPM2) [1,2]. Since 2009, the methodology that underpins SAPM has been further developed and new data have been incorporated.

The key model developments and new data are:

- How sensitive are consumers to changes in price? - New econometric modelling has been developed to estimate price elasticities of alcohol demand using Living Cost and Food Survey (LCF, formerly EFS) data. In addition to using new methods for estimating price elasticities, LCF/EFS data from 2001/2 to 2009 [3] is used (the previous model used 2001/2 to 2005/6 data). Sensitivity analyses addressing the econometric modelling are extended and include analyses using an econometric model developed independently by HMRC.

- The separation of cider as a distinct beverage type - cider has been separated from beer and the 10 beverage types modelled here are off/on-trade beer, cider, wine, spirit and ready-to-drink (RTD).
- A specific focus on low income groups - In addition to the population being separated into subgroups for sex, age and drinking level (moderate/hazardous/harmful), the population is now also categorised into low income (below the relative poverty line defined as 60% of median equivalised household income) and higher income (i.e. above the relative poverty line). Therefore, income-specific impacts of policy interventions such as minimum unit pricing (MUP) can now be estimated for alcohol consumption and alcohol-related harms to health.
- An exclusive focus on the 16 plus age range: the revised model now focuses only on the population aged 16 and over.
- Updated to use the latest alcohol consumption data - New consumption data from the General Lifestyle Survey (GLF) has become available for 2009 (the previous model used 2006 data).
- Updated to use the latest information on alcohol prices - The Home Office and NHS Health Scotland have procured market research data on the overall 2011 price distribution of off-trade and on-trade alcohol in England from The Nielsen Company and CGA Strategy respectively. The LCF/EFS 2001/2 to 2009 data has also been used to update model inputs on prices paid by population subgroups.
- Updated to use the latest information on crime - New crime volume and costs data for 2011 has been incorporated.

The detailed modelling methods and data sources are described in the sections which follow.

ACKNOWLEDGEMENTS

The ScHARR team would like to acknowledge the following people and organisations for advice and support during the development of this research: William Ponicki (Pacific Institute for Research and Evaluation, US), Paul Gruenewald (Pacific Institute for Research and Evaluation, US), Tim Stockwell (University of Victoria, Canada), Andrew Leicester (Institute for Fiscal Studies, UK), and other members of our research team and scientific advisory group who provided advice or other contributions during the production of this report.

This work was funded by the Medical Research Council and the Economic and Social Research Council (G0000043).

2 OVERVIEW OF SAPM2.5

The aim of SAPM2.5 is to appraise MUP policy options via cost-benefit analyses. We have broken down the aims into a linked series of policy impacts to be modelled

- The effect of the policy on the distribution of prices for different types of alcohol;
- The effect of changes in price distributions on patterns of both on-trade and off-trade alcohol consumption;
- The effect of changes in alcohol consumption patterns on revenue for retailers and the exchequer;
- The effect of changes in alcohol consumption patterns on consumer spending on alcohol;
- The effect of changes in alcohol consumption patterns on levels of alcohol-related health harms;
- The effect of changes in alcohol consumption patterns on levels of crime;
- The effect of changes in alcohol consumption patterns on levels of workplace absenteeism;

To estimate these effects, two connected models have been built:

a) A model of the relationship between alcohol prices and alcohol consumption which accounts for the relationship between mean weekly and peak daily consumption and how consumption is distributed within the population. These relationships are modelled for both the total population and for 96 population subgroups defined by sex, age, income and consumption level (see Table 2.1).
b) A model of the relationship between (1) mean weekly and peak daily consumption and (2) harms related to health, crime and workplace absenteeism and costs associated with these harms.

Figure 2.1 indicates the main datasets used to provide different aspects of the picture. The model links evidence from these datasets to enable comprehensive appraisals of the potential impacts of a policy on a range of outcomes of interest.

Table 2.1: Lists of categories by which population subgroups are defined

Age	Sex	Income[1]	Consumption Level[2]
16 – 17	Male	Low income	Moderate
18 – 24	Female	Higher income	Hazardous
25 – 34			Harmful
35 – 44			
45 – 54			
55 – 64			
65 – 74			
75 +			

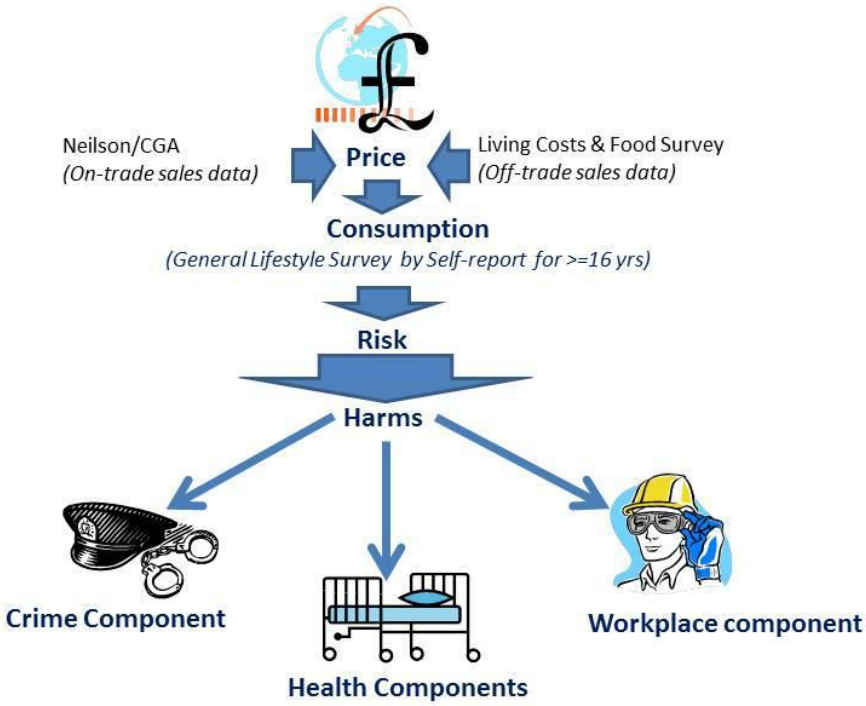


Figure 2.1: Schematic on integrating data sources

[1] See Section 0 for definitions
[2] See Section 3 for definitions

3 DISCUSSION OF ISSUES RELATING TO THE QUANTIFICATION OF ALCOHOL CONSUMPTION IN ENGLAND

One major aspect in the modelling exercise was to integrate datasets on price and consumption due to the absence of an English dataset covering both of these components. While the General Lifestyle Survey (GLF, formerly GHS) provides good estimates of subgroup-specific alcohol consumption patterns in England, it does not contain information on purchasing. In particular, it provides no information on how much was paid for alcohol consumed or whether it was purchased in the on-trade or the off-trade. Conversely, while the Living Costs and Food Survey (LCF) provides a good picture of alcohol purchasing in England, a consumption distribution based on this dataset may not reflect accurately patterns of consumption in England at the subgroup level, as it only covers a two week diary period and purchasers of alcohol are not necessarily the consumers. The link between price and consumption was thus modelled using different datasets.

Population surveys continue to provide the main approach to assessing alcohol consumption in the population of England. Such surveys ask respondents about the volume of certain types of alcoholic beverages bought or consumed over a certain time period. The reported beverage volumes are then converted to units of alcohol (1 UK unit = 8g/10ml of pure ethanol) by a methodology outlined on page 14. From 2006, UK government surveys have started to implement a revised methodology of unit counting which addresses several reasons for underestimating consumption [4].

Importantly, it is generally accepted that this self-reported data underestimates actual consumption by as much as 50% [5]. For example, in the GHS 2005, males and females reported a mean weekly alcohol consumption of 15.8 units and 6.5 units respectively [6], whereas the estimate for all adults based on clearance data from HMRC was 21.9 units [7]. It is important to understand not only the magnitude of such underestimation, but also the potential biases:

- **Under-sampling:** household surveys under-represent some of the groups who drink the most (eg. those in unstable living conditions) [5]
- **Variation in under-reporting by pattern of consumption:** when asked about typical drinking, people do not take into account heavy drinking occasions [4,5].
- **Variation in under-reporting by drinker type:** heavier drinkers tend to underestimate their drinking more than moderate drinkers [8].

Regarding alcohol consumption, one main aspect is the classification of drinkers/non-drinkers in terms of typical alcohol intake per week and the maximum intake in a single occasion (ie. heavy episodic or 'binge' drinking).

Consistent with other analyses [9], in this analysis drinkers in England are classified into one of three drinking categories based on their mean intake per week:

- *Moderate drinkers* – drinkers with an intake of alcohol less likely to damage health and/or be associated with negative consequences (less than 21 units per week for men; less than14 units per week for women).
- *Hazardous drinkers* – drinkers with an increased risk of psychological consequences (such as mood disturbance) and physical consequences (such as injuries) due to alcohol intake (more than or equal to 21 but less than 50 units per week for men; more than or equal to 14 but less than 35 units for women).
- *Harmful drinkers* – drinkers with an intake that is likely to adversely affect health and/or have other negative consequences (more than or equal to 50 units per week for men; more than or equal to 35 units per week for women).

Additionally, an individual is classified as a *binge drinker* if he or she exceeds a certain maximum intake of alcohol during a single session. A binge is commonly defined as an intake of over twice the recommended daily limit (ie. over 8 units per day for men and over 6 units per day for women). Binge drinking can and does occur in each of the moderate to harmful drinking categories; however both likelihood and scale of the binge (how much is drunk on each occasion) are strongly associated with mean consumption.

4 ALCOHOL CONSUMPTION DATA

4.1 GENERAL LIFESTYLE SURVEY

Estimates of alcohol consumption for people in England aged 16 and over are taken from the General Lifestyle Survey (GLF), previously known as the General Household Survey (GHS).

The GLF is an annual cross-sectional household survey of individuals living in UK households. Along with detailed demographic characteristics (such as age, sex, and income), respondents are asked how often over the last year they have drunk each of four different types of alcoholic beverage (beer and cider, wine, spirit, and RTD[3]), and how much they have usually drunk on any one day. Respondents are also asked how much of the four different types of alcoholic beverage they have consumed on the heaviest drinking day in the past week. The volumes drunk are then standardised by converting them into units of alcohol. The conversion of reported volumes to units is based on assumptions made by the ONS [4] about the average alcohol by volume (ABV) content of the different beverage types.

In terms of limitations, the GLF does not provide:

- Information on some at-risk groups (eg. homeless people).
- Information on whether bingeing occurred on more than one occasion in the past week or how typical this is for the respondent

Data for the most recent year of the survey (at the time of analysis) – GLF 2009 [10] – is used to represent baseline consumption in the model. Only data from the English section of the sample is included. Of 16,199 respondents resident in the 6,964 English households surveyed (70.5% response rate), 11,385 individuals provided data for both the mean weekly consumption and the maximum consumption one day over the past week.

4.2 MEAN WEEKLY CONSUMPTION

The method used for calculating mean weekly consumption for an individual is to multiply the number of units of each type of beverage drunk on a usual drinking day by the frequency with which it was drunk and then to sum these values across the four beverage types. The mean weekly consumption was capped at a maximum value of 300 units. Mean weekly consumption provides a proxy for average consumption.

[3] RTD – ready-to-drink (also known as alcopops or pre-mixed drinks)

Figure 4.1 presents the distributions of mean weekly alcohol consumption for males and females in England based on the GLF 2009.

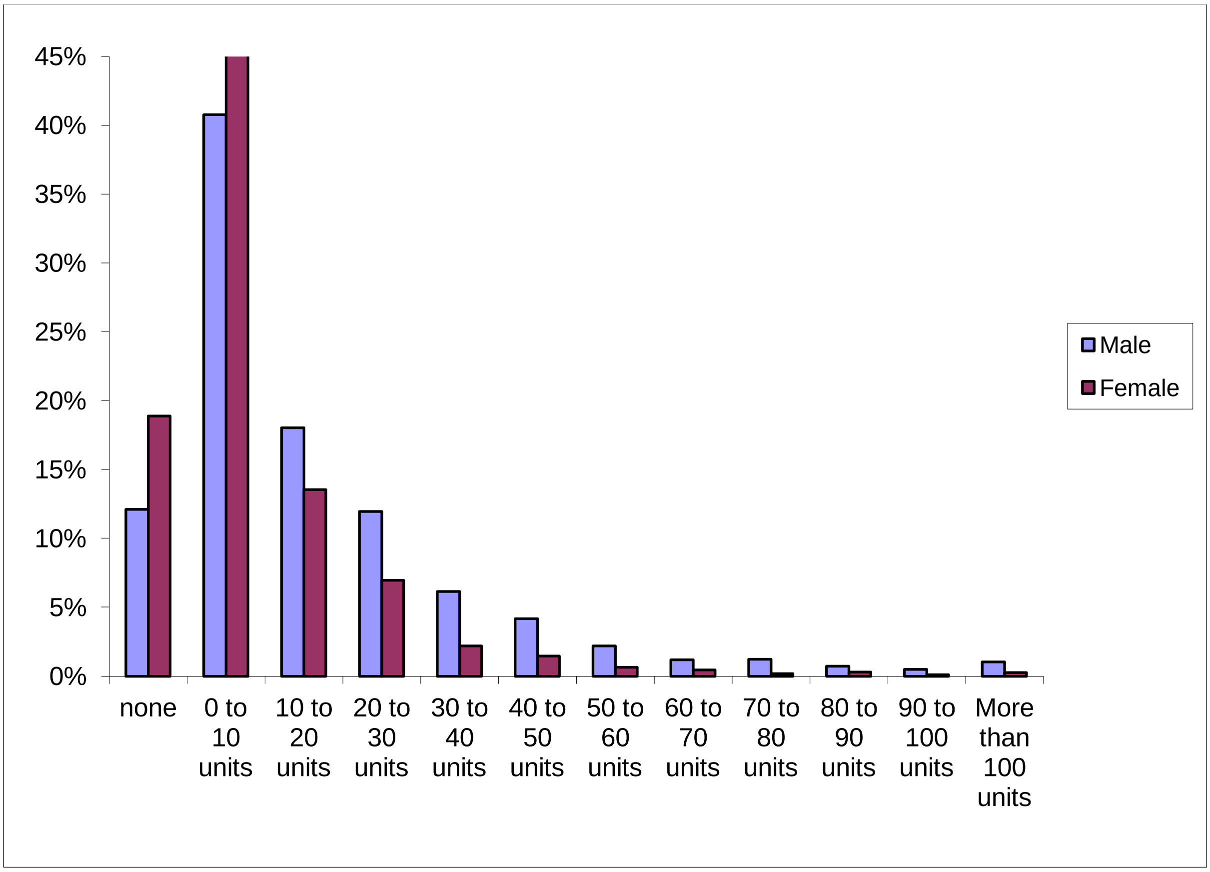


Figure 4.1: Distribution of mean weekly alcohol consumption among individuals in England aged 16 years old and over (GLF 2009)

4.3 PEAK DAY CONSUMPTION IN MOST RECENT WEEK

The method used for calculating peak day consumption for an individual is to sum the number of units of each type of beverage drunk on the heaviest drinking day in the past week. Peak day consumption provides a proxy for binge drinking.

Figure 4.2 presents the distributions of peak daily alcohol consumption for males and females in England based on the GLF 2009. Please note that the proportion of respondents reporting zero consumption is larger for peak daily consumption than for mean weekly consumption as it is based only on drinking in the survey week rather than the last year.

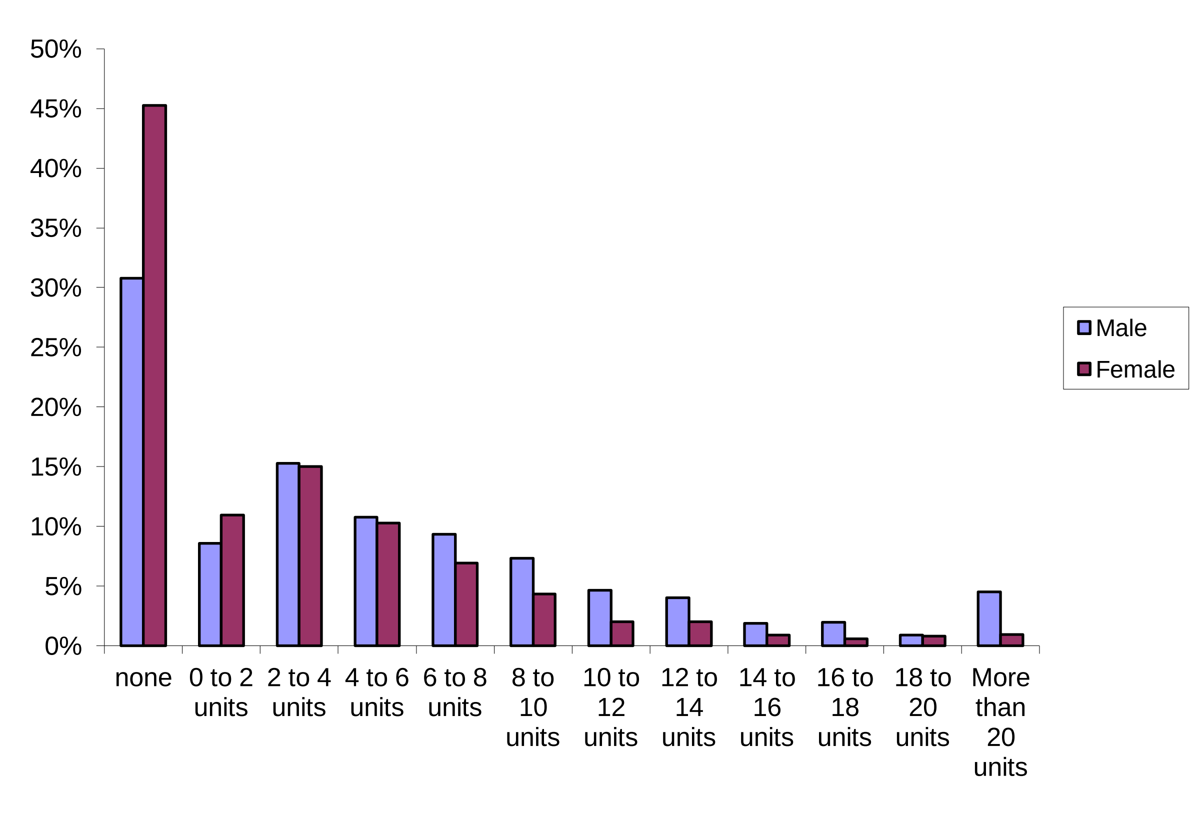


Figure 4.2: Distribution of peak daily intake (units drunk on heaviest drinking day in the last week) among individuals in England aged 16 years old and over (GLF 2009)

4.4 RELATING PEAK DAY MAXIMUM CONSUMPTION TO MEAN CONSUMPTION USING THE GLF

As in previous versions of the model, the price elasticities used in SAPM 2.5 relate a change in price to a change in mean consumption; therefore an additional step is required to estimate the effects of a change in price on peak daily consumption This is achieved by estimating the average relationship between relative change in mean weekly consumption and relative change in peak daily consumption at subgroup level and using this relationship to estimate how individuals' peak daily consumption changes following a change in mean weekly consumption.

One main advantage of the GLF is the availability of data for both the mean weekly intake (here converted to mean daily intake) and the maximum units drunk on the heaviest day. It was thus possible to map the scale of binge from the mean intake using standard statistical regression model techniques. Separate linear models were constructed for each drinker type due to the anticipated differences in behaviour of moderate, hazardous and harmful drinkers. For each age group and sex, the models predict the maximum daily intake from the mean daily intake of alcohol.

The regression models are used to predict the relative change in the scale of binging between baseline and an intervention. The relative change is then applied to the baseline unit of alcohol drunk on the heaviest drinking day (original data from the GLF).

The methodology is applied in SAPM analyses and the resulting model parameters from the GLF 2009 data are shown in Table 4.1.

Figure 4.3 illustrates the three models plotted for males aged 35 to 44 years. The gradient of the regression models are less steep as the daily intake of alcohol increase.

To illustrate the functionality of the binge model, consider a GLF sample for a male aged 40 with a mean daily intake at baseline of 3.5 units (i.e. a hazardous drinker) who drank 10 units on the heaviest drinking day. Consider a policy that reduces the mean daily intake by 1 unit. This changes the mean consumption from 3.5 units to 2.5 units, a reduction of 29%. The regression model for a hazardous drinker with mean daily consumption of 3.5 units predicts a maximum consumption on the heaviest day of 8.6 units. The same regression model is extrapolated for a mean daily consumption of 2.5 units and predicts a maximum consumption on the heaviest day of 7.7 units, ie. a reduction of 11% in the scale of the binge. The predicted maximum consumption on the heaviest day for the selected individual would thus be reduced by 11% to 8.9 units.

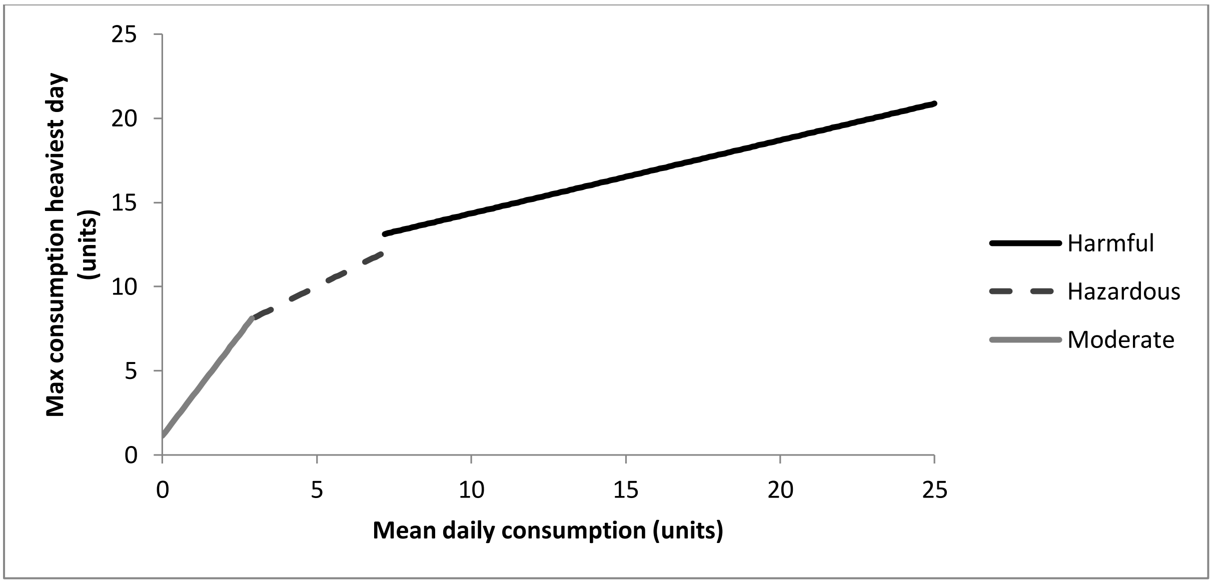


Figure 4.3: Illustrative example of binge relationship in males aged 35 to 44, GLF 2009

Table 4.1: Statistical regression model: relationship between peak daily consumption and mean daily consumption.

Independent variables	Moderate	Hazardous	Harmful
Slope	2.403	0.923	0.435
male aged 18 – 24	1.202	3.909	5.057
male aged 25 – 34	1.772	5.493	0.574
male aged 35 – 44	0.898	3.178	0.914
male aged 45 – 54	0.946	2.448	-0.640
male aged 55 – 64	0.466	0.839	-1.486
male aged 65 – 74	-0.122	-0.736	-3.087
male aged 75 +	-0.637	-1.233	-5.418
female aged 16 – 17	1.174	2.174	5.654
female aged 18 – 24	0.824	4.483	1.889
female aged 25 – 34	1.009	2.815	0.925
female aged 35 – 44	0.705	2.625	-3.159
female aged 45 – 54	0.373	0.893	-3.407
female aged 55 – 64	0.237	-0.140	-4.853
female aged 65 – 74	-0.073	-0.629	-7.382
female aged 75 +	-0.261	-1.646	-8.835
Constant	0.239	2.226	9.088
Adjusted R-squared	0.309	0.150	0.192
Root MSE	2.939	5.381	7.473

Remark: Male aged 16 – 17 as reference group.

5 PRICES PAID DATA

5.1 LIVING COSTS AND FOOD DATA

The Living Cost and Food Survey (LCF), previously known as the Expenditure and Food Survey (EFS), is an annual survey of around 6,500 households in the United Kingdom. It records the purchasing of a range of goods, via a diary system for the individual over a two week period. Parents keep diaries for children under 16, whilst over 16s complete their own diary. In general, LCF records the amount of a good bought, the price paid by the purchaser and the type of outlet where the purchase was made.

The standard LCF/EFS data is available from the UK Data Archive; however anonymised transaction-level LCF/EFS diary data for individuals was obtained directly from DEFRA after a special data request. Anonymised individual-level diary data on 25 categories of alcohol (e.g., off-trade beers, see Table 5.1 for a complete list) detailing both expenditure (in pence) and quantity (in natural volume of product) were made available to the authors. England-only LCF/EFS transaction data for the nine years from 2001/2 to 2009 [3] is used with a total sample size of 227,933 purchasing transactions. These transactions were used for constructing the baseline empirical price distributions for each modelled subgroup and each of ten modelled beverage types (off/on-trade: beer, cider, wine, spirit, and RTD). In total, 960 empirical price distributions were produced, with an average sample size of around 220 observations per distribution.

Some limitations of the LCF/EFS need to be taken into consideration:

- A low response rate of 55.6% of all approached households for survey years 2001/2 to 2009, with potentially important differences in the response rates by age, social class and educational status [11].

The resulting data allows an assessment for each individual of:

- The price paid, type of alcohol, volume of beverage and hence number of units purchased. This is split by beverage type (beer, cider, wine, spirit, and RTD) and by on-trade versus off-trade purchasing.
- Mean units per week purchased over the two weeks (split as above), providing a proxy for mean consumption.
- Units purchased on each day during the two weeks. Although off-trade purchasing may be consumed over several days or weeks, on-trade purchasing probably provides a satisfactory proxy of actual consumption.

- Purchasers' individual characteristics including age, sex, income, education.

The LCF/EFS does not provide:

- Information on actual consumption of alcohol – only purchasing and prices paid.
- Information on some high-risk groups not covered by household surveys (eg. those who are homeless).

It is clear that off-trade purchasing on a particular day may bear little relationship to actual consumption that day since the purchase can be stored and consumed later. It is also the case that at a population level, the fortnightly purchasing distribution from the LCF/EFS may bear some relationship to the mean weekly consumption from GLF. Comparison of this with the analogous GLF distribution shows that a higher proportion of the population are towards either end of the distribution in the LCF/EFS and fewer in the middle area of the distribution. This is firstly because many of the people who purchased no alcohol in the LCF/EFS may have purchased just before or just after the fortnight diary. Secondly, some of the 'harmful purchase' from LCF/EFS may be shared with other individuals in terms of consumption. This comparison underlines the need to utilise GLF as the baseline for consumption patterns, and to make some form of link to LCF/EFS, which has the data combining purchases and prices paid.

Table 5.1: Matching of LCF/EFS product categories to modelled categories and ABV estimates

LCF off/on trade	**LCF category**	**Modelled category**	**ABV estimate**
Off-trade	Beers	off-trade beer	3.9%
Off-trade	Lagers and continental beers	off-trade beer	3.9%
Off-trade	Ciders and perry	off-trade cider	4.8%
Off-trade	Champagne, sparkling wines and wine with mixer	off-trade wine	11.2%
Off-trade	Table wine	off-trade wine	12.7%
Off-trade	Spirits with mixer	off-trade spirit	7.3%
Off-trade	Fortified wines	off-trade wine	14.3%
Off-trade	Spirits	off-trade spirit	39.6%
Off-trade	Liqueurs and cocktails	off-trade spirit	33.3%
Off-trade	Alcopops	off-trade RTD	4.6%
On-trade	Spirits	on-trade spirit	41.8%
On-trade	Liqueurs	on-trade spirit	29.9%
On-trade	Cocktails	on-trade spirit	13.2%
On-trade	Spirits or liqueurs with mixer	on-trade spirit	7.7%
On-trade	Wine (not sparkling) including unspecified 'wine'	on-trade wine	11.1%
On-trade	Sparkling wines and wine with mixer (e.g. Bucks Fizz)	on-trade wine	9.5%
On-trade	Fortified wine	on-trade wine	17.3%
On-trade	Cider or perry - half pint or bottle	on-trade cider	4.8%
On-trade	Cider or perry - pint or can or size not specified	on-trade cider	4.8%
On-trade	Alcoholic soft drinks (alcopops), and ready-mixed bottled drinks	on-trade RTDs	4.6%
On-trade	Bitter - half pint or bottle	on-trade beer	4.3%
On-trade	Bitter - pint or can or size not specified	on-trade beer	4.3%
On-trade	Lager or other beers including unspecified 'beer' - half pint or bottle	on-trade beer	5.0%
On-trade	Lager or other beers including unspecified 'beer' - pint or can or size not specified	on-trade beer	5.0%
On-trade	Round of drinks, alcohol not otherwise specified	on-trade beer	4.8%

5.2 NIELSEN DATA ON PRICE DISTRIBUTION OF ALCOHOIL SOLD OFF-TRADE & CGA DATA ON PRICE DISTRIBUTION OF ALCOHOL SOLD ON-TRADE

In 2011 updated data from the Nielsen Company for England and Wales were made available to the authors by NHS Health Scotland [12]. The Nielsen company is unable to estimate off-trade sales by Aldi and Lidl from September 2011, and therefore the off-trade price distributions for 2011 are based on off-trade sales excluding these stores [12]. The impact of excluding Aldi and Lidl on off-trade price distributions in Scotland using 2009 and 2010 data was examined and only a marginal impact on the overall off-trade price distribution was detected [12]. Data is available for Great Britain and can also be partitioned for England & Wales. Data for England in isolation is not available hence data from England and Wales was used for the analysis.

Nielsen collects data from off-trade stores across the UK on a weekly basis. They have an extremely detailed dataset over the past three years. As each new week of data becomes available, the three year period is redefined and data older than 3 years is discarded. Whilst the detailed data provides a wealth of material, Nielsen does not provide any demographic data on purchasers (eg. no age/sex data), nor does it provide any direct information on actual consumption (as distinct from purchase) of alcohol.

For the database known as *Grocery Multiples channel*, which is essentially supermarket chains, sales data is stored at ‘stock keeping unit (SKU) level’. An SKU would, for example, be a 4-pack of 440ml cans of Carling and is defined by a unique bar-code. To protect the anonymity of individual brand data, Nielsen are unable to provide data at SKU level. However they are able to group the SKUs into 32 product types. The Nielsen data on a particular SKU for alcoholic beverages include the following fields: SKU code, week, store/outlet (at individual store level), volume of sales (in litres of beverage – Nielsen are unable to convert to units of alcohol using ABV), value of sales (in £), and product category.

The model performs analysis at the aggregated level of beer, cider, wine, spirit, and RTD, requiring aggregation of the Nielsen product categories. The aggregation requires a transformation from litres of beverage to units of alcohol. This is achieved by applying ABV estimates to the volume of the product to obtain ethanol quantity and then converting to units.

For SKU anonymity reasons, Nielsen limited the number of categories of price range for which data was to be summarised to 17. These were defined at product level in terms of price per litre of beverage, with the prices selected such that each category mapped back to an equivalent price per unit of alcohol (see Table 5.2).

Table 5.2: Price ranges for the Nielsen data

Price category	**Off-trade price (£) per unit of alcohol**	
	Lower	**Upper**
1	0.00	0.10
2	0.10	0.15
3	0.15	0.20
4	0.20	0.25
5	0.25	0.30
6	0.30	0.35
7	0.35	0.40
8	0.40	0.45
9	0.45	0.50
10	0.50	0.55
11	0.55	0.60
12	0.60	0.65
13	0.65	0.70
14	0.70	0.75
15	0.75	0.80
16	0.80	0.85
17	0.85	N/A

CGA Strategy, a market research company specialising in on-trade information, maintain a database of prices for beer/cider, wine, spirit and RTD purchases in the on-trade. CGA Strategy data [13] for England and Wales in 2011 was used to adjust the LCF/EFS on-trade prices. The CGA data was purchased by the Home Office and, although the detailed dataset is not publicly available, the University of Sheffield is permitted to use the data for SAPM.

CGA Strategy's pricing database for the on-trade (known as *Ons Prices*) records price information for products in a sample of outlets. The outlets in the sample are selected to be representative of the entire on-trade universe. Unique products are defined by brand and method of serve (eg. for beer, a product could be a 4 pint jug of draught Carling or a 330ml bottle of Becks).

To construct a price distribution, sales volumes (in terms of alcohol units) are required. Unfortunately CGA's pricing database does not include data of this type. However, a separate sales database (known as *Managed House EPoS Pricing Data Pool*) does record total daily sales value (in £) and sales volume (in litres of beverage) for a sample of outlets. For most products, ABV information is also recorded, enabling volume to be converted to units of alcohol.

5.3 ACCOUNTING FOR PRICE INFLATION

Alcohol-specific RPIs for off- and on-trade beer and cider and off- and on-trade wine and spirit (see Table 5.3) were used to adjust to 2011 prices the data in the LCF/EFS 2001/2 to 2009. The 2011 price could then be aligned with the more accurate but more aggregated sales data from the Nielsen Company data and CGA strategy data using the methods described in Section 5.6. All final off- and on-trade price distributions used in SAPM2.5 are in 2011 prices and are calculated for England only. The baseline year of 2011 is chosen for the model because the latest available Nielsen and CGA price data is based on that year.

Table 5.3: ONS alcohol-specific RPIs 2001 to 2011

Year	Beer on-trade	Beer off-trade	Wine & spirit on-trade	Wine & spirit off-trade
2001	215.6	161.6	203.3	152.3
2002	221.7	160.7	210.6	153.3
2003	228.3	157.8	217.5	153.7
2004	234.9	153.5	223.0	155.0
2005	242.8	148.3	228.5	155.6
2006	251.1	147.8	235.4	156.5
2007	261.0	148.9	243.3	158.4
2008	272.4	149.0	253.1	165.2
2009	281.4	153.6	261.9	173.2
2010	291.8	155.4	271.5	180.4
2011	307.8	163.9	287.2	191.8

5.4 RESULTANT PRICE DISTRIBUTIONS BY BEVERAGE TYPE

The final England aggregate price distributions for off- and on-trade beer, cider, wine, spirit and RTD in 2011 prices used in the model are shown in Figure 5.1, Figure 5.2 and the proportions of each beverage category sold below different MUP thresholds in 2014/15 prices are shown in Table 5.4.

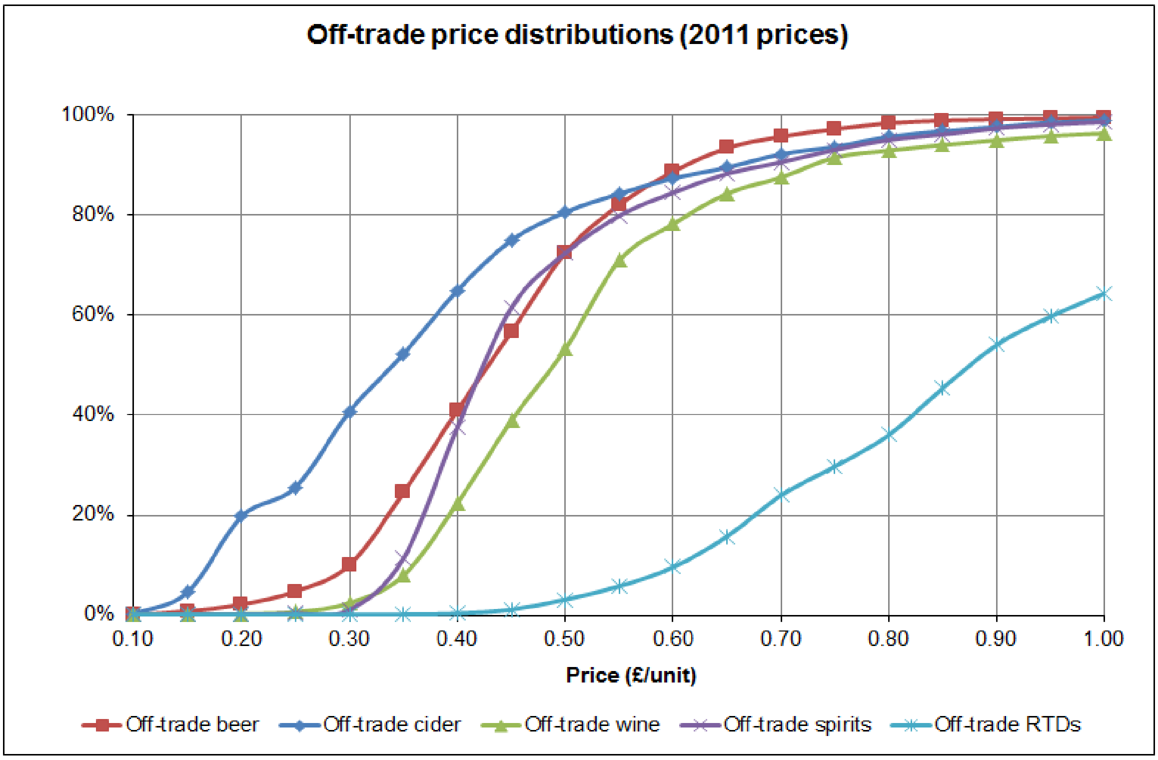


Figure 5.1: Final off-trade price distributions for beer, cider, wine, spirit and RTD in 2011 prices

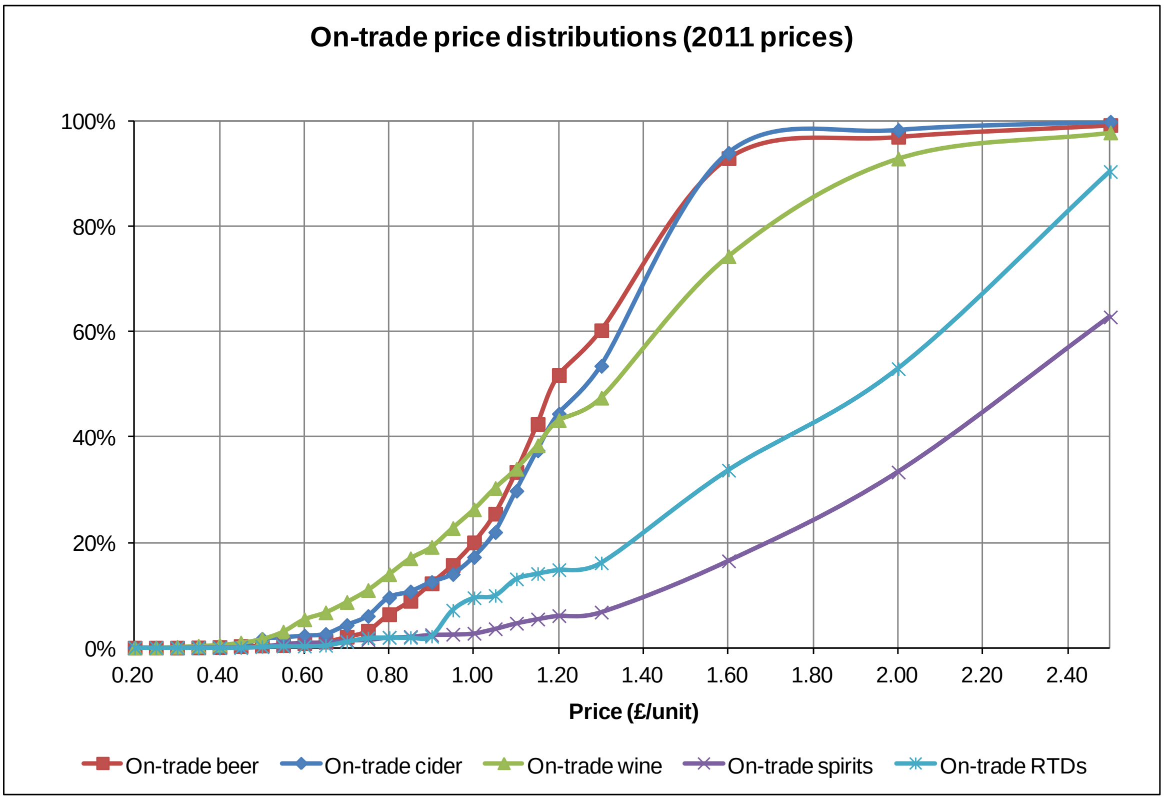


Figure 5.2: Final on-trade price distributions for beer/cider, wine, spirit and RTD in 2011 prices

Table 5.4: Proportions of alcohol sold below a range of MUP thresholds

	Proportions sold below thresholds (2014/15 prices)		
	40p	45p	50p
Off-trade beer	29.4%	44.8%	59.5%
Off-trade cider	59.8%	70.2%	77.3%
Off-trade wine	10.7%	24.9%	41.2%
Off-trade spirit	13.1%	38.5%	59.8%
Off-trade RTD	0.2%	0.8%	1.6%
On-trade beer	0.0%	0.2%	0.4%
On-trade cider	0.0%	0.0%	0.3%
On-trade wine	0.4%	0.6%	1.2%
On-trade spirit	0.1%	0.1%	0.1%
On-trade RTD	0.0%	0.0%	0.1%

Although SAPM works on subgroup-specific price distributions, the figures and table provide approximations of the overall proportion of alcohol within each category that would be directly affected by MUP policies. It is apparent that these policies have a minimal impact on on-trade prices and mainly target off-trade prices; especially prices for off-trade cider, beer and spirit. For example, a 45p MUP defined in 2014/15 prices would affect around 70.2% of cider sales, 44.8% of beer, 38.5% of spirits, 24.9% of wine and 0.8% of RTDs in the off-trade and <0.6% of on-trade sales.

5.5 INCOME GROUP SPECIFIC PRICE DISTRIBUTIONS

In SAPM2.5, apart from age group, sex, and consumption level, individuals in the LCF/EFS are categorised as low income (below 60% of median equivalised household income) or higher income bracket (above this threshold) to construct subgroup-specific price distributions. The threshold used is the standard definition of relative poverty in the UK and this definition uses equivalised household income to account for differences in levels of disposable income based on household composition. Table 5.5 shows the proportions of individuals categorised as low income in each LCF/EFS survey based on the equivalised household income variables recorded in these surveys.

Table 5.5: Proportions of LCF/EFS individuals categorised as low income

Year	Low income (%)
2001	23.5%
2002	23.3%
2003	19.6%
2004	19.2%
2005	19.7%
2006	22.0%
2007	21.5%
2008	19.8%
2009	20.1%
Total	21.5%

Table 5.6 compares the average price per unit paid and the proportions of alcohol sold below 45p per unit for 10 modelled beverage types and for low and higher income drinkers. It shows that low income drinkers pay around 14.9% (ranging from 5.1% to 17.1%) less than higher income drinkers per unit of alcohol. Compared to higher income drinkers, low income drinkers have higher proportions of alcohol sold below modelled MUP thresholds for most beverage types. For example, while 44.8% of off-trade beer sold is below 45p per unit for the England population (see Table 5.4), the proportions are 50.1% and 43.1% for low- and higher income drinkers respectively. For all alcohol sold (off- and on-trade), the proportions sold below a 45p MUP threshold are 31.5% and 20.9% for low- and higher income drinkers. The data indicates that low income drinkers will be more affected by MUP polices than higher income drinkers.

Table 5.6: Comparison of average price paid and proportions of alcohol sold below 45p per unit between two income groups

	Average price paid in pence per unit (2011 prices)			Proportion of purchases below 45p per unit (2014/15 prices)	
	Low income	Higher income	% difference	Low income	Higher income
Off-trade beer	42.9	45.2	5.1%	50.1%	43.1%
Off-trade cider	33.6	39.9	15.9%	78.3%	66.2%
Off-trade wine	47.8	55.3	13.5%	36.6%	22.4%
Off-trade spirit	46.0	49.9	7.8%	43.9%	36.3%
Off-trade RTD	74.0	78.4	5.6%	0.7%	0.8%
On-trade beer	113.3	126.6	10.5%	0.2%	0.1%
On-trade cider	103.2	124.4	17.1%	0.0%	0.0%
On-trade wine	116.1	139.5	16.8%	1.6%	0.5%
On-trade spirit	221.3	248.7	11.0%	0.1%	0.1%
On-trade RTD	164.8	184.9	10.9%	0.0%	0.0%
Total	73.1	85.9	14.9%	31.5%	20.9%

Table 5.7 compares the average price per unit paid and the proportions of alcohol sold below 45p per unit for 10 modelled beverage types and for moderate, hazardous and harmful drinkers. It shows that harmful drinkers pay around 23.1% less than moderate drinkers per unit of alcohol (range from 1.4% to 27.3%). Compared to moderate drinkers, hazardous and harmful drinkers have higher proportions of alcohol sold below modelled MUP thresholds. For example, while 44.8% of off-trade beer sold is below 45p per unit for the England population (see Table 5.4), the proportions purchased below this threshold are 28.3%, 42.3% and 53.5% for moderate, hazardous and harmful drinkers respectively. For all alcohol sold (off- and on-trade), the proportions sold below a 45p MUP threshold are 12.5%, 19.5% and 30.5% for moderate, hazardous and harmful drinkers. The data indicates that hazardous and harmful drinkers will be more affected by MUP policies than moderate drinkers.

Table 5.7: Comparison of average price paid and proportions of alcohol sold below 45p per unit by moderate, hazardous and harmful drinkers (pence per unit)

	Average price paid in pence per unit (2011 prices)				Proportion of purchases below 45p per unit (2014/15 prices)		
	Moderate	Hazardous	Harmful	% (moderate vs. harmful)	Moderate	Hazardous	Harmful
Off-trade beer	49.2	45.1	41.5	15.7%	28.3%	42.3%	53.5%
Off-trade cider	45.0	39.5	33.6	25.5%	54.2%	64.8%	77.4%
Off-trade wine	56.2	53.8	52.9	5.9%	21.0%	21.3%	27.9%
Off-trade spirit	52.3	48.3	46.1	11.9%	30.0%	34.0%	41.9%
Off-trade RTD	95.3	81.0	69.3	27.3%	0.6%	0.6%	1.2%
On-trade beer	130.7	122.8	118.3	9.5%	0.0%	0.2%	0.2%
On-trade cider	126.2	120.9	114.1	9.5%	0.0%	0.0%	0.0%
On-trade wine	139.0	134.8	137.0	1.4%	0.6%	0.4%	1.0%
On-trade spirit	254.6	236.4	222.0	12.8%	0.0%	0.2%	0.0%
On-trade RTD	189.9	177.7	176.5	7.1%	0.0%	0.0%	0.0%
Total	96.8	80.5	74.4	23.1%	12.5%	19.5%	30.5%

5.6 ESTIMATING BEVERAGE PREFERENCES

By using combined purchasing data from LCF/EFS, Nielsen and CGA it is possible to estimate the parameters at subgroup level for the beverage preference vector and the 10 price distributions (on-/off- trade beer, cider, wine, spirit, RTD).

The LCF/EFS provides the basis for the price distributions (comprised of individual transactions, defined by purchase price, purchase volume and sample weight). In the off-trade, the more aggregated but more accurate Nielsen data is used to adjust the LCF/EFS cumulative distribution so that it matches the Nielsen data at the known price points. The CGA data is used in the same manner for the on-trade data. The LCF/EFS data is then linearly interpolated between the known market research price points (retaining the maximum and minimum LCF/EFS prices as the boundaries of the distribution). The result is 10 price distributions: beer, cider, wine, spirit and RTD in both the off-trade and on-trade.

6 PRICE ELASTICITIES OF ALCOHOL DEMAND

A new econometric model has been developed to estimate price elasticities of demand for alcohol. The key motivations for developing this model are: 1) estimating the price elasticity of cider separately to beer, 2) taking advantage of a longer period of the LCF/EFS data, 3) addressing limitations arising from the cross-sectional nature of the LCF/EFS, and 4) addressing limitations arising from the two-week data collection period in the LCS/EFS and the significant numbers of zero purchases this produces in the dataset.

The new econometric model applies a pseudo-panel approach to the cross-sectional LCF/EFS 2001/2–2009 datasets to estimate the own- and cross- price elasticities of off- and on- trade beer, cider, wine, spirits and ready-to-drinks in the UK. 72 pseudo-panels were constructed defined by birth year (12), sex (2) and socioeconomic status (3). Fixed effects models were applied to analyse the pseudo-panel data.

Details of the econometric model that has been used in SAPM2.5 have now been published in the Journal of Health Economics [14]. The paper describes the rationale, method, data, results and limitations of the econometric analysis; and it forms an essential accompaniment to this technical appendix. Table 6.1 summaries the key result of the econometric analysis as a 10x10 elasticity matrix, with values on the diagonal representing own-price elasticities and remaining values representing cross-price elasticities. Elasticities are available for the 10 modelled categories of beverage: on- and off- trade beer, cider, wine, spirit, and RTD.

As a simple example of how to interpret the elasticity matrices, consider Table 6.1. The lead diagonal shown in bold in the table contains the own-price elasticities. For example, the table shows an own-price elasticity of -0.980 for off-trade beer, indicating that a 1% increase in the price of off-trade beer would lead to an approximately 0.98% reduction in the demand for this beverage. Complement and substitute relationships between beverages are also indicated by the cross-price elasticities that comprise the remainder of the matrix. The majority of cross-price effects are of a substitute-based nature. For example, the cross-price elasticity between off-trade beer and off-trade wine is indicating an estimated 0.096% rise in demand for off-trade wine if the price of off-trade beer were to rise by 1%.

Table 6.1: Estimated own- and cross-price elasticities for off- and on-trade beer, cider, wine, spirit and RTD in the UK

		Purchase									
		Off-beer	Off-cider	Off-wine	Off-spirit	Off-RTD	On-beer	On-cider	On-wine	On-spirit	On-RTD
Price	Off-beer	-0.980*	-0.189	0.096	-0.368	-1.092	-0.016	-0.050	0.253	0.030	0.503
	Off-cider	0.065	-1.268*	0.118	-0.122	-0.239	-0.053	0.093	0.067	-0.108	-0.194
	Off-wine	-0.040	0.736*	-0.384*	0.363	0.039	-0.245	-0.155	0.043	-0.186	0.110
	Off-spirit	0.113	-0.024	0.163	-0.082	-0.042	0.167	0.406	0.005	0.084	0.233
	Off-RTD	-0.047	-0.159	-0.006	0.079	-0.585*	-0.061	0.067	0.068	-0.179*	0.093
	On-beer	0.148	-0.285	0.115	-0.028	0.803	-0.786*	0.867	1.042*	1.169*	-0.117
	On-cider	-0.100	0.071	0.043	0.021	0.365	0.035	-0.591*	0.072	0.237*	0.241
	On-wine	-0.197	0.094	-0.154	-0.031	-0.093	-0.276	-0.031	-0.871*	-0.021	-0.363
	On-spirit	0.019	-0.117	-0.027	-0.280	-0.145	-0.002	-0.284	0.109	-0.890*	0.809*
	On-RTD	0.079	0.005	-0.085	-0.047	0.369	0.121	-0.394	-0.027	-0.071	-0.187

Remarks *: p-value <0.05

7 PRICE TO CONSUMPTION MODEL SUMMARY

Data from the GLF 2009 were used to provide the baseline data for alcohol consumption in England. The main mechanism of the model is that a change in price modifies the consumption patterns derived from the GLF. Within the model, a new GLF is simulated for each modelled year based on the estimated impact of the policy which is being appraised. However, the GLF does not provide information about on- and off-trade consumption, nor does it differentiate between beer and cider consumption. These are critical additional components required to model the impact of policies with differential impacts on prices by beverage type, and by the on- and off-trade. Thus the baseline GLF needs to be augmented using the LCF so that beer and cider consumption can be disaggregated and the on- versus off- trade distinction can be properly accommodated in the model.

The price to consumption model is therefore composed of three major steps (Figure 7.1):

1. The LCF is used to derive a new GLF containing consumption estimates for 10 beverage types; off- and on- trade beer, cider, wine, spirit, RTD.
2. The LCF is interpolated using Nielsen and CGA data (described in Section 5.6).
3. The model is then used to estimate the impact of a proposed policy change in terms of change in consumption.

Step 1 was carried out by combining the consumption distribution from the GLF with the LCF purchasing distribution and interpolating to produce a “new GLF” for the 10 elements of the matrices.

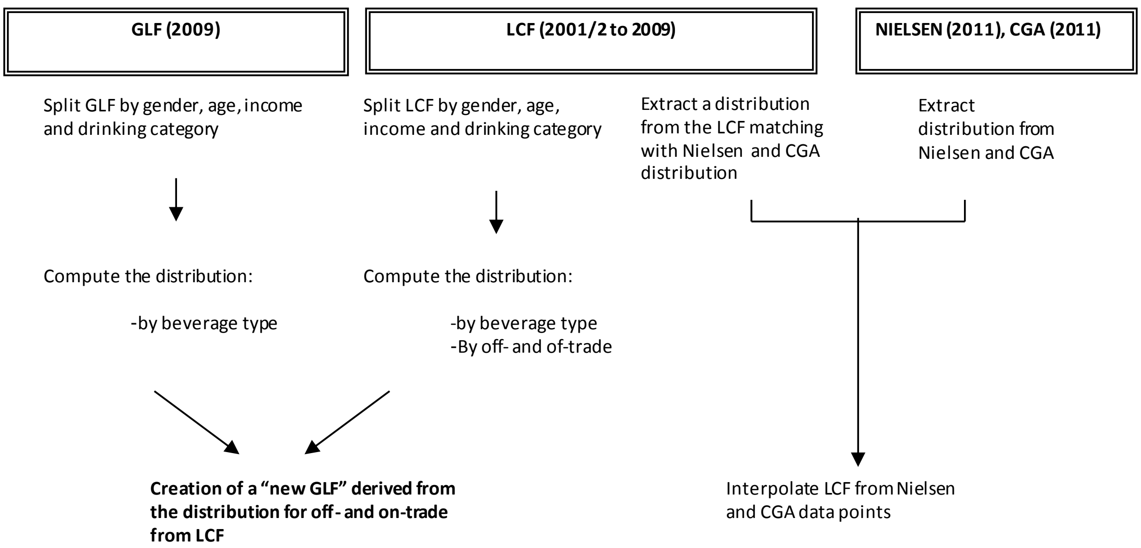


Figure 7.1: Model construction steps: creation of a new GLF and new LCF/EFS-Nielsen-CGA dataset

Finally, in step 3, after a "new GLF" has been created, the impact of a price policy on mean weekly consumption was examined for each modelled subgroup using the elasticity matrix described in Table 6.1. The formula used to apply the elasticity matrix is shown below:

$$\%\Delta C_i = (1 + e_{ii}\%\Delta p_i)(1 + \sum_{j \neq i}^{\forall j} e_{ij}\%\Delta p_j) - 1$$ *Equation 1*

Where, $\%\Delta C_i$ is the estimated percentage change in consumption for beverage *i*, e_{ii} is the own-price elasticity for beverage *i*, $\%\Delta p_i$ is the percentage change in price for beverage *i*, e_{ij} is the cross-price elasticities for the consumption of beverage *i* due to a change in the price of beverage *j*, and $\%\Delta p_j$ is the percentage change in price for beverage *j*.

As described in Section 4.4, the estimated relative change in weekly consumption for each subgroup is then used to predict the relative change in peak daily consumption for that subgroup.

8 APPROACH TO MODELLING THE RELATIONSHIP BETWEEN CONSUMPTION AND HARM

8.1 MODEL STRUCTURE

An epidemiological approach is used to model the relationship between consumption and harm, relating changes in the prevalence of alcohol consumption to changes in prevalence of risk of experiencing harmful outcomes. Risk functions relating consumption (however described) to level of risk are the fundamental components of the model.

The ‘consumption to harm’ model considers the impact of consumption on harms in three domains: health (including the impact on both mortality and morbidity), crime and the workplace.

8.2 ALCOHOL-ATTRIBUTABLE FRACTIONS AND POTENTIAL IMPACT FRACTIONS

The methodology is similar to that used in Gunning-Scheper’s Prevent model [15], being based on the notion of the alcohol-attributable fraction (AAF) and its more general form, the potential impact fraction (PIF).

The AAF of a disease can be defined as the difference between the overall average risk (or incidence rate) of the disease in the entire population (drinkers and never-drinkers) and the average risk in those without the exposure factor under investigation (never-drinkers), expressed as a fraction of the overall average risk. For example, the AAF for female breast cancer is simply the risk of breast cancer in the total female population minus the risk of breast cancer in women who have never drunk alcohol, divided by the breast cancer risk for the total female population. Thus, AAFs are used as a measure of the proportion of the disease that is attributable to alcohol. While this approach has traditionally been used for chronic health-related outcomes, it can in principle be applied to other harms (including those outside of the health domain).

The AAF can be calculated using the following formula:

$$AF = \frac{\sum_{i=1}^{n} p_i \left(RR_i - 1\right)}{1 + \sum_{i=1}^{n} p_i \left(RR_i - 1\right)}$$

Equation 2

where, *RRi* is the relative risk (RR) due to exposure to alcohol at consumption state *i*, *pi* is the proportion of the population exposed to alcohol at consumption state *i*, and *n* is the number of consumption states.

If the reference category is abstention from alcohol then the AAF describes the proportion of outcomes that would not have occurred if everyone in the population had abstained from drinking. Thus the numerator is essentially the excess expected cases due to alcohol exposure and the denominator is the total expected cases. In situations where certain levels of alcohol consumption reduce the risk of an outcome (e.g. coronary heart disease) the AAF can be negative and would describe the additional cases that would have occurred if everyone was an abstainer.

Note that there are methodological difficulties with AAF studies. One problem is in defining the non-exposed group – in one sense ‘never drinkers’ are the only correct non-exposed group, but they are rare and usually quite different from the general population in various respects. However, current non-drinkers include those who were heavy drinkers in the past (and these remain a high-risk group, especially if they have given up due to alcohol-related health problems). Several studies show that findings of avoided coronary heart disease risk may be based on systematic errors in the way abstainers were defined in the underlying studies [16].

The PIF is a generalisation of the AAF based on arbitrary changes to the prevalence of alcohol consumption (rather than assuming all drinkers become abstainers). Note that a lag may exist between the exposure to alcohol and the resulting change in risk. The PIF can be calculated using the following formula:

$$PIF = 1 - \frac{\sum_{i=0}^{n} \overline{p_i} RR_i}{\sum_{i=0}^{n} p_i RR_i}$$

Equation 3

where $\overline{p_i}$ is the modified prevalence for consumption state *i* and state 0 corresponds to abstention.

In the model, alcohol consumption in a population subgroup is described non-parametrically by the associated observations from the GLF. For any harmful outcome, risk levels are associated with consumption level for each of the observations (note that these are not person-level risk functions). The associated prevalence for the observation is simply defined by its sample weight from the survey. Therefore, the PIF is implemented in the model as:

$$PIF = 1 - \frac{\sum_{i=0}^{N} w_i \overline{RR_i}}{\sum_{i=0}^{N} w_i RR_i}$$

Equation 4

where w_i is the weight for observation *i*, $\overline{RR_i}$ is the modified risk for the new consumption level and *N* is the number of samples.

8.3 DERIVATION OF RISK FUNCTIONS

The impact of a change in consumption on harm was examined using three categories of risk functions:

1. Relative risk functions already available in the published literature.
2. Relative risk functions derived from the AAF for partially attributable harms.
3. Absolute risk functions for wholly attributable harms.

8.3.1 Relative risk functions already available in the published literature

The relative risk functions for all chronic conditions that are partially attributable to alcohol are shown in Table 8.1 and are taken from the published literature (see Table 9.1).

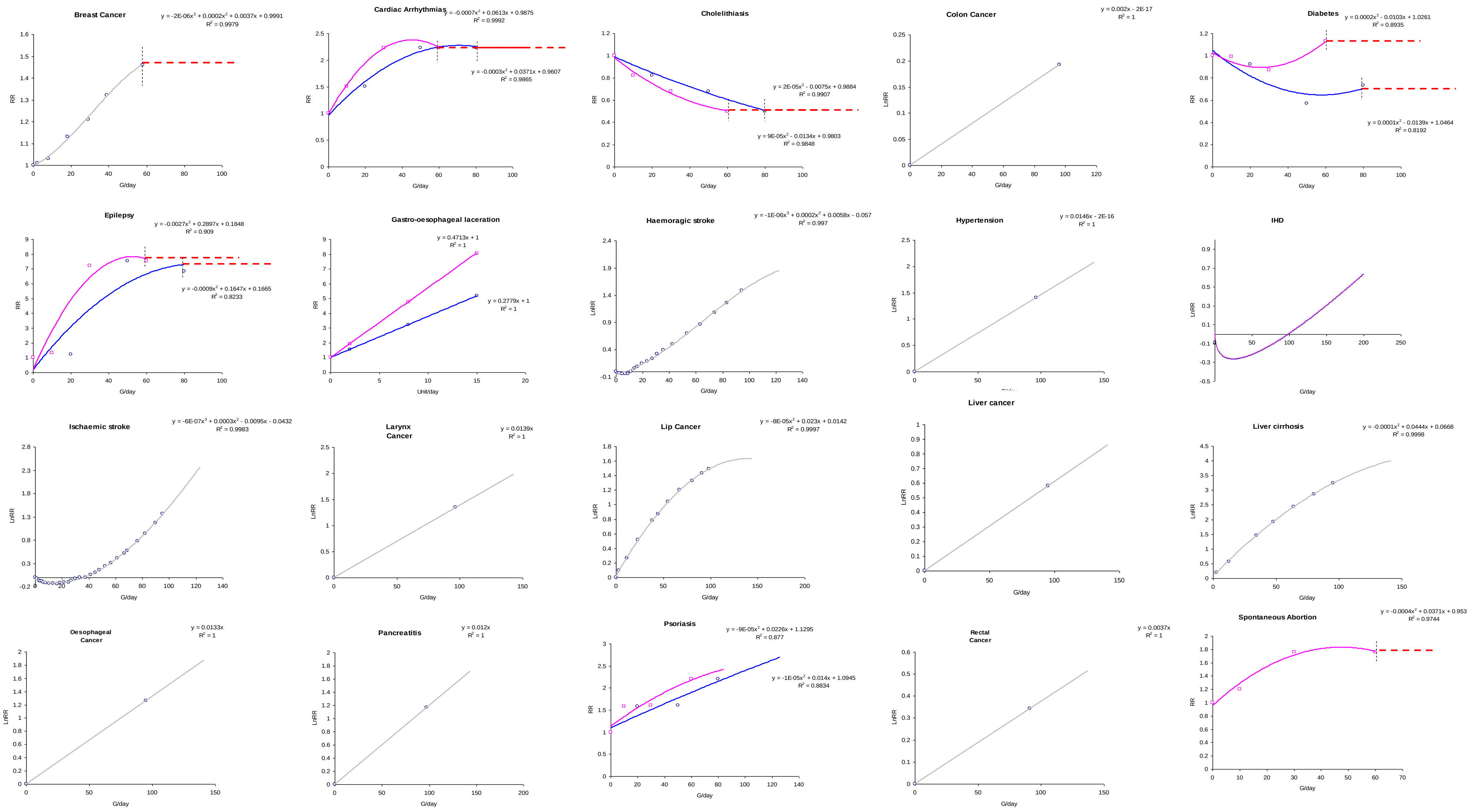
8.3.2 Relative risk functions derived from the AAF for partially attributable harms

For some types of harms, such as crime and acute health harms that are partially attributable to alcohol, evidence is available for the AAF but not risk functions. The AAF evidence can be used to derive a relative risk function assuming the relationship described in Equation 2 since the AAF is a positive function of the prevalence of drinking and the relative risk function.

Two assumptions are necessary to compute a relative function from an AAF: assumptions about the form of the curve (or risk function) and assumptions about the threshold below which the relative risk is unity (i.e., harm is not associated with alcohol). Linear functions were selected for the present analyses due to the lack of data in the literature.

For acute harms partially attributable to alcohol, a threshold relating to the NHS definition of bingeing (more than 8 and 6 units for males and females respectively) and a threshold of zero were both considered for use in the model. It is important to note that the available GLF data relates to peak consumption on the heaviest drinking day in the previous 7 days and is therefore only a proxy measure for patterns of drinking to intoxication. It does not measure frequency or variation in binge drinking behaviour. 8/6 units was not selected as the threshold since it was considered that a peak measurement of, for example, 7 units in a male respondent would constitute some evidence for drinking to intoxication over the course of a year. Zero units was not selected since it was also considered that a peak measurement of, for example, 1 unit was insufficient evidence of drinking to intoxication. Therefore a threshold of 4/3 units was chosen as a compromise solution since this corresponds to the mid-way point of the bingeing definition.

Table 8.1: Relative risk functions for chronic conditions partially attributable to alcohol



The resulting relative risk functions are therefore a function of consumption (for which a slope is defined) and threshold as follows:

$RR(c) = 1 \; if \; c < T$

$RR(c) = \beta \, (c - T) + 1 \;\; otherwise$ *Equation 5*

where *c* = mean consumption level, *T* = threshold and *β*=slope parameter.

An example of a linear function constructed from an AAF is shown in Figure 8.1.

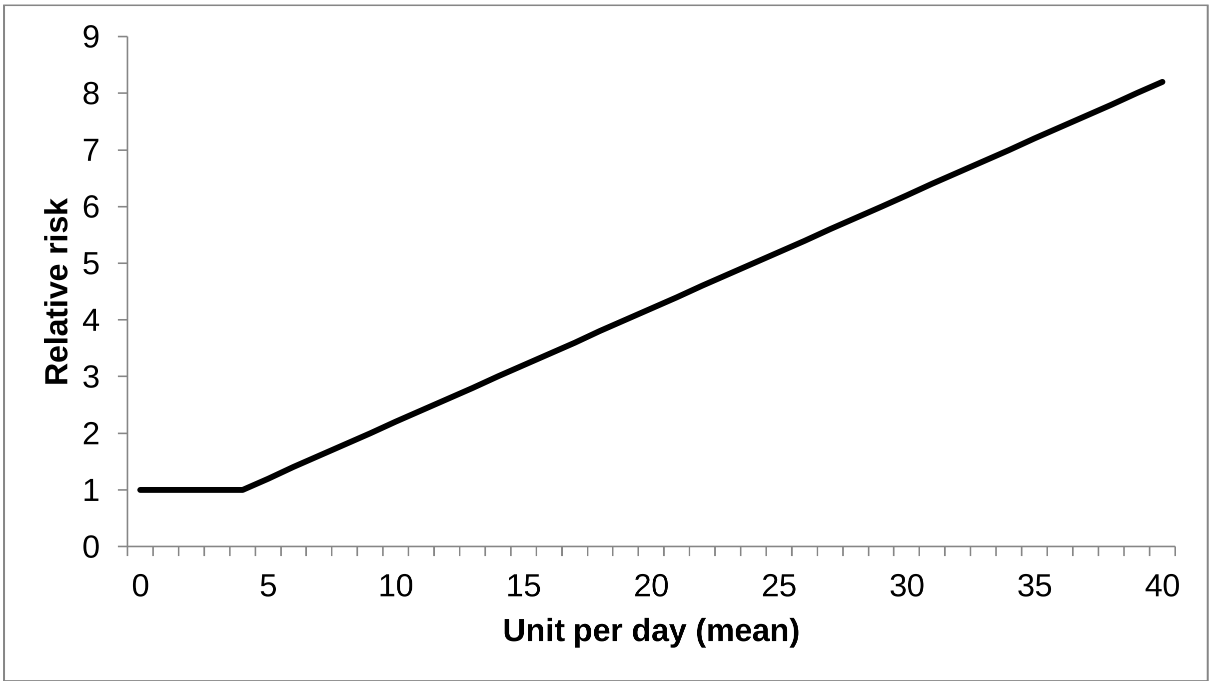


Figure 8.1: Illustrative linear relative risk function for a partially attributable acute harm (threshold of 4 units)

8.3.3 Absolute risk functions for wholly attributable harms

While it was possible to estimate relative risk functions for most harms, it was impossible to derive such functions for wholly attributable harms (with an AAF of 100%) due to the absence of a reference group.

An alternative approach was thus adopted: absolute risk functions were calculated based on the number of harm events, the drinking prevalence, and the total population. As for the relative risk functions derived in Section 8.3.2, assumptions were necessary about the form and the starting threshold of the absolute risk functions. For consistency, the same linear form was assumed and the male/female thresholds for wholly attributable acute harms set equal to those for partially attributable acute harms.

For wholly attributable chronic harms the risk was assumed to start from 3 units per day for males and 2 units per day for females. These thresholds were derived from the Royal

College of Physicians' (RCP) limits [17], (i.e. drinking less than 21 units per week for males and 14 units per week for females). Risk was not assumed to start from zero units, since it was thought inappropriate to assume that populations drinking below the RCP limits would be at increased risk of chronic conditions such as alcoholic liver disease.

The resulting absolute risk function is therefore a function of consumption (for which a slope is defined) and threshold as follows:

$AR(c) = 0 \; if \; c < T$

$AR(c) = \beta \; (c - T) \;\; otherwise$ *Equation 6*

where AR = absolute risk, *c* = peak consumption level, *T* = threshold and *β*=slope parameter.

An example of a linear absolute risk function constructed from the number of deaths is presented in Figure 8.2. When using real data, the units on the vertical axis would be deaths or hospitalisations depending on the component of the model. The key difference of the absolute risk function compared to RR function is that the absolute risk equals 0, rather than 1, when the peak day intake is below the threshold.

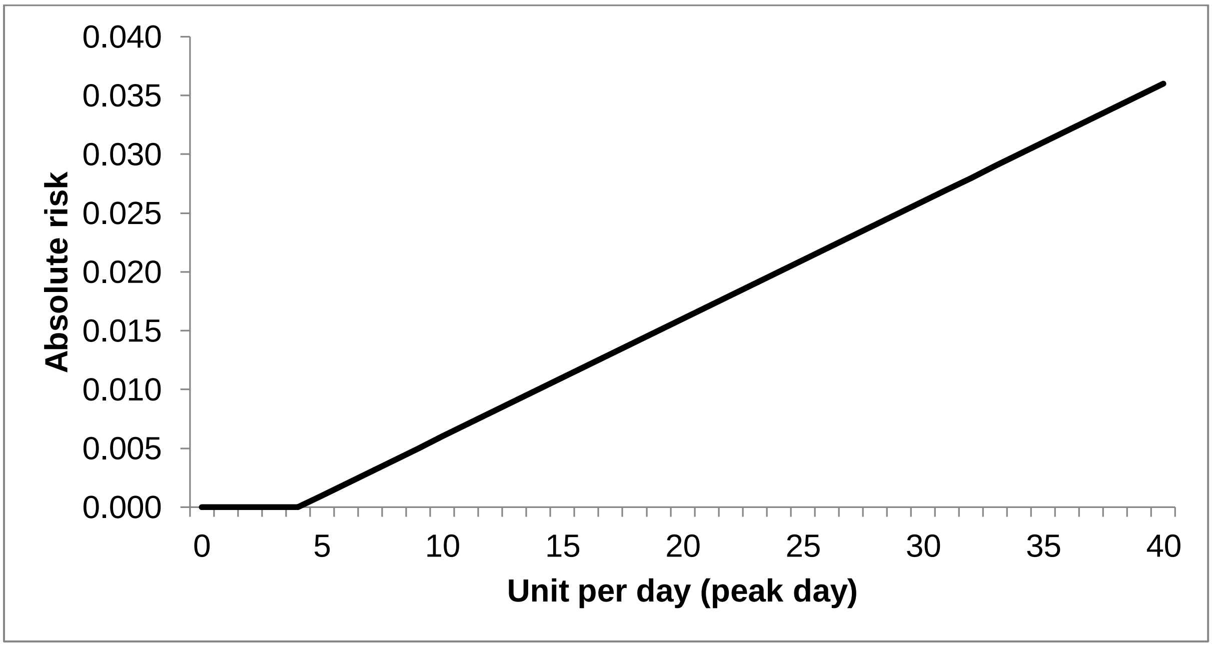


Figure 8.2: Illustrative linear absolute risk function for a wholly attributable acute harm (threshold of 4 units)

9 CONSUMPTION TO HEALTH HARMS MODEL

9.1 HEALTH MODEL STRUCTURE

The model aims to capture policy impacts for the large number of health conditions for which evidence suggests alcohol plays a contributory role. The actual set of conditions used is taken from The North West Public Health Observatory's (NWPHO) 2008 report [18] on alcohol-attributable mortality and hospital admissions in England. Foetal alcohol syndrome and other health conditions relating to the secondary consequential impact of alcohol on the unborn foetus were not included in the model.

NWPHO classified harms into four categories of attribution:

1. Wholly attributable (AAF=100%) chronic – meaning that the harm cannot occur in the absence of alcohol consumption, and risk of occurrence changes with chronic exposure to alcohol (eg. alcoholic liver disease, ICD10 code = K70)
2. Wholly attributable acute – meaning that the harm cannot occur without alcohol as its cause, and risk of occurrence changes with acute exposure to alcohol including intoxication (eg. accidental poisoning by and exposure to alcohol, ICD10 code = X45)
3. Partially attributable chronic – meaning that the harm can occur without alcohol but the risk of occurrence changes with chronic exposure to alcohol (eg. malignant neoplasm (cancer) of the oesophagus, ICD10 code = C15)
4. Partially attributable acute – meaning that the harm can occur without alcohol but the risk of occurrence changes with acute exposure to alcohol (eg. falls, ICD10 code = W00-W19, or assault, ICD10 = X85-Y09).

The same set of conditions is assessed in the modelling, with one exception: heart failure was excluded from the analysis due to the very small AAF reported in the NWPHO report. The list of 47 conditions is presented in Table 9.1.

Table 9.1: Health conditions included in the model

	Condition	ICD-10 code	Con. type	Source of AAF or risk function
Wholly attributable chronic conditions	Alcohol-induced pseudo-Cushing's syndrome	E24.4	Mean	100% attributable
	Degeneration of the nervous system	G31.2	Mean	
	Alcoholic polyneuropathy	G62.1	Mean	
	Alcoholic myopathy	G72.1	Mean	
	Alcoholic cardiomyopathy	I42.6	Mean	
	Alcoholic gastritis	K29.2	Mean	
	Alcoholic liver disease	K70	Mean	

	Condition	ICD-10 code	Con. type	Source of AAF or risk function
	Chronic pancreatitis	K86.0	Mean	
Wholly attr. acute conditions	Mental and behavioural disorders due to use of alc.	F10	Peak	100% attributable
	Ethanol poisoning	T51.0	Peak	
	Methanol poisoning	T51.1	Peak	
	Toxic effect of alcohol, unspecified	T51.9	Peak	
	Accidental poisoning by exposure to alcohol	X45	Peak	
Partially attributable chronic conditions	Malignant neoplasm of lip, oral cavity and pharynx	C00-C14	Mean	[19]
	Malignant neoplasm of oesophagus	C15	Mean	
	Malignant neoplasm of colon	C18	Mean	
	Malignant neoplasm of rectum	C20	Mean	
	Malig. neoplasm of liver and intrahepatic bile ducts	C22	Mean	
	Malignant neoplasm of larynx	C32	Mean	
	Malignant neoplasm of breast	C50	Mean	[20]
	Diabetes mellitus (type II)	E11	Mean	[21]
	Epilepsy and status epilepticus	G40-G41	Mean	[22]
	Hypertensive diseases	I10-I15	Mean	[19]
	Ischaemic heart disease	I20-I25	Mean	
	Cardiac arrhythmias	I47-I48	Mean	[21]
	Haemorrhagic stroke	I60-I62, I69.0-I69.2	Mean	[19,19]
	Ischaemic stroke	I66-I66,I69.3, I69.4	Mean	
	Oesophageal varices	I85	Mean	
	Gastro-oesophageal laceration-haemorrhage synd.	K22.6	Mean	[23]
	Unspecified liver disease	K73, K74	Mean	[19]
	Cholelithiasis	K80	Mean	[21]
	Acute and chronic pancreatitis	K85, K86.1	Mean	[19]
	Psoriasis	L40 excludes L40.5	Mean	[21]
	Spontaneous abortion	O03	Mean	
Partially attributable acute conditions	Road traffic accidents - non pedestrian	V (various)	Peak	[24]
	Pedestrian traffic accidents	V (various)	Peak	
	Water transport accidents	V90-V94	Peak	[25]
	Air/space transport accidents	V95-V97	Peak	
	Fall injuries	W00-W19	Peak	[24]
	Work/machine injuries	W24-W31	Peak	[23]
	Firearm injuries	W32-W34	Peak	[25]
	Drowning	W65-W74	Peak	[23]
	Inhalation of gastric contents	W78	Peak	[25]
	Fire injuries	X00-X09	Peak	
	Accidental excessive cold	X31	Peak	
	Intentional self-harm	X60-X84	Peak	[23]
	Assault	X85-Y09	Peak	[25]

9.2 MORTALITY MODEL STRUCTURE

A simplified version of the model structure for mortality is presented in Figure 9.1. The model is developed to represent the population of England in a life table. Separate life tables have been implemented for males and females.

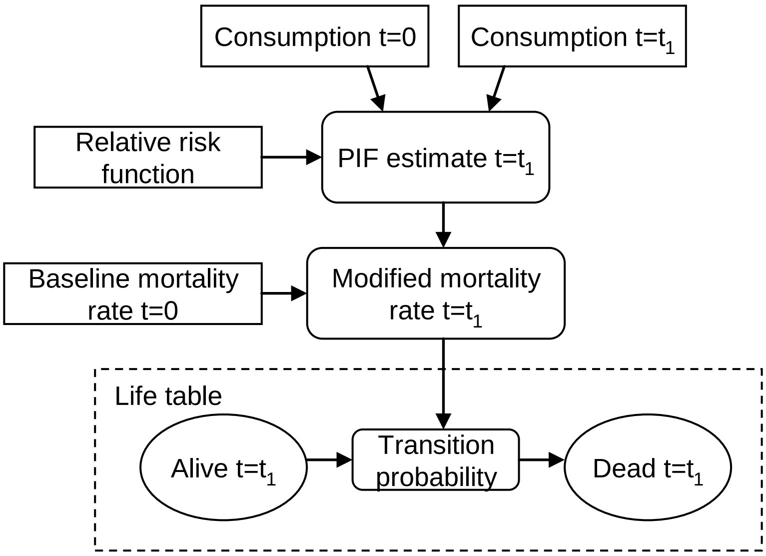


Figure 9.1: Simplified mortality model structure

The life table is implemented as a linked set of simple Markov models with individuals of age *a* transitioning between two states – alive and dead – at model time step *t*. Those of age *a* still alive after the transition then form the initial population for age *a+1* at time *t+1* and the sequence repeats.

The transition probabilities from the alive to dead state are broken down by condition and are individually modified via potential impact fractions over time *t*, where the PIF essentially varies with consumption (mean for chronic conditions and maximum daily for acute conditions) over time:

$$PIF_t = 1 - \frac{\sum_{i=1}^{N} w_i RR_{i,t}}{\sum_{i=1}^{N} w_i RR_{i,0}}$$ *Equation 7*

where PIF_t is the potential impact fraction relating to consumption at time *t*, *i* = GLF sample number, *N* = number of samples in subgroup *i*, $RR_{i,t}$ is the risk relating to the consumption of GLF sample *i* at time *t*, $RR_{i,0}$ is the risk at baseline, and w_i is the weight of sample *i*.

Note that the PIF can be decomposed to enable different population groups at baseline – for example, moderate, hazardous and harmful drinkers – to be followed separately over the course of the model.

The model computes mortality results for two separate scenarios (a baseline – implemented as 'no change to consumption' in the analysis herein – and an intervention). The effect of the intervention is then calculated as the difference between the life tables of two scenarios: enabling the change in the total expected deaths attributable to alcohol due to the policy to be estimated.

Outcomes from the mortality modelling are expressed in terms of life years saved. Morbidity valuation is the purpose of a second model described below.

9.3 MORBIDITY MODEL STRUCTURE

A simplified schematic of the morbidity model is shown in Figure 9.2. The model focuses on the expected disease prevalence for population cohorts and as such is quite simple. Note that if an incidence-based approach were used instead, then much more detailed modelling of survival time, cure rates, death rates and possibly disease progression for each disease for each population subgroup would be needed.

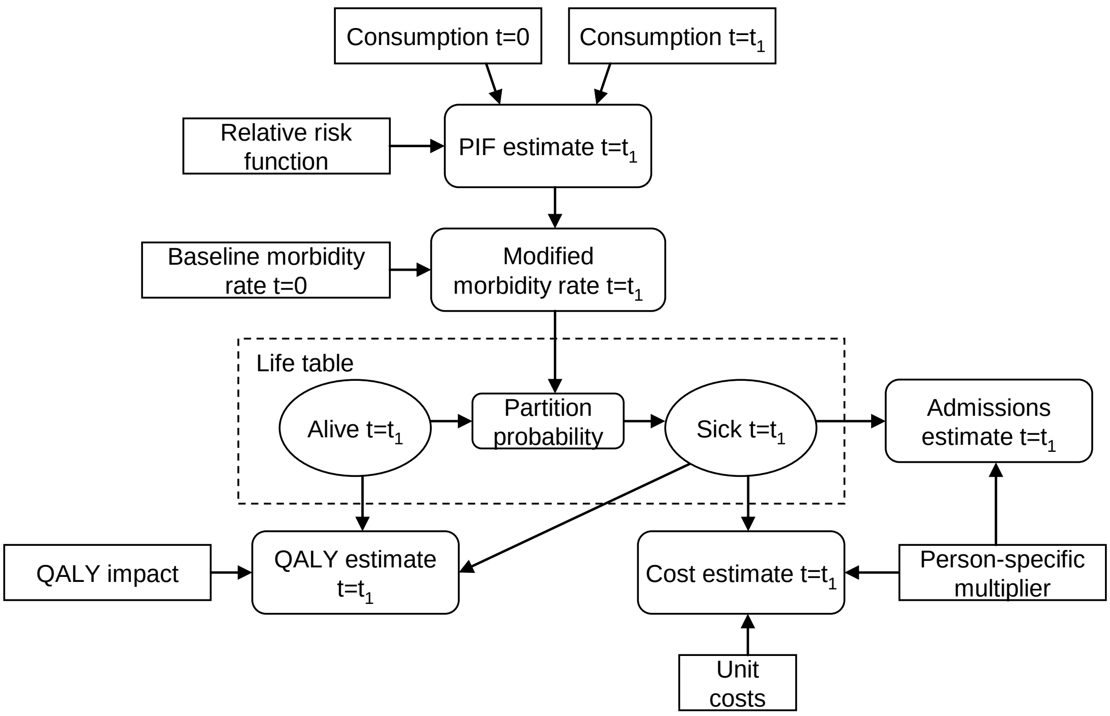


Figure 9.2: Simplified structure of morbidity model

The morbidity model works by partitioning the alive population at time *t*, rather than using a transition approach between states as previously described for the mortality model. Alive individuals are partitioned between all 47 alcohol-related conditions (and a 48th condition representing overall population health, not attributable to alcohol) analysed based on person-specific disease prevalence rates calculated from the NWPHO work [18].

As in the mortality model, the PIF is calculated based on the consumption distribution at time *0* and *t* and risk functions. The PIF is then used to modify the partition rate (i.e., the distribution of the 47 conditions for alive individuals) to produce person-specific sickness volumes. These volumes then form the basis for estimating both health service costs and health related quality of life.

Quality Adjusted Life Years (QALYs) are examined using the difference in health-related quality of life (utility) in individuals with alcohol health harms and the quality of life measured in the general population (or “normal health”). Utility scores usually range between 1 (perfect health) and 0 (a state equivalent to death), though it is possible for some extreme conditions to be valued as worse than death. The utility scores are an expression of societal preference for health states with several different methods available to estimate them. Note that because a life table approach has been adopted, the method to estimate QALY change for morbidity also encompasses the mortality valuation.

9.4 TIME LAG EFFECTS FOR CHRONIC HARMS

When modelling the link between consumption and harm, one important input is the assumption surrounding the ‘time lag’ – the time needed to achieve the full benefit (reduction in harms) associated with a reduction of consumption. Such data is necessary for chronic conditions where the development of diseases often occurs over many years.

A mean lag of 10 years was assumed for all chronic conditions. While such a lag may under- or over-estimate the true mean time lag for some conditions, given the lack of consensus it is considered to be a plausible estimate. The time lag for acute conditions was assumed to be zero since benefits associated with a reduction of acute harms occur instantaneously [26]. One potential limitation is the assumption that the time lag is similar for both morbidity and mortality which is unlikely to be true for many conditions. However in the absence of data and consensus, such an assumption had to be made.

The time lag effect was considered in our model assuming a linear progression. This is supported by Norström and Skog, who fitted a geometric function with $\lambda=0.8$ to estimate the effect of the lag, which is very close to a linear effect.

Thus, for a 10 year time lag, benefits associated with a reduction in consumption at year 1 will be associated with one tenth of the expected full benefits. One tenth of full benefits will be achieved each year up to year 10. An illustration is shown in Figure 9.3.

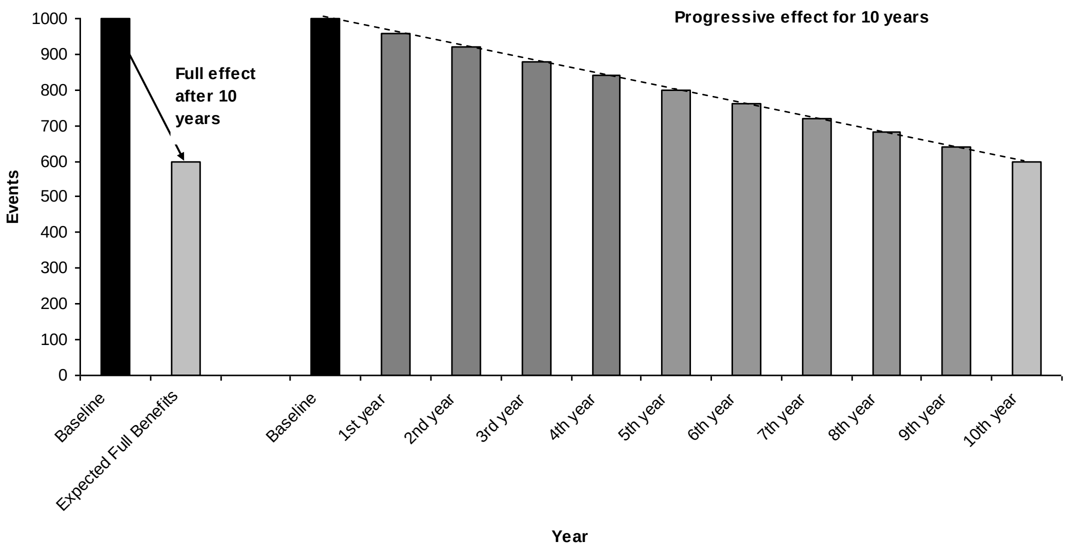


Figure 9.3: Illustrative example of the time lag effect for chronic conditions

9.5 MORTALITY MODEL PARAMETERS

Mortality rates are derived from ONS mortality statistics for England & Wales for 2006 [27]. Risk functions were estimated using the methods described in Section 8.3 using the AAFs from the NWPHO report [18] and GLF 2009 age/sex specific distributions of average weekly and peak day alcohol consumption where required. Parameter estimates for mortality risk functions are presented in Table A.1 and Table A.3.

The baseline population for the life table, used to model transitions between alive and dead, is derived from England population statistics in 2010 from the ONS [28] which was the latest available age-specific population survey in England.

9.6 MORBIDITY MODEL PARAMETERS

9.6.1 Life table data

As for the mortality model, the baseline population for the morbidity life table was derived from England population statistics in 2010 from the ONS [28].

9.6.2 Morbidity prevalence rates

Morbidity prevalence rates are based on person-specific hospitalisations from the Hospital Episodes Statistics (HES) database, as calculated by NWPHO [18]. Because the HES data is individualised, and different admissions for the same person can be examined, it is possible to analyse how many individual persons have been admitted. Thus, for example, if the same person was admitted on three separate occasions for oesophageal cancer during the year, then this would be counted as just one person-specific hospitalisation. One major limitation of the NWPHO data is that persons with an alcohol-attributable disease who are not hospitalised during the year are not included in the dataset.

Annual healthcare costs to the NHS associated with alcohol related harms are estimated based on the cost per hospital admission. Since the model works on person-specific morbidity, a multiplier was used to derive the number of actual hospital admissions. Multipliers have been estimated to create a mapping between the two measures for each condition.

The multiplier is calculated from the volume of total hospital admissions related to alcohol (Department of Health personal communication, 2008) in 2006 and the number of person-specific hospitalisations attributable to alcohol [18] for the same year. It was possible to calculate a multiplier only for conditions with a positive AAF; the average multiplier was applied for conditions with a negative AAF. The multipliers used are presented in Table B.1.

As for mortality, risk functions were estimated using the methods described in Section 8.3, using the AAFs from the NWPHO report [18] and the GLF 2009 age/sex specific distributions of average weekly and peak day alcohol consumption where required. Parameter estimates for morbidity risk functions are presented in Table A.2 and Table A.3.

9.6.3 Healthcare costs to NHS

Costs to the NHS have been derived from work by the Department of Health [29] on NHS costs of alcohol-attributable diseases. This cost is broken down by hospital inpatient and day visits, hospital outpatient visits, accident and emergency visits, ambulance services, NHS GP consultations, Practice Nurse consultations, dependency prescribed drugs, specialist treatment services and other health care costs.

Inpatient costs were not available for all the conditions analysed in the NWPHO report due to the indicator chosen (Public Service Agreement, NHS Performance Framework and Local Government Performance Framework). Conditions with a small AAF were also excluded. Unavailable inpatients costs were taken to be the average tariff from the NHS reference costs while the number of alcohol hospital admissions was derived from the HES data and the NWPHO report [18]. The cost per hospital admission for each condition is reported in Table B.1.

Since [29] did not report the breakdown per condition for other costs to the NHS (eg. outpatient, A&E, ambulance, GP costs), an alternative method was used to estimate the breakdown of events (consultations) per condition. After discussion with clinical colleagues, costs were derived using the estimated total number of consultations due to alcohol in England and the likelihood of a consultation/event per condition (based on expert judgement). The mean number of consultations (for example, outpatient, GP, nurse visits) was estimated for each condition and calibrated using clinical colleagues opinion so that the total number of consultations approach the DH estimates for the total cost of alcohol to the NHS.

Finally, all healthcare costs were adjusted to 2011 prices using annual RPIs from the ONS.

9.6.4 Health related quality of life

Utilities for all 47 conditions included in the model were derived from a single source, the Health Outcomes Data Repository (HODaR) [30], to avoid potential bias and variability between studies. The HODaR data measures utilities using the EQ-5D, a widely used generic (disease non-specific) quality of life instrument as recommended by NICE for health economic evaluation. Data was collected by the Cardiff & Vale NHS Hospital Trust serving a local population of 424,000, and providing tertiary care for the whole of Wales. Patients discharged from hospital are requested to complete an EQ-5D questionnaire 6 weeks after their discharge via postal questionnaire. Data is collected on: demography, health utility (EQ5D index) and diagnoses (ICD-10), as well as a large range of other clinical, administrative and economic related information.

A mean utility value was thus extracted for each condition based on diagnoses (or ICD-10 codes). While utilities can be extracted per age and sex group, only the mean utility was extracted because direct analysis at a condition / age level involves very small sample sizes. The mean utilities for the condition were adjusted for age using the % increment/decrement observed for utilities in the general population [31]. Utilities for individuals aged 16–17 years were assumed to be similar to the utility in individuals aged 18–24 years. The utility was also assumed to be similar for males and females.

For conditions where no utility data was available, utilities were assumed to be similar to close conditions. Thus, utilities for mental and behavioural and alcohol induced Cushing syndrome were assumed to be similar to alcoholic polyneuropathy. Utilities for alcoholic myopathy were assumed to be similar to utilities for alcoholic cardiomyopathy. The utility for methanol poisoning was assumed to be similar to ethanol poisoning. Utilities for air/space and water transport accidents were assumed to be similar to road traffic accidents. Finally, utilities for firearm injuries, drowning, fire injuries and accidental excessive cold were assumed to be similar to pedestrian traffic accident.

The resulting utilities for each of the 47 conditions by age group are shown in Table C.1.

There are some limitations relating to use of the HODaR data in the model. In particular, for acute conditions such as admission for road traffic accident, or fall or intentional self-harm, there is a question as to whether the measure of utility at 6 weeks following discharge is representative of the full consequences of the disease. For acute conditions there is clearly the likelihood that utility scores might be worse than the 6 week recorded measure immediately around the time of the incident. Equally, it is plausible that through the recovery process, patients' utility score might be better 6 or 9 months post incident than they were at just 6 weeks. In the absence of data at other time points it is assumed that the 6 week utility score is representative of the score for a full year in the model. This may underestimate or overestimate the QALY gains of avoided health harms for acute conditions.

Utilities in the general population for 'normal health' were extracted from [31] for each age group. This study showed that the average health related utility score reduces fairly steadily with age because on average more health related problems emerge for people at older ages.

9.6.5 Valuation of Health Harms and Discounting

For the purpose of valuing harm reduction, it was necessary to assign a financial value for discounted QALYs. Analyses were conducted assuming a financial value of £60,000 per QALY, consistent with Department of Health impact assessments. In this analysis QALYs and costs were discounted at 3.5% annually.

10 CRIME HARMS

10.1 SUMMARY OF MODEL STRUCTURE

The modelling of crime-related harms adapts original work by the Cabinet Office which has been updated by UK Government analysts [32]. The latest analysis examined 20 alcohol-related crimes and all of these are included in the model (see Table 10.1). Note that low-level anti-social behaviour is not currently included in the modelling.

A simplified schematic of the crime model is shown in Figure 10.1. As for the health model, the main mechanism is the PIF, which is calculated based on the consumption distribution at time *0* and time *t* and an estimated risk function. The PIF is then applied directly to the baseline number of offences to give a new volume of crime for time *t*. The model uses the consumption distribution for the intake in the heaviest drinking day in the past week (peak consumption) since crime was assumed to be a consequence of acute drinking rather than mean drinking (and so there is no time delay between change in exposure to alcohol and subsequent change in risk of committing a crime).

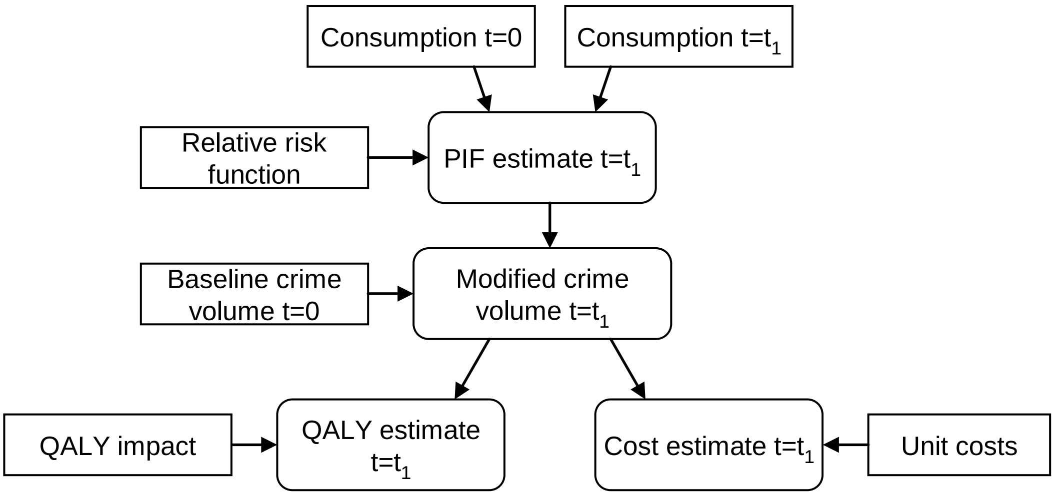


Figure 10.1: Simplified structure of crime model

Outcomes are presented in terms of the number of offences and the associated cost of crime. The outcomes from the ‘do nothing’ and the policy scenario are then compared to estimate the incremental effect of the implementation of the policy.

In this analysis, loss of QALYs for crime victims is set to zero as the related cost is embedded within the estimated financial costs of crime.

10.2 BASELINE VOLUME OF OFFENCES

Baseline levels of crime volumes used the latest police recorded crime data for England and Wales [33] and the latest estimates of crime multipliers which account for under-reporting of crimes within the recorded crime data [34] (see Table 10.1). England-specific crime volume data was not available at the level of modelled crime categories and therefore was estimated by apportioning England and Wales total crime volumes using high level crime volume information for England and Wales.

Unfortunately this data does not provide a breakdown of offences by age and sex. This information has been derived from the 2003 Offending, Crime and Justice Survey (OCJS) distribution of offenders found guilty or cautioned in 2003 [35]. Distributions were available for the following age groups, split by sex: 16-24, 25-34, 35-65 for six crime categories. Assumptions were made about the mapping between crime categories and the modelled offences (shown in Table 10.3). Mapping to the model age groups was also necessary: the distribution of individuals aged 16 to 24 years old was collapsed for individuals aged 16 to 17 years old and 18 to 24 years old assuming an equal probability of crime at each age in the group. For individuals aged 35 years old and over, it is unlikely that the probability of committing a crime is similar between a person aged 35 years and 75 years. It was judged that a decrease in crime with increasing age was the most appropriate assumption. Based on this, the distribution for 35-65 years olds was collapsed assuming that 50%, 27.5%, 15% and 7.5% of crimes committed in this age group were committed by 35-44, 45-54, 55-64 and 65-74 years olds, respectively. Finally, no alcohol-related crimes were assumed to be committed by individuals aged over 75 years old.

The use of OCJS 2003 statistics is not ideal and may overestimate or underestimate the distribution for particular age/sex groups. For example, a bias could have been introduced since young offenders may be more or less likely to be found guilty or cautioned than older offenders.

Table 10.1: Crime volumes (2011/12), multipliers (2010/11) and costs (2010) in England

Crime categories	Recorded volumes	Multipliers	Total volumes	Costs (£)
Causing death by dangerous driving under the influence, driving after having consumed excess alcohol	23	1.0	23	1,774,681
More serious wounding	17,260	1.5	25,889	25,747
Less serious wounding	299,072	1.5	448,608	9,790
Assault on a constable	14,777	7.9	116,738	1,750
Assault without injury	191,082	7.9	1,509,544	1,750
Criminal damage	589,136	5.9	3,475,905	1,053
Theft from the person	93,746	4.6	431,232	763
Robbery	66,556	4.8	319,468	8,810
Robbery (Business)	6,634	4.8	31,844	9,372
Burglary in a dwelling	233,771	2.8	654,558	3,925
Burglary not in a dwelling	243,701	1.9	463,033	4,608
Theft of a pedal cycle	108,018	3.6	388,866	763
Theft from vehicle	285,367	3.5	998,784	1,034
Aggravated vehicle taking	5,941	1.3	7,723	4,970
Theft of vehicle	81,514	1.3	105,968	4,970
Other theft	458,124	2.7	1,236,935	763
Theft from shops	287,350	16.1	4,626,340	124
Violent disorder	648	1.5	972	12,632
Total sexual offences *(2008/9 multiplier)*	50,402	13.6	685,461	36,952
Homicide	517	1.0	517	1,774,681

10.3 CRIME RISK FUNCTION PARAMETERS

Prevalence-based risk modelling is not as well developed for crime as for chronic health conditions. The situation is more similar to acute health outcomes where attribution is based on direct measurement rather than an epidemiological fraction. Therefore risk functions are not generally available in the literature (the exception perhaps being road traffic accidents where there is evidence linking blood alcohol concentration prevalence to increased relative risk).

The Cabinet Office's alcohol-attributable fractions [36] for crime are estimated, from a sample of arrestees, as the ratio of arrestees with a positive urine test for alcohol to the total number of arrestees. This would tend to overestimate the AAF defined in classic epidemiological terms since it will contain a proportion of arrestees who would have committed the offence even without consuming alcohol. This is true of all AAFs based purely on identified consumption, be this due to self-reporting, judgment by a third party (eg. police or accident and emergency services) or measurement by a test.

However it is also possible to estimate an AAF based on attribution of consumption to the outcome (usually self-reported). In surveys of criminality this is typically done by asking the respondent if he or she committed the act because of his or her alcohol consumption. If attributable fractions relating to self-reported attribution are available, then it is possible to reconstruct a relative risk and thus to model changes in these outcomes due to changes in consumption (either side of a defined threshold for excess risk).

The OCJS 2005 [37] – a self-reported and confidential survey of young people (aged 10 to 25) in England and Wales – includes two questions on offending related to alcohol. The first question (Q1) asks whether the offender was drunk at the time of the offence ("had you taken drugs or drunk alcohol when you did it?"). The second question (Q2) asks whether, in the offender's view, he had undertaken the offence because he was drunk ("still thinking about when this happened, were any of these things reasons you did it?" followed by a multiple-choice list of responses, including alcohol use, where multiple responses are allowed). The data enables attribution based on alcohol use, drug use, both of these simultaneously, and other causes. The Home Office update [38] to the Cabinet Office cost of alcohol-related crime report [36] used results from Q1. This approach posits that alcohol consumption prior to the offence defines the attribution to alcohol, rather than whether offenders attribute their crimes to the use of alcohol.

A more conservative approach is adopted for the modelling, basing AAFs on responses to Q2 (since AAFs from Q1 are generally higher than those estimated from Q2, eg. the respective AAFs for wounding for males aged 16 to 25 are 26% and 11%). It was possible to derive AAFs from the OCJS 2005 [37] for males and females aged 16 to 25 years old. Further subgroup breakdowns were not possible due to the small sample sizes in the survey. Estimated AAFs are reported in Table 10.2.

Table 10.2: AAFs for each crime category from the OCJS

		Reason for committing crime				
Crime category	**N**	**Under the influence of alcohol only**	**Under the influence of alcohol and other**	**Other reason**	**No reason given**	**AAF**
Males 16-25						
Violent disorder	267	5.5%	9.0%	78.5%	6.9%	**14.5%**
Wounding	132	2.3%	9.0%	78.0%	10.7%	**11.3%**
Assault without injury	135	8.9%	9.1%	79.1%	2.9%	**18.0%**
Vehicle related thefts	32	5.3%	0.0%	80.3%	14.4%	**5.3%**
Burglary, robbery, other	183	1.4%	0.0%	84.0%	14.6%	**1.4%**
Criminal damage	70	24.0%	7.1%	57.2%	11.8%	**31.1%**
Females 16-25						
Violent disorder	163	1.1%	20.1%	64.7%	14.1%	**21.2%**
Wounding	88	0.0%	28.3%	61.0%	10.7%	**28.3%**
Assault without injury	75	2.2%	12.5%	68.1%	17.3%	**14.7%**
Vehicle related thefts	10	51.4%	0.0%	32.0%	16.6%	**51.4%**
Burglary, robbery, other	134	0.9%	0.4%	91.0%	7.7%	**1.3%**
Criminal damage	20	4.0%	30.1%	61.1%	4.9%	**34.1%**

Risk functions for the modelled offences (based on a mapping of crime categories from OCJS 2005, see Table 10.3) were estimated from the AAFs by the usual method (see Section 8.3.2) using sex-specific distributions for 16-25 year olds of peak day alcohol consumption from GLF 2009.

The risk functions for 16-25 year olds were re-used for over 25s due to the lack of data for the latter. This approach is not ideal since it is likely that AAFs for older individuals are different to those for younger individuals. Whilst this is a limitation, it is not likely to impact greatly on the modelling results since individuals over 25 years old contribute to less than 30% of all crimes. Relative risk functions are shown in Figure 10.2 and Figure 10.3[1].

[1] Note that whilst the relative risks often appear to be greater for females than for males (particularly in terms of vehicle related thefts), the absolute prevalence levels for females are generally much lower than for males. This suggests that vehicle related theft is very unlikely to occur amongst females unless alcohol is involved, whereas for males a higher proportion of vehicle thefts occur without alcohol.

Table 10.3: Slope of relative risk functions for modelled offences, split by crime category and OCJS sex and age sub-groups

		Male		Female	
Offences	**AAF used**	**Under 16 years old**	**16 years and over**	**Under 16 years old**	**16 years and over**
More serious wounding	Assault with Injury	0	0.038099084	0.009594672	0.127546864
Less serious wounding	Assault with Injury	0	0.038099084	0.009594672	0.127546864
Assault on a constable	Assault without Injury	0	0.065647526	0.006935395	0.055689177
Assault without injury	Assault without Injury	0	0.065647526	0.006935395	0.055689177
Criminal damage	Criminal damage	0.019417005	0.134989795	0.108638568	0.167213547
Theft from the person	Other theft	0.028534668	0.004246302	0.016387841	0.004256265
Robbery	Other theft	0.028534668	0.004246302	0.016387841	0.004256265
Robbery (Business)	Other theft	0.028534668	0.004246302	0.016387841	0.004256265
Burglary in a dwelling	Other theft	0.028534668	0.004246302	0.016387841	0.004256265
Burglary not in a dwelling	Other theft	0.028534668	0.004246302	0.016387841	0.004256265
Theft of a pedal cycle	Other theft	0.028534668	0.004246302	0.016387841	0.004256265
Theft from vehicle	Vehicle related thefts	0	0.016737308	0.637131033	0.341766515
Aggravated vehicle taking	Vehicle related thefts	0	0.016737308	0.637131033	0.341766515
Theft of vehicle	Vehicle related thefts	0	0.016737308	0.637131033	0.341766515
Other theft	Other theft	0.028534668	0.004246302	0.016387841	0.004256265
Theft from shops	Other theft	0.028534668	0.004246302	0.016387841	0.004256265
Violent disorder	All violent offences	0	0.050717939	0.008260967	0.086938499
Total sexual offence	All violent offences	0	0.050717939	0.008260967	0.086938499
Homicide	All violent offences	0	0.050717939	0.008260967	0.086938499

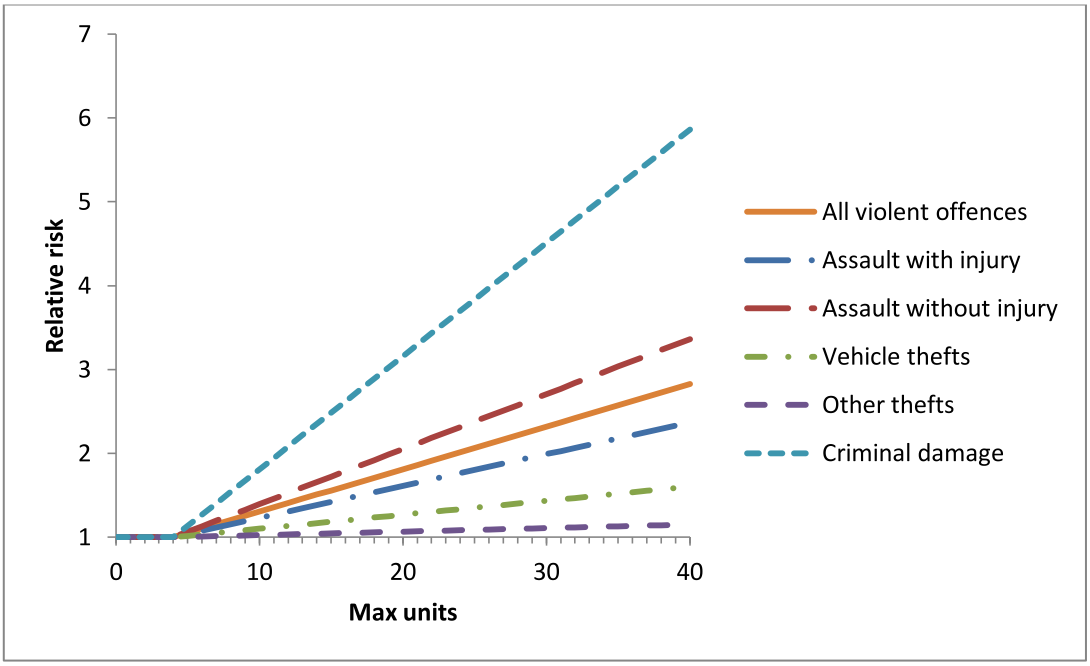


Figure 10.2: Relative risk functions for males

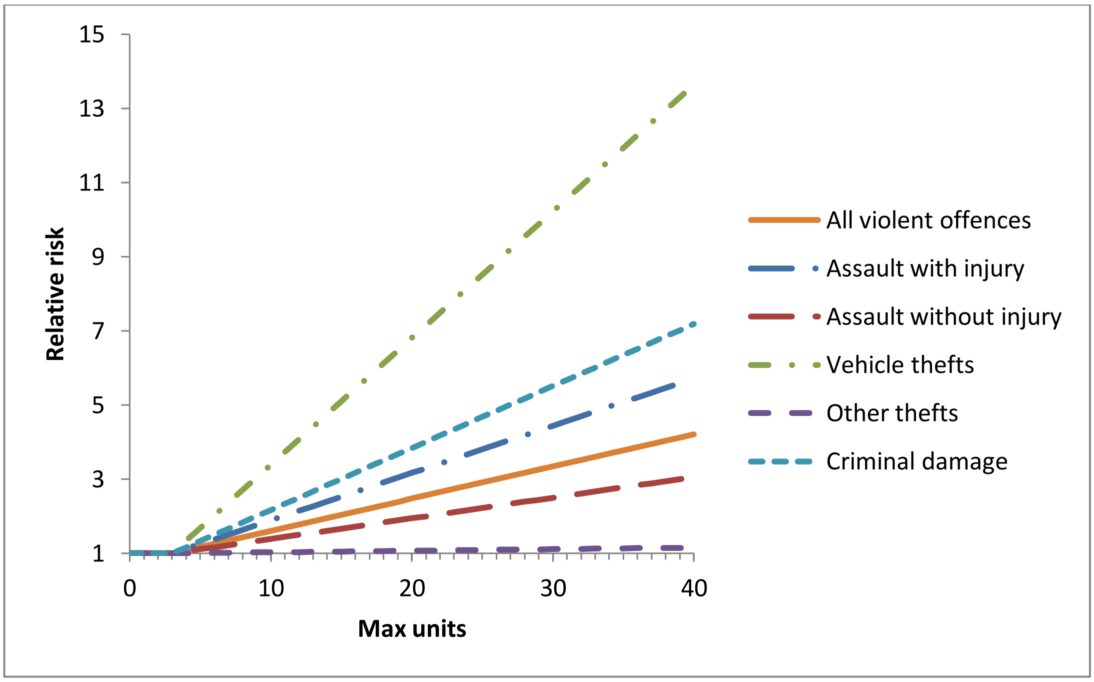


Figure 10.3: Relative risk functions for females

10.4 COSTS OF CRIME

The costs of crime used were the latest estimates available [34] (see Table 10.1). Unit costs of crimes committed in future years have their value discounted at an annual rate of 3.5%.

11 WORKPLACE HARMS

11.1 SUMMARY OF MODEL STRUCTURE

A 2003 Cabinet Office report [36] examined three separate effects of alcohol on workplace-related issues. The three components in these studies are:

- Lost outputs due to early death.
- Unemployment
- Absence from work

Loss of outputs due to premature mortality were excluded to avoid double-counting the social value of life years lost already estimated in the health and crime models. Unemployment is not included in SAPM2.5 due to concerns regarding the robustness of the evidence detailing the relationship between unemployment and alcohol consumption. Note that the exclusion of unemployment does not mean we believe alcohol consumption, especially at harmful levels, will not affect unemployment.

A simplified schematic of the workplace model is shown in Figure 11.1. Based on baseline consumption, consumption at time *t* and risk functions derived above, a PIF is calculated and applied to the absence rate. Absenteeism is assumed to be related to acute drinking and so maximum daily intake is applied as the consumption measure and it is assumed that there is no time delay between change in exposure to alcohol and subsequent change in risk of absenteeism.

Using the Labour Force Survey [39], the number of days absent from work is then calculated based on the absence rate, the mean number of days worked and the number of working individuals in each age/sex subgroup. Days absent from work are then valued using individuals' daily gross income. The costs of absenteeism were adjusted to 2011 prices using annual RPIs from the ONS.

Outcomes for two scenarios – do nothing and policy implementation – are computed separately. The difference is then taken to estimate the incremental effect of the policy.

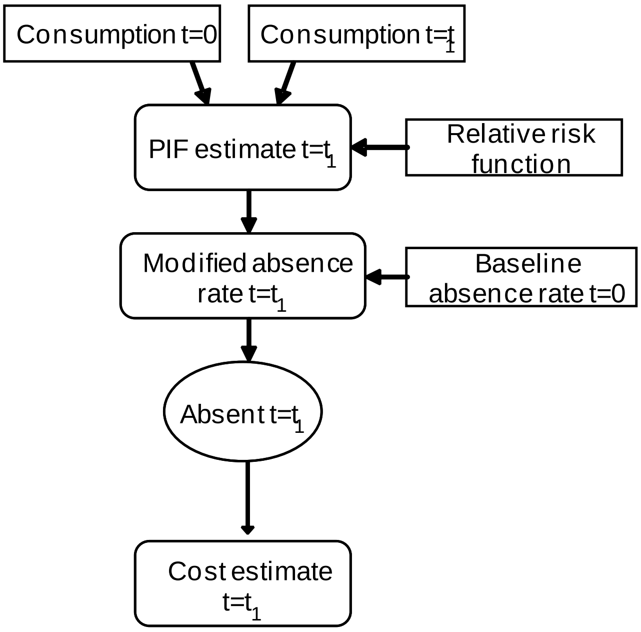


Figure 11.1: Simplified structure of workplace model

11.2 WORKPLACE ABSENTEEISM MODEL PARAMETERS

The original Cabinet Office report [36] used the Whitehall II study [40] of civil servant health and employment to estimate the effects of alcohol on absenteeism (reproduced in Table 11.1). The Cabinet Office assumes relative risks of absenteeism of 1.20 and 1.19 for alcohol over certain ranges, based on the relative risk of absence from work due to injury (although this is actually applied to volumes of absence for any reason).

There is an endogeneity problem with alcohol and absence from work, in that on the one hand people who drink too heavily can become absent from work (causal) but, on the other hand people who are absent from work due to significant illness may be less likely to drink alcohol. Table 11.1 shows that this can be the case since the relative risks of “all absences” as opposed to “absence due to injury” actually slope in the opposite direction, ie. people who drink more have lower absence rates. This is probably due to people with significant illnesses and higher absence rates drinking less alcohol.

Table 11.1: Reproduction of Table 28 from the Whitehall II study [40] – rate ratios for spells of absence attributable to injury and for all spells by units of alcohol consumption in the last 7 days

Units per week		**Rate ratios for males and females combined**	
Males	**Females**	**Spells due to injury**	**Spells for all reasons**
0	0	1.04	1.06
1-10	1-7	1.00	1.00
11-21	8-14	1.20	0.98
22-35	15+	1.19	0.93

In searching the literature, one important non-UK study was identified that enables some further analysis and assessment of the appropriateness of the Cabinet Office assumption: an article by Roche *et al*. [41] examining absenteeism due to alcohol in Australia. The study provides useful further evidence because it explicitly asks respondents whether their absence was caused by alcohol. The study suggests that 3.5% of people took absence from work for one day or more in the previous three months as a consequence of their alcohol consumption, compared with 39.7% due to illness/injury not due to alcohol. In contrast to the Whitehall II study [40], Roche *et al*. [41] also shows a positive slope for the relation between all illness/injury absenteeism and alcohol consumption. In particular, the risks of absence were 7.34 for people drinking at "high risk levels" (males >43, females >29 units per week) and 4.26 for people drinking at "risky" levels (males >29, females >15 units per week).

Whilst the findings from the Whitehall II study were England-specific, evidence from Roche *et al.* [41] was preferred for the model baseline due to the absence of a split by age groups and sex in the former study. Results based on self-attribution are also preferred, from a modelling perspective, to purely associative evidence. Furthermore the Whitehall II study [40] reported the relative risk for absenteeism due to injury which may not accurately reflect the relative risk of absenteeism due to alcohol.

Table 11.2: Reproduction of Table 5 from Roche et al*. [41] – proportion absent from work*

Age	Male workers Estimated workforce (millions)	Male workers Proportion absent for at least one day	Female workers Estimated workforce (millions)	Female workers Proportion absent for at least one day
Alcohol related absenteeism				
14-19	0.182 (0.149-0.214)	7.2% (3.9-12.9%)	0.127 (0.101-0.153)	11.0% (6.7-17.7%)
20-29	0.891 (0.820-0.961)	9.2% (7.2-11.7%)	0.686 (0.636-0.737)	5.3% (4.1-6.9%)
30-39	1.141 (1.071-1.2111)	4.2% (3.3-5.4%)	0.801 (0.748-0.855)	2.0% (1.4-2.9%)
40-49	1.146 (1.070-1.222)	2.6% (1.6-4.0%)	0.859 (0.799-0.918)	1.4% (0.8-2.4%)
50-59	0.820 (0.761-0.879)	1.3% (0.7-2.3%)	0.537 (0.498-0.577)	0.1% (0.0-0.3%)
60+	0.181 (0.156-0.207)	0.3% (0.0-2.4%)	0.124 (0.102-0.146)	0.0%
Total	4.361 (4.196-4.526)	4.2% (3.6-5.0%)	3.134 (3.009-3.260)	2.5% (2.1-3.1%)
Illness/injury absenteeism				
14-19	0.175 (0.143-0.208)	59.3% (50.5-67.7%)	0.123 (0.098-0.149)	69.7% (61.7-76.6%)
20-29	0.865 (0.795-0.934)	47.4% (43.5-51.3%)	0.664 (0.614-0.713)	55.2% (51.9-58.5%)
30-39	1.065 (0.998-1.132)	40.7% (37.9-43.6%)	0.735 (0.685-0.786)	44.9% (42.1-47.7%)
40-49	1.057 (0.983-1.131)	33.4% (30.4-36.4%)	0.784 (0.728-0.839)	35.6% (32.5-38.7%)
50-59	0.747 (0.690-0.803)	27.0% (23.7-30.5%)	0.473 (0.435-0.511)	30.3% (26.7-34.1%)
60+	0.156 (0.133-0.179)	18.0% (13.4-23.8%)	0.112 (0.091-0.132)	23.8% (17.1-32.2%)
Total	4.065 (3.905-4.224)	37.6% (36.0-39.3%)	2.890 (2.771-3.010)	42.6% (41.0-44.2%)

AAFs for absenteeism were calculated according as follows:

$$AAF = \frac{a_{alc}}{a_{alc} + a_{inj/ill}}$$ *Equation 8*

where a_{ak} is the proportion of absence of a least one day due to alcohol and $a_{inj/ill}$ is the proportion of absence of at least one day due to injury or illness. The AAFs for absenteeism by age and sex group are reported in Table 11.3.

Relative risk functions were calculated for each age/sex group derived from the AAFs in the usual way (see Section 8.3.2) using age/sex specific distributions of peak day alcohol consumption from GLF 2009. Absenteeism due to alcohol was assumed to be a consequence of the acute consumption (supported by [41]). Excess risk was assumed to start after a threshold of 4 units for men and 3 units for women, as for other acute harms. The estimated risk functions for absenteeism are presented in Figure 11.2 and Figure 11.3 for males and females respectively.

Table 11.3: Estimated AAFs for absenteeism based on Roche et al*. [41]*

Age	**Males**	**Females**
16 – 17	10.8%	13.6%
18 – 24	14.5%	10.5%
25 – 34	13.2%	6.8%
35 – 44	8.4%	4.1%
45 – 54	6.1%	2.2%
55 – 64	3.4%	0.2%

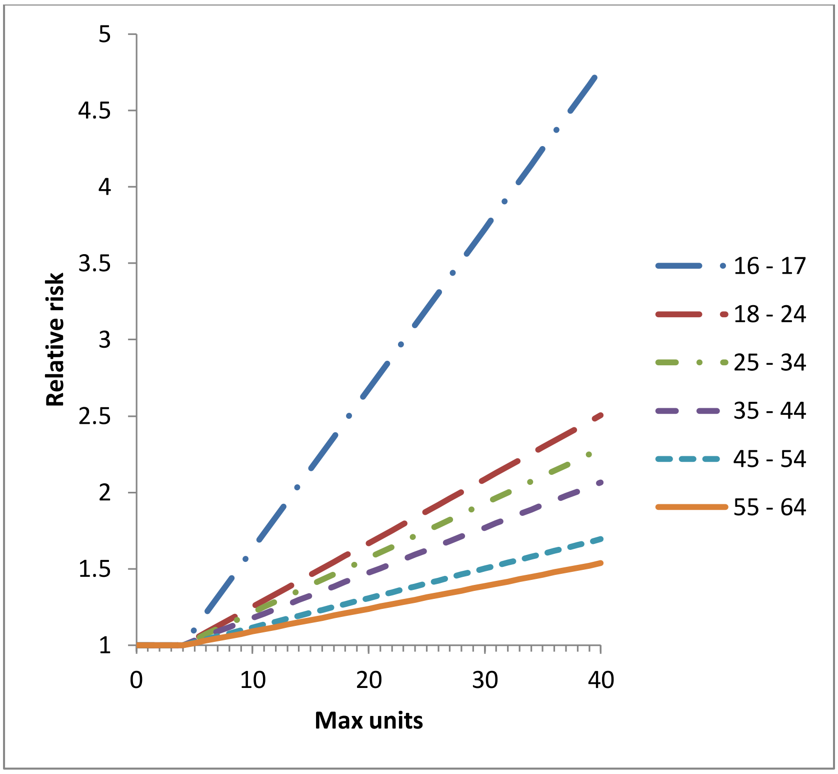


Figure 11.2: Risk functions for absenteeism in males

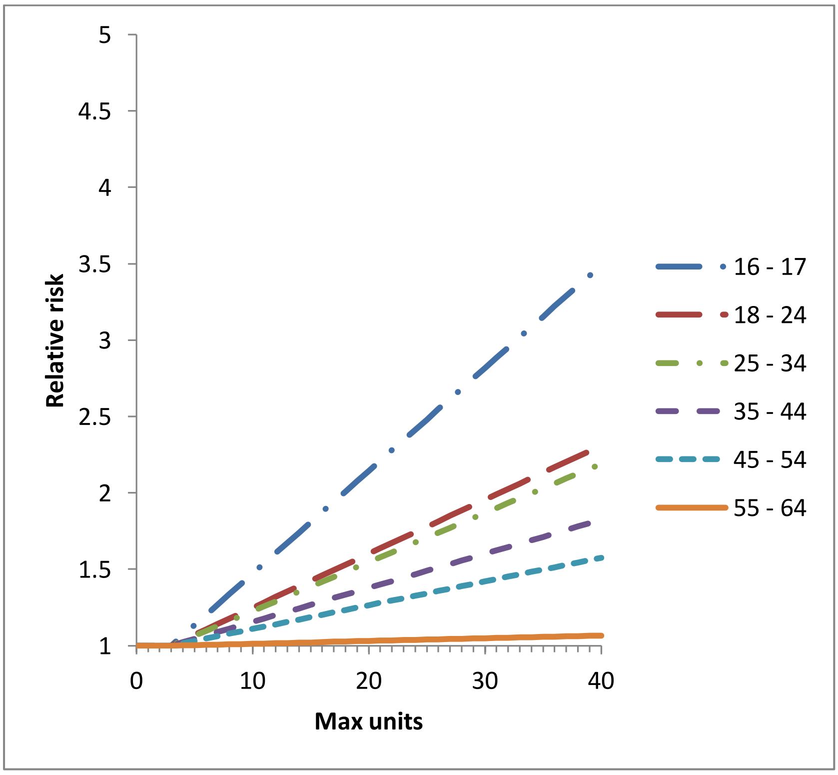


Figure 11.3: Risk functions for absenteeism in females

12 SENSITIVITY ANALYSIS

Best practice for policy modelling suggests reporting a single base case estimate, supported by a range of sensitivity analysis to reveal the effect of key uncertainties in the evidence base [42]. We have focused the sensitivity analyses on uncertainties around the elasticities estimated for the base case because elasticities are the active ingredients of minimum unit price (MUP) and banning below cost selling (BBCS) appraisals. These are also where the most substantial changes to the model have occurred between SAPM2 and SAPM2.5. As the elasticities are subject to both structural and parameter uncertainty the sensitivity analyses use probabilistic sensitivity analysis (PSA).

The pseudo-panel method [14] used to estimate price elasticities produces a series of variance-covariance matrices. In these circumstance, assuming conditions of multivariate normality, Cholesky decomposition can be used to sample alternative parameter estimates (from which own-price and cross-price elasticities can directly be derived). The model is then re-run with the new parameter estimates to generate fresh outcomes. The process is repeated a number of times (30 runs for most base case modelled scenarios) to produce a distribution of outcomes.

The alternative elasticity estimates tested are:

1. Assuming all cross-price elasticities to be zero (i.e. assuming no cross-price effect) in the elasticity matrix estimated for the base case;
2. Excluding non-significant elasticities (p-value greater than 0.05) in the elasticity matrix estimated for the base case;
3. Separate moderate and hazardous/harmful-specific elasticity matrices were estimated using the pseudo-panel approach;
4. Separate low income and higher income-specific elasticity matrices were estimated using the pseudo-panel approach;
5. Elasticities were estimated using a time series analysis [43] of national aggregate data on alcohol cleared for consumption or sale from 1964 to 2011;
6. Latest elasticities estimated by Her Majesty's Revenue and Customs (HMRC) in 2012.

The elasticities used for the sensitivity analyses are described in Appendix D:.

13 DATA PREPARATION AND SPECIFIC METHODS FOR THE ANALYSIS OF BELOW COST-SELLING

The same policy appraisal model (the Sheffield Alcohol Policy Model version 2.5 or SAPM2.5) and the same methodologies are used for the appraisal of the banning below cost selling (BBCS) policy as for the appraisal of the minimum unit pricing (MUP) policies in our main report. The only difference is that the minimum price thresholds used as model inputs are adjusted to those implied by the new policy. As VAT is levied as a percentage of the retail price of a product, the effect of a BBCS policy is to set a minimum price equivalent to the duty payable for a product plus the VAT payable on that duty. At the current rate of VAT, this means the effective minimum price is the duty payable plus 20%. Therefore, in this analysis, the BBCS policy is treated as a special case of a MUP policy where the MUP thresholds are defined as the estimated duty plus VAT per unit of alcohol (1 unit = 8g/10ml of ethanol) payable for each of the 10 modelled beverage types.

Table 13.1 summarises the estimated average duty plus VAT per unit of alcohol for beer, cider, wine, spirit and RTD (ready-to-drink beverages or alcopops) in the UK based on the the duty rates set by Her Majesty's Revenue and Customs (HMRC) effective from 25th March 2013 to 24th March 2014. A number of assumptions are used to estimate these thresholds as (1) different duty rates exist for the same modelled beverage type (e.g. there are currently three duty rates for beer which increase with alcohol content) and (2) duty rates for cider and wine are calculated based on product volume rather than ethanol content. When multiple duty rates exist (for beer, cider and wine), we choose the most typical (mode) duty rate. The ABV assumptions for cider and wine are based on the average ABV used by HMRC (personal communication with HMRC in March 2013). The estimated duty plus VAT payable per unit of alcohol is 22.9p, 9.4p, 24.5p, 33.9p and 33.9p for beer, cider, wine, spirit and RTD respectively.

The estimated duty plus VAT per unit of alcohol figures shown in Table 13.1 were effective from 25th March 2013 until HMRC updated the duty rates effective from 24th March 2014. Table 13.2 presents the thresholds for the BBCS policy and for a 45p MUP policy adjusted to 2011 prices. The adjustment factors to convert duty plus VAT rates in 2014/15 prices to 2011 prices (shown in Table 13.4) are derived from data provided by the Home Office for a 2014/15 45p MUP threshold converted to 2011 prices by beverage type. The thresholds for the BBCS policy are much lower than those for the 45p MUP policy and this is particularly the case for cider.

Table 13.1: Method and assumptions to estimate threshold prices under BBCS:- estimated duty plus VAT per unit of alcohol for beer, cider, wine, spirit and RTD in the UK (based on duty rates from 25th March 2013 to 24th March 2014)

Beverage type	**Duty rates as set by HMRC from 25th March 2013 (£)**	**Assumed duty rate for SAPM2.5**	**Assumed average ABV for wine and cider**	**Estimated duty in pence per unit of alcohol**	**Estimated duty plus VAT in pence per unit of alcohol**
Beer	9.17 to 24.21 per hectolitre per cent of alcohol in the beer (varies according to ABV: general - 19.12, lower strength - 9.17, higher strength - 24.21)	**£19.12** per hectolitre per cent of alcohol in product (general duty rate)	n/a	19.1	22.9
Cider	39.66 to 258.23 per hectolitre of product (still cider - 39.66 to 59.52, sparking cider - 39.66 to 258.23)	**£39.66** per hectolitre of product (still cider with ABV 1.2% to 7.5% and sparkling cider with ABV 1.2% to 5.5%)	5.06%	7.8	9.4
Wine	82.18 to 355.59 per hectolitre of product (wine, still wine and made wine - 82.18 to 355.59, sparkling wine and made wine - 258.23 to 341.63) or 28.22 per litre of pure alcohol (wine with ABV > 22%)	**£266.72** per hectolitre of product (still wine with ABV 5.5% to 15%)	13.05%	20.4	24.5
Spirit	28.22 per litre of pure alcohol	**£28.22** per litre of pure alcohol	n/a	28.2	33.9
RTD	28.22 per litre of pure alcohol (spirit based)	**£28.22** per litre of pure alcohol (spirit based)	n/a	28.2	33.9

Table 13.2: Comparison of Implied Thresholds (pence per unit) for the BBCS and 45p MUP policies in 2011 prices

	Estimated duty plus VAT in 2011 prices (pence per unit of alcohol)	45p MUP thresholds in 2011 prices (pence)
Off-trade beer	21.0	41.2
Off-trade cider	8.8	42.3
Off-trade wine	22.5	41.2
Off-trade spirit	30.2	40.1
Off-trade RTD	31.5	41.8
On-trade beer	21.1	41.4
On-trade cider	8.7	41.8
On-trade wine	22.6	41.6
On-trade spirit	31.3	41.6
On-trade RTD	31.3	41.5

Table 13.3 presents the proportion of alcohol units sold below the duty plus VAT thresholds in 2011 and the relative change in average price for the BBCS policy for the 10 modelled beverage types. Overall, only 0.7% of alcohol is sold below the thresholds of the BBCS policy and the estimated overall price increase is 0.1%. Figure 13.1 and Figure 13.2 compare the proportion of alcohol sold and relative change in average price in the off-trade between the BBCS and the 45p MUP policies.

Table 13.3: Proportion of alcohol units sold below the duty plus VAT thresholds and the relative change in average price for the BBCS policy

	Proportion sold below duty plus VAT	% change in price
Off-trade beer	2.4%	0.2%
Off-trade cider	0.1%	0.0%
Off-trade wine	0.4%	0.1%
Off-trade spirit	1.2%	0.1%
Off-trade RTD	0.1%	0.0%
On-trade beer	0.0%	0.0%
On-trade cider	0.0%	0.0%
On-trade wine	0.0%	0.0%
On-trade spirit	0.0%	0.0%
On-trade RTD	0.0%	0.0%
Total	0.7%	0.1%

Table 13.4: Adjustment factors (by beverage) from 2014/15 prices to 2011 prices

	Adjustment factor from 2014/15 price to 2011 price
Off-trade beer	0.916
Off-trade cider	0.940
Off-trade wine	0.916
Off-trade spirit	0.891
Off-trade RTD	0.929
On-trade beer	0.920
On-trade cider	0.929
On-trade wine	0.924
On-trade spirit	0.924
On-trade RTD	0.922

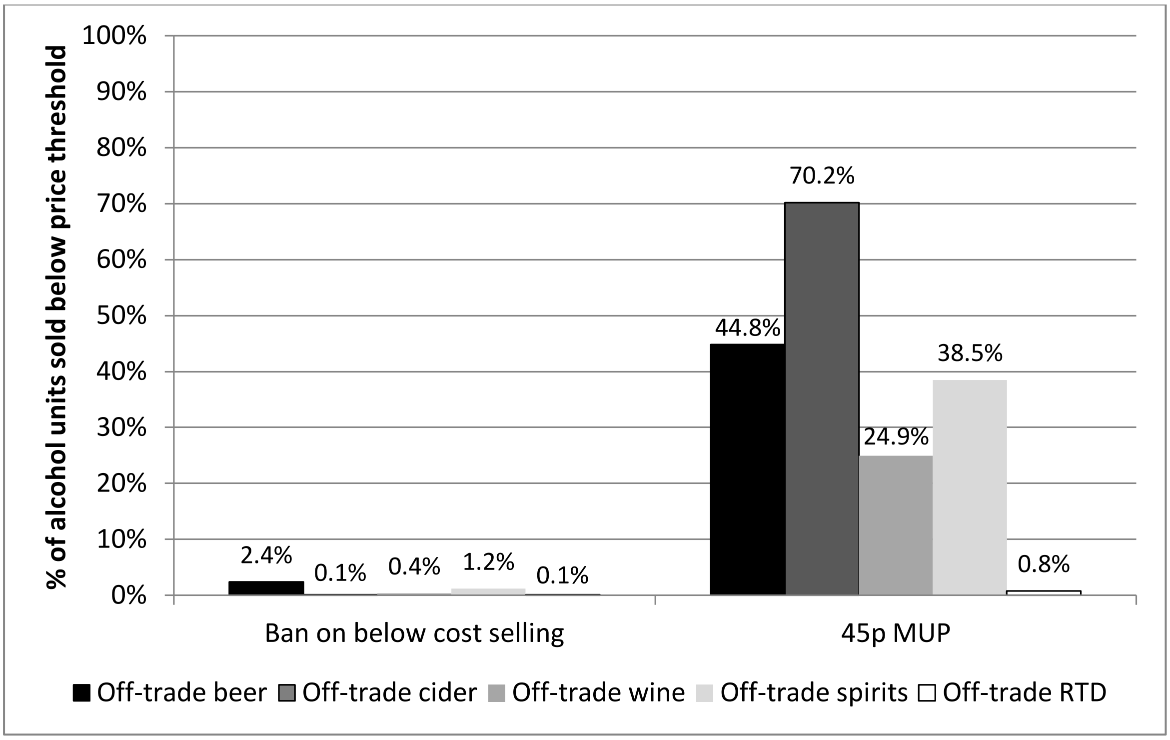


Figure 13.1: Comparison of proportions of alcohol units sold in the off-trade below the price thresholds used by the BBCS and the 45p MUP policies

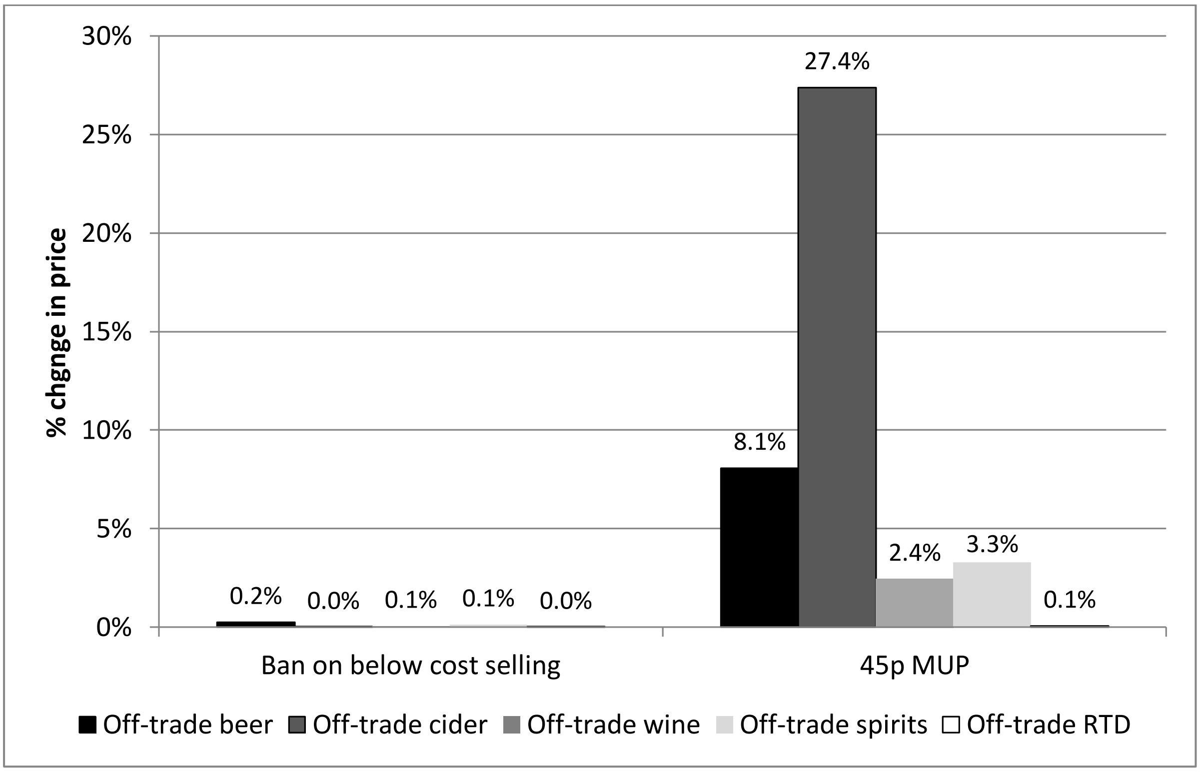


Figure 13.2: Comparing relative change in average price in the off-trade between the BBCS and the 45p MUP policies

14 SOME NOTES ON THE FRAMEWORK AND PERSPECTIVE FOR ECONOMIC APPRAISAL OF ALCOHOL POLICIES

14.1 ASSESSMENT FRAMEWORK FOR SCREENING AND BRIEF INTERVENTIONS

The analysis undertaken for assessing the cost-effectiveness of screening and brief interventions is similar to that undertaken for NICE technology appraisals of healthcare interventions. The costs of the intervention incurred by the NHS and social services are examined and balanced against the health benefits gained in terms of quality adjusted life years, with account also taken of any financial savings to health and social care due to reduced illness. The analysis calculates an incremental cost-effectiveness ratio for implementation of the intervention versus current practice in terms of the incremental cost per quality adjusted life year gained.

14.2 ASSESSMENT FRAMEWORK FOR PRICING POLICIES AND OTHER MACRO-LEVEL INTERVENTIONS

There are extended challenges in applying economic modelling to macro-level interventions, beyond those commonly encountered in NICE health technology assessments. In particular, the range of costs and benefits to be included can be difficult to determine, especially when decision-maker and stakeholder concerns may not be limited to the immediate and direct effects of an intervention. The inclusions and exclusions concerning direct and indirect economic effects of macro-level alcohol interventions are discussed below.

14.3 CONVENTIONAL ASSESSMENT FRAMEWORK

14.3.1 Policy implementation costs to government and public sector savings

In general, NICE is interested in a public sector perspective on the costs and financial benefits of a public health intervention. However for regulation of alcohol prices, advertising, outlet density or licensing hours, the public sector borne costs of the intervention are likely to be minimal (consisting of legislative processes, implementation and enforcement through existing mechanisms). These costs will almost certainly be outweighed by the public sector savings from the direct costs of services considered (healthcare, social care and criminal justice system). At this stage, the potential direct costs on government and the public sector for each of the policies examined are excluded from the analysis.

14.3.2 Valuation of health and crime harm reductions

The effectiveness of the macro-level interventions, in terms of reductions in health harms, are estimated using a quality adjusted life years gained framework. A financial value for a health-related QALY is subsequently applied.

14.4 EXTENDED ASSESSMENT FRAMEWORK

Some might argue for a purely public sector stance to be taken by decision-makers for macro-level policies. Ignoring wider issues, the modelling results would show that larger price increases would produce larger health gains and larger financial value of harms avoided with small, fixed implementation costs. This would imply that larger price increases should be considered more 'cost-effective' than smaller price increases. However, it is recognised that such an economic framework cannot fully capture the wider economic effects of possible policies. Other factors, not all of which have been quantified in the current analyses, may need to be considered as discussed below.

14.4.1 Valuation of workplace harm reductions

The Sheffield Alcohol Policy Model quantifies the reduction in workplace harm (specifically sickness absence) financially, based on average salaries. From a public sector perspective the costs to be included would be the lost productivity from public sector employees. While lost productivity is included in the current analysis, the public sector component has not been separated out.

14.4.2 Costs to individuals (consumers of alcohol), retailers and the wider economy

Costs to individuals are outwith the scope of NICE economic assessments, although they may be considered in terms of equity implications. In the case of alcohol pricing policies, regulation to increase prices could cause increased expenditure by consumers. Such direct effects are reported, together with the effect on "consumers' pockets" (the hypothetical increase in expenditure faced by a drinker prior to a reduction in consumption).

For retailers, the model produces estimates of changes in volumes of alcohol expected to be sold as a consequence of each policy, which are then combined with price information to derive, for the country as a whole, the retail sales value (£) of different types of alcohol in both the off-trade and on-trade. These estimates are not broken down by type of retailer or particular named retailers. Nor do they make any estimates of profit or otherwise from alcohol for retailers since analysis of retailers' cost-base are not included in the modelling. Similarly, there is no quantified assessment here (beyond the retail sales overall) of the potential impact on different producers of alcohol, since direct information on their costs, the wholesale market, and the profit made by producers in selling on to retailers are not covered by the modelling. Some other transitional costs are not examined here, including effects on the advertising or media industry.

It is important not to misinterpret the increased costs to consumers and increased sales values to retailers: the changes in consumer expenditure under the different scenarios are not ‘net effects’ and cannot be interpreted as ‘costs of the intervention’ against which the ‘savings of the intervention’ (eg. in terms of public sector health and crime or wider workforce savings) should be balanced. This is because the increased expenditure by consumers has to be considered in conjunction with the increased revenue to the alcohol industry (producers, wholesalers and retailers) and possibly reduced revenue to other sectors of the economy. The increased revenue to the alcohol industry will return to the wider economy in a variety of ways; for example, wages and salaries to industry employees, profits to individual and institutional shareholders, including pension funds, and potential price reductions on other goods where retailers have been using alcohol as a loss leader. The analysis presented here does not include this dynamic analysis of the full effects of redistribution through the economic system.

14.4.3 Tax and duty revenues to government

Expected changes in tax revenue income to government are modelled for information purposes. Alcohol sales are implicitly divided in three main revenues: retail sale, duty and value-added tax (VAT). As detailed in Section 13, the duty schedule is different for different beverage type (beer, cider, wine, spirit), can vary within these types, and is calculated either based on units of alcohol or litres of product.

Using average duty per unit estimates for the five beverage types (see Table 13.1) and the model results for volume (in units) and value of sales (in £), estimates of the value of the VAT (associated with the duty and the retail), the value of duty, and the value of retail can be made for each policy scenario.

Again it should be emphasised that these are not necessarily ‘net effects’ and are included for information, rather than for direct trade-off calculations in relation to public sector benefits. If increased revenue were to accrue to the Treasury, then this can be conceived of as returning to the wider economy in the form of increases in government services or reductions in other taxes.

14.4.4 Consumer welfare

The public sector focus of NICE economic evaluations also excludes consideration of welfare losses (typically defined by consumer surplus – an economic measure of consumer satisfaction that is based on the difference between the price of a product and the price a consumer is willing to pay) arising from reduced consumption of alcohol. Hence consumer welfare analysis has not been undertaken as part of this study. Such an analysis would need to account for potential increases in consumer surplus from any price reductions elsewhere in the economy and the problems of estimating a ‘pure’ demand curve for alcoholic beverages.

REFERENCE LIST

1. Purshouse RC, Brennan A, Latimer N, Meng Y, Rafia R, Jackson R. Modelling to assess the effectiveness and cost-effectiveness of public health related strategies and interventions to reduce alcohol attributable harm in England using the Sheffield Alcohol Policy Model version 2.0: Report to the NICE Public Health Programme Development Group. Sheffield: University of Sheffield; 2009.

2. Purshouse RC, Meier PS, Brennan A, Taylor KB, Rafia R. Estimated effect of alcohol pricing policies on health and health economic outcomes in England: an epidemiological model. Lancet 2010;375(9723):1355-64.

3. University of Essex.Institute for Social and Economic Research and National Centre for Social Research. Living Costs and Food Survey (formally known as Expenditure and Food Survey). Colchester, Essex: UK Data Archive; 2011.

4. Goddard E. Estimating alcohol consumption from survey data: updated method of converting volumes to units. London: Office for National Statistics; 2007.

5. Stockwell T, Donath S, Cooper-Stanbury M, Chikritzhs T, Catalano P, Mateo C. Under-reporting of alcohol consumption in household surveys: a comparison of quantity-frequency, graduated-frequency and recent recall. Addiction 2004;99(8):1024-33.

6. Goddard E. General Household Survey 2005: Smoking and drinking among adults. Office for National Statistics; 2006.

7. UK HMRC. Alcohol Factsheet 2010. 2010.

8. Townshend JM, Duka T. Patterns of alcohol drinking in population of young social drinkers: a comparison of questionnaire and diary measures. Alcohol & Alcoholism 2002;37(2):187-92.

9. North West Public Health Observatory. LAPE: Local Alcohol Profiles for England 2012. User Guide. North West Public Health Observatory; 2012.

10. University of Essex.Institute for Social and Economic Research and National Centre for Social Research. General Lifestyle Survey (formally known as General Household Survey). Colchester, Essex: UK Data Archive; 2009.

11. Dunn E. Family Statistics, 2007 edition. London: Office for Nation Statistics; 2008.

12. NHS Health Scotland. Monitoring and Evaluating Scotland's Alcohol Strategy: An update of alcohol sales and price band analyses. 2012.

13. CGA Strategy. Data deliverables for 'Requirement specification for price and promotiondistribution of alcohol sales in the on-trade'. CGA Strategy; 2009.

14. Meng Y, Brennan A, Purshouse R, Hill-MacManus D, Angus C, Holmes J, et al. 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. J Health Econ 2014;34:96-103.

15. Gunning-Schepers L. The health benefits of prevention: a simulation approach. Health Policy 1989;12(1-2):1-255.

16. Fillmore KM, Kerr WC, Stockwell T, Chikritzhs T, Bostrom A. Moderate alcohol use and reduced mortality risk: Systematic error in prospective studies. Addict Res Theory 2006;14:101-32.

17. Royal College of Physicians. Royal College of Physicians' written evidence to Science and Technology Select Committee Inquiry on alcohol guidelines. London: Royal College of Physicians; 2011.

18. Jones L, Bellis MA, Dedman D, Sumnall H, Tocque K. Alcohol-attributable fractions for England: alcohol-attributable mortality and hospital admissions. Liverpool: Liverpool John Moores University, Centre for Public Health; 2008.

19. Corrao G, Bagnardi V, Zambon A, La Vecchia C. A meta-analysis of alcohol consumption and the risk of 15 diseases. Prev Med 2004;38(5):613-9.

20. Hamajima N, Hirose K, Rohan T, Calle EE, Heath CW, Coates RJ, et al. Alcohol, tobacco and breast cancer - collaborative reanalysis of individual data from 53 epidemiological studies, including 58515 women with breast cancer and 95067 women without the disease. Br J Cancer 2002;87(11):1234-45.

21. Gutjahr E, Gmel G, Rehm J. Relation between average alcohol consumption and disease: An overview. Eur Addict Res 2001;7(3):117-27.

22. Rehm J, Room R, Monteiro M, Gmel G, Graham K. Alcohol Use. In: Ezzati M, Lopes AD, Rodgers A, Murray CJL, editors. Comparative quantification of health risks. Global and regional burden of disease attribution to selected major risk factors. 2004.

23. English D, Holman DA, Australia.Dept.of Community Services and Health, National Drug Strategy A. The Quantification of Drug Caused Morbidity and Mortality in Australia: Pages 1-262. Australian Govt. Pub. Service; 1995.

24. Ridolfo B. The quantification of drug-caused mortality and morbidity in Australia, 1998 / Bruno Ridolfo, Chris Stevenson. Canberra : Australian Institute of Health and Welfare; 2001.

25. Single E, Ronson L, Xie X, Rehm J. The cost of substance abuse in Canada. Ottawa: Canadian Centre on Substance Abuse; 1996.

26. Norström T, Skog OJ. Alcohol and mortality: methodological and analytical issues in aggregate analyses. Addiction 2001;96:S5-S17.

27. Office for National Statistics. Mortality Statistics: Deaths Registered in England and Wales (Series DR), 2006. 2008.

28. Office for National Statistics. Population Estimates for UK, England and Wales, Scotland and Northern Ireland, Mid-2010. 2011.

29. Health Improvement Analytical Team. The cost of alcohol harm to the NHS in England. An update to the Cabinet Office (2003) study. London: Department of Health; 2008 Jul 23.

30. Cardiff Research Consortium. Health Outcomes Data Repository. 2011.

31. Kind P, Dolan P, Gudex C, Williams A. Variations in popultation health status: results from a United Kingdom national questionnaire survey. Brit Med J 1998;316(7133):736-41.

32. Department of Health. Safe, Sensible, Social - Consultation on further action. Impact Assessments. London; 2008 Jul.

33. Office for National Statistics. Crime in England and Wales, year ending September 2012 - Statistical Bulletin. 2013.

34. Home Office. Revisions made to the multipliers and unit costs of crime used in the Integrated Offender Management Value for Money Toolkit. 2011.

35. Home Office. Offending, Crime and Justice Survey, 2003. Colchester, Essex: UK Data Archive; 2005 Oct.

36. Cabinet Office, Strategy Unit. Alcohol misuse: How much does it cost? London: The Stationery Office; 2003.

37. Home Office. Social Research, Offending, Crime and Justice Survey, 2005. Colchester, Essex: UK Data Archive; 2008 Dec.

38. Wilson D. Young People and Crime: Findings from the 2005 Offending, Crime and Justice Survey. Home Office; 2006.

39. University of Essex.Institute for Social and Economic Research and National Centre for Social Research. Labour Force Survey. Colchester, Essex: UK Data Archive; 2007.

40. University College London. Work environment, alcohol consumption and ill-health: The Whitehall II Study. Health and Safety Executive; 2002.

41. Roche AM, Pidd K, Berry JG, Harrison JE. Workers' drinking patterns: the impact on absenteeism in the Australian work-place. Addiction 2008;103(5):738-48.

42. HM Treasury. The Green Book: Appraisal and Evaluation in Central Government. London: TSO; 2011.

43. Huang C-D. Econometric Models of Alcohol Demand in the United Kingdom. London: HM Customs and Excise; 2003.

APPENDIX A: RISK FUNCTIONS FOR HEALTH CONDITIONS

Table A.1: Slope of the linear absolute risk function for mortality for wholly attributable conditions

	11 – 15 years		16 - 17 years		18 - 24 years		25 - 34 years		35 - 44 years		45 - 54 years		55 - 64 years		65 - 74 years		75 + years	
Conditions	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
Alcohol-induced pseudo-Cushing's syndrome																		
Mental and behavioural disorders due to use of alcohol	1.7E-07		9.6E-07		2.7E-07		1.7E-06	6.3E-07	6.4E-06	4.6E-06	8.0E-06	9.8E-06	1.4E-05	1.7E-05	1.7E-05	1.0E-05	2.8E-05	2.7E-05
degeneration											4.8E-07		8.7E-07		5.6E-07		5.8E-06	
Alcoholic polyneuropathy											4.8E-07							
Alcoholic myopathy											4.8E-07		8.7E-07					
Alcoholic cardiomyopathy							6.2E-07	7.4E-07	3.4E-06		5.0E-06	2.3E-06	6.7E-06	2.0E-06	8.9E-06	1.6E-06	1.9E-06	3.2E-06
Alcoholic gastritis								7.4E-07			2.4E-07		2.9E-07		5.6E-07			
Alcoholic liver disease					1.1E-06	1.3E-06	2.8E-05	3.5E-05	1.3E-04	1.2E-04	2.2E-04	2.7E-04	2.6E-04	3.0E-04	2.4E-04	3.4E-04	2.7E-04	2.5E-04
Chronic pancreatitis							9.3E-07	7.4E-07	1.0E-06	4.4E-07	3.4E-06	1.7E-06	2.6E-06	1.3E-06	1.7E-06	1.6E-06	3.9E-06	
Ethanol poisoning					9.6E-08			1.3E-07	7.1E-07	2.6E-07	3.5E-07	3.9E-07	5.4E-07	3.1E-07	3.5E-07			
Methanol poisoning									7.9E-08		8.7E-08							
Toxic effect of alcohol, unspecified		4.4E-08		2.5E-07	1.9E-07	1.7E-07	9.3E-07	3.8E-07	1.7E-06	2.0E-06	3.0E-06	2.7E-06	1.7E-06	3.4E-06	2.8E-06	3.4E-06	1.3E-06	
Accidental poisoning by exposure to alcohol		4.4E-08		2.5E-07	2.9E-07	1.7E-07	8.0E-07	6.3E-07	2.3E-06	2.3E-06	3.2E-06	3.1E-06	2.2E-06	3.7E-06	2.8E-06	2.6E-06	1.3E-06	

Table A.2: Slope of the linear absolute risk function for morbidity for wholly attributable conditions

	11 – 15 years		16 - 17 years		18 - 24 years		25 - 34 years		35 - 44 years		45 - 54 years		55 - 64 years		65 - 74 years		75 + years	
Conditions	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
Alcohol-induced pseudo-Cushing's syndrome																		
Mental and behavioural disorders due to use of alcohol	4.4E-04	2.9E-04	2.0E-03	4.8E-04	5.7E-04	3.3E-04	6.7E-04	4.7E-04	1.3E-03	8.2E-04	1.3E-03	1.2E-03	1.7E-03	1.3E-03	2.4E-03	1.8E-03	4.6E-03	4.7E-03
degeneration							3.2E-07	7.7E-07	8.3E-06	7.0E-06	1.8E-05	1.8E-05	2.0E-05	1.9E-05	2.5E-05	1.9E-05	5.0E-05	3.4E-05
Alcoholic polyneuropathy							1.9E-06	3.1E-06	2.5E-06	1.9E-06	6.3E-06	9.2E-06	1.0E-05	5.7E-06	1.2E-05	8.7E-06	2.3E-05	2.1E-05
Alcoholic myopathy									5.5E-07	4.7E-07	2.0E-06	6.1E-07	3.1E-06	7.2E-07	3.0E-06	1.7E-06	8.3E-06	3.4E-06
Alcoholic cardiomyopathy							2.3E-06		1.3E-05	2.8E-06	3.0E-05	5.5E-06	4.9E-05	7.9E-06	6.1E-05	5.2E-06	7.7E-05	3.1E-05
Alcoholic gastritis			5.5E-05	1.8E-05	1.9E-05	1.6E-05	2.9E-05	1.5E-05	3.5E-05	1.8E-05	2.5E-05	1.7E-05	1.7E-05	1.2E-05	1.8E-05	1.6E-05	2.9E-05	1.0E-05
Alcoholic liver disease			1.5E-05	6.0E-06	5.2E-06	5.2E-06	7.6E-05	1.3E-04	3.4E-04	3.2E-04	5.9E-04	7.0E-04	8.0E-04	7.8E-04	8.7E-04	1.1E-03	1.1E-03	9.2E-04
Chronic pancreatitis			3.3E-05	7.2E-06	1.1E-05	6.3E-06	5.0E-05	2.5E-05	9.1E-05	3.8E-05	6.6E-05	4.4E-05	4.5E-05	2.1E-05	3.1E-05	2.9E-05	3.7E-05	1.0E-05
Ethanol poisoning	2.2E-04	2.7E-04	4.4E-04	3.6E-04	1.2E-04	2.5E-04	1.2E-04	2.6E-04	1.4E-04	3.1E-04	7.7E-05	2.6E-04	4.9E-05	1.3E-04	3.6E-05	9.5E-05	6.2E-05	1.2E-04
Methanol poisoning			2.8E-07	4.4E-07	7.9E-08	3.1E-07	2.1E-07	1.3E-07	1.7E-07	5.4E-07	3.7E-07	6.2E-07	1.4E-07				1.3E-06	5.7E-06
Toxic effect of alcohol, unspecified			1.5E-05	1.2E-05	4.3E-06	8.2E-06	3.7E-06	8.3E-06	6.6E-06	1.0E-05	3.3E-06	8.3E-06	1.9E-06	6.6E-06	1.1E-06	4.5E-06	2.7E-06	2.9E-06
Accidental poisoning by exposure to alcohol			2.2E-05	1.1E-05	6.3E-06	7.9E-06	3.9E-06	6.3E-06	4.4E-06	7.3E-06	3.1E-06	6.0E-06	1.9E-06	4.3E-06	3.3E-06	1.8E-06	6.7E-06	2.0E-05

Table A.3: Slope of the linear risk function for acute conditions partially attributable to alcohol

	16 - 24 years		25 - 34 years		35 - 44 years		45 - 54 years		55 - 64 years		65 - 74 years		75 + years	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Road traffic accidents - non pediastrian	0.17564	0.07094	0.13789	0.09680	0.18937	0.11580	0.17514	0.14981	0.04146	0.00000	0.07252	0.00000	0.20074	0.00000
Pedestrian traffic accidents	0.66565	0.32315	0.32422	0.12438	0.33560	0.38199	0.31038	0.49419	0.07985	0.06347	0.13968	0.12672	0.38662	0.44045
Water transport accidents	0.07477	0.08079	0.05869	0.11025	0.08061	0.13188	0.07455	0.17061	0.10480	0.24858	0.18333	0.49634	0.50743	1.72511
Air/space transport accidents	0.05696	0.06155	0.04472	0.08400	0.06142	0.10048	0.05680	0.12999	0.07985	0.18940	0.13968	0.37816	0.38662	1.31437
Fall injuries	0.08435	0.05261	0.06622	0.07179	0.09095	0.08587	0.08411	0.11110	0.11823	0.16187	0.10000	0.08272	0.27678	0.28752
Work/machine injuries	0.02251	0.02432	0.01767	0.03319	0.02427	0.03971	0.02245	0.05137	0.03155	0.07484	0.05520	0.14943	0.15278	0.51939
Firearm injuries	0.09969	0.10772	0.07826	0.14700	0.10748	0.17584	0.09940	0.22748	0.13973	0.33144	0.24444	0.66178	0.67658	2.30015
Drowning	0.15406	0.16647	0.12095	0.22718	0.16611	0.27175	0.15362	0.35156	0.21594	0.51223	0.37776	1.02275	1.04562	3.55478
Inhalation of gastric contents	0.09969	0.10772	0.07826	0.14700	0.10748	0.17584	0.09940	0.22748	0.13973	0.33144	0.24444	0.66178	0.67658	2.30015
Fire injuries	0.18330	0.19806	0.14390	0.27028	0.19763	0.32331	0.18277	0.41827	0.25692	0.60943	0.44945	1.21682	1.24403	4.22931
Accidental excessive cold	0.09969	0.10772	0.07826	0.14700	0.10748	0.17584	0.09940	0.22748	0.13973	0.33144	0.24444	0.66178	0.67658	2.30015
Intentional self-harm	0.15406	0.17400	0.12095	0.21720	0.17362	0.27175	0.17514	0.35156	0.23579	0.46792	0.32946	0.66178	0.75072	1.72511
Assault	0.11061	0.11952	0.08684	0.16311	0.11926	0.19511	0.11030	0.25241	0.15504	0.36777	0.27122	0.73430	0.75072	2.55222

APPENDIX B: MOBIDITY COSTS TO THE NHS

Table B.1: Morbidity cost data

Conditions	ICD-10 codes	Multiplier	Inpatient visits	Outpatient visits	A&E visits	Ambulance	GP consultation	Nurse visits	Other health care cost	Total cost per person-specific hospitalisation
Alcohol-induced pseudo-Cushing's syndrome	E24.4	2.04	£4,885	£920	£0	£0	£0	£0	£0	£5,805
Mental and behavioural disorders due to use of alcohol	F10	1.05	£1,422	£473	£1,882	£979	£164	£15	£1,006	£5,942
Degeneration	G31.2	3.50	£8,325	£1,977	£2,095	£654	£439	£41	£3,359	£16,890
Alcoholic polyneuropathy	G62.1	2.26	£5,101	£1,532	£1,353	£422	£284	£27	£1,808	£10,526
Alcoholic myopathy	G72.1	2.71	£6,497	£1,834	£1,619	£506	£340	£32	£2,164	£12,991
Alcoholic cardiomyopathy	I42.6	1.86	£3,469	£1,261	£1,670	£1,043	£234	£22	£893	£8,592
Alcoholic gastritis	K29.2	2.63	£2,896	£1,187	£4,718	£2,456	£330	£31	£841	£12,459
Alcoholic liver disease	K70	1.32	£2,538	£297	£788	£492	£83	£8	£421	£4,626
Chronic pancreatitis	K86.0	4.64	£7,821	£2,619	£4,164	£2,601	£582	£54	£1,484	£19,324
Ethanol poisoning	T51.0	1.39	£576	£0	£2,494	£1,558	£0	£0	£0	£4,627
Methanol poisoning	T51.1	1.24	£857	£0	£2,226	£1,391	£0	£0	£0	£4,474
Toxic effect of alcohol, unspecified	T51.9	8.00	£3,531	£0	£14,371	£8,977	£0	£0	£0	£26,879
Accidental poisoning by exposure to	X45	0.51	£314	£0	£917	£572	£0	£0	£0	£1,803

Conditions	**ICD-10 codes**	**Multiplier**	**Inpatient visits**	**Outpatient visits**	**A&E visits**	**Ambulance**	**GP consultation**	**Nurse visits**	**Other health care cost**	**Total cost per person-specific hospitalisation**
alcohol										
Malignant neoplasm of lip, oral cavity and pharynx	C00-C14	2.54	£4,924	£1,437	£762	£476	£319	£30	£407	£8,355
Malignant neoplasm of oesophagus	C15	2.43	£2,964	£1,373	£727	£454	£229	£21	£389	£6,158
Malignant neoplasm of colon	C18	3.77	£4,324	£2,130	£1,129	£705	£355	£33	£603	£9,280
Malignant neoplasm of rectum	C20	3.27	£3,751	£1,845	£978	£611	£308	£29	£523	£8,044
Malignant neoplasm of liver and intrahepatic bile ducts	C22	2.19	£3,428	£1,239	£656	£410	£207	£19	£351	£6,310
Malignant neoplasm of larynx	C32	1.65	£3,769	£932	£494	£308	£155	£15	£264	£5,937
Malignant neoplasm of breast	C50	1.77	£2,172	£998	£529	£330	£166	£16	£283	£4,494
Diabetes mellitus (typeII)	E11	2.04	£2,367	£1,150	£199	£1,142	£383	£36		£5,277
Epilepsy and status epilepticus	G40-G41	1.71	£2,612	£773	£2,561	£1,600	£269	£25	£0	£7,840
Hypertensive diseases	I10-I15	2.20	£3,819	£744	£0	£0	£413	£39	£0	£5,015
Ischaemic heart disease	I20-I25	2.04	£2,054	£690	£1,828	£0	£0	£0		£4,572
Cardiac arrhythmias	I47-I48	1.58	£3,269	£712	£1,886	£1,178	£99	£9	£0	£7,153
haemorrhagic stroke	I60-I62, I69.0-I69.2	1.10	£3,517	£498	£990	£619	£104	£10	£0	£5,738

Conditions	ICD-10 codes	Multiplier	Inpatient visits	Outpatient visits	A&E visits	Ambulance	GP consultation	Nurse visits	Other health care cost	Total cost per person-specific hospitalisation
Ischaemic stroke	I66-I66,I69.3, I69.4	2.04	£3,402	£920	£1,828	£1,142	£192	£18		£7,502
Oesophageal varices	I85	2.65	£2,609	£599	£2,379	£1,486	£166	£16	£0	£7,254
Gastro-oesophageal laceration-haemorrhage syndrome	K22.6	0.80	£839	£181	£720	£450	£25	£2	£0	£2,218
Unspecified liver disease	K73, K74	1.54	£2,646	£347	£921	£575	£97	£9	£0	£4,595
Cholelithiasis	k80	2.04	£2,093	£230	£2,437	£0	£0	£0		£4,760
Acute and chronic pancreatitis	K85, K86.1	1.26	£2,466	£568	£1,130	£706	£79	£7	£0	£4,956
Psoriasis	L40 excluding L40.5	2.31	£3,766	£782	£0	£0	£362	£34	£0	£4,944
Spontaneous abortion	O03	1.10	£657	£372	£1,641	£820	£138	£13	£0	£3,639
Road traffic accidents - non pedestrian		2.92	£5,004	£660	£5,243	£3,275	£183	£17	£0	£14,382
Pedestrian traffic accidents		4.95	£9,785	£1,119	£7,412	£4,630	£311	£29	£0	£23,285
Water transport accidents	V90-V94	1.24	£2,294	£279	£1,851	£1,156	£39	£4	£0	£5,624
Air/space transport accidents	V95-V97	2.34	£4,010	£529	£2,101	£1,312	£0	£0	£0	£7,952
Fall injuries	W00-W19	0.82	£1,852	£92	£1,465	£763	£77	£7	£0	£4,255
Work/machine injuries	W24-W31	1.26	£2,162	£142	£1,887	£943	£119	£11	£0	£5,264

Conditions	ICD-10 codes	Multiplier	Inpatient visits	Outpatient visits	A&E visits	Ambulance	GP consultation	Nurse visits	Other health care cost	Total cost per person-specific hospitalisation
Firearm injuries	W32-W34	1.16	£1,562	£131	£1,730	£1,080	£0	£0	£0	£4,502
Drowning	W65-W74	1.05	£1,220	£236	£939	£587	£33	£3	£0	£3,018
Inhalation of gastric contents	W78	0.79	£1,771	£178	£945	£591	£25	£2	£0	£3,513
Fire injuries	X00-X09	0.75	£1,274	£170	£1,125	£703	£24	£2	£0	£3,298
Accidental excessive cold	X31	0.91	£1,636	£103	£1,638	£1,023	£29	£3	£0	£4,432
Intentional self-harm	X60-X84	1.22	£641	£137	£2,182	£1,136	£114	£11	£0	£4,222
Assault	X85-Y09	1.15	£1,252	£130	£2,067	£1,076	£36	£3	£0	£4,564

APPENDIX C: UTILITIES

Table C.1: Utility values by age group

	11 - 15 years	16 – 17 years	18 - 24 years	25 - 34 years	35 - 44 years	45 - 54 years	55 - 64 years	65 - 74 years	75 +
Alcohol-induced pseudo-cushing	0.608	0.608	0.608	0.587	0.560	0.534	0.507	0.480	0.451
Mental and behavioural disorders	0.569	0.569	0.569	0.550	0.524	0.500	0.475	0.450	0.423
Degeneration of nervous system	0.608	0.608	0.608	0.587	0.560	0.534	0.507	0.480	0.451
Alcoholic polyneuropathy	0.608	0.608	0.608	0.587	0.560	0.534	0.507	0.480	0.451
Alcoholic myopathy	0.651	0.651	0.651	0.629	0.600	0.571	0.544	0.515	0.484
Alcoholic cardiomyopathy	0.651	0.651	0.651	0.629	0.600	0.571	0.544	0.515	0.484
Alcoholic gastritis	0.543	0.543	0.543	0.524	0.500	0.476	0.453	0.429	0.403
Alcoholic liver disease	0.563	0.563	0.563	0.544	0.519	0.494	0.470	0.445	0.418
Chronic pancreatitis (alcohol induced)	0.509	0.509	0.509	0.491	0.469	0.447	0.424	0.403	0.377
Ethanol poisoning	0.434	0.434	0.434	0.418	0.400	0.381	0.361	0.343	0.322
Methanol poisoning	0.434	0.434	0.434	0.418	0.400	0.381	0.361	0.343	0.322
Toxic effect of alcohol, unspecified	0.732	0.732	0.732	0.705	0.674	0.642	0.609	0.578	0.542
Accidental poisoning by exposure to alcohol	0.639	0.639	0.639	0.617	0.588	0.562	0.533	0.505	0.474

	11 - 15 years	**16 – 17 years**	**18 - 24 years**	**25 - 34 years**	**35 - 44 years**	**45 - 54 years**	**55 - 64 years**	**65 - 74 years**	**75 +**
Malignant neoplast of lip, oral cavity and pharynx	0.716	0.716	0.716	0.691	0.660	0.629	0.598	0.566	0.532
Malignant neoplast of oesophagus	0.784	0.784	0.784	0.756	0.723	0.688	0.653	0.620	0.581
Malignant neoplast of colon	0.841	0.841	0.841	0.812	0.775	0.737	0.702	0.664	0.625
Malignant neoplast of rectum	0.858	0.858	0.858	0.828	0.790	0.752	0.716	0.678	0.637
Malignant neoplast of liver and bile	0.690	0.690	0.690	0.667	0.636	0.607	0.576	0.545	0.513
Malignant neoplast of larynx	0.908	0.908	0.908	0.877	0.836	0.796	0.758	0.717	0.674
Malignant neoplast of breast	0.840	0.840	0.840	0.811	0.774	0.736	0.701	0.664	0.624
Diabetes mellitus (Type II)	0.704	0.704	0.704	0.680	0.649	0.617	0.588	0.556	0.523
Epilepsy and status epilepticus	0.623	0.623	0.623	0.600	0.574	0.546	0.519	0.492	0.461
Hypertensive diseases	0.769	0.769	0.769	0.743	0.709	0.675	0.642	0.608	0.572
Ischaemic Heart Disease	0.734	0.734	0.734	0.707	0.676	0.643	0.611	0.580	0.543
Cardiac arrhythmias	0.795	0.795	0.795	0.768	0.733	0.699	0.664	0.628	0.591
Haemorrhagic stroke	0.750	0.750	0.750	0.724	0.691	0.657	0.626	0.592	0.557
Ischaemic stroke	0.643	0.643	0.643	0.620	0.593	0.564	0.535	0.508	0.476
Oesophageal varices	0.709	0.709	0.709	0.683	0.653	0.622	0.590	0.560	0.525
Gastro_oeso	0.946	0.946	0.946	0.911	0.871	0.829	0.787	0.748	0.701

	11 - 15 years	16 – 17 years	18 - 24 years	25 - 34 years	35 - 44 years	45 - 54 years	55 - 64 years	65 - 74 years	75 +
Unspecified liver disease	0.698	0.698	0.698	0.674	0.643	0.612	0.583	0.552	0.519
Heart failure	0.679	0.679	0.679	0.655	0.625	0.597	0.566	0.536	0.504
Cholelithiasis	0.844	0.844	0.844	0.813	0.777	0.740	0.702	0.667	0.625
Acute an chronic pancreatitis	0.693	0.693	0.693	0.667	0.638	0.607	0.576	0.547	0.513
Psoriasis	0.733	0.733	0.733	0.707	0.676	0.643	0.610	0.580	0.543
Spontaneous abortion	0.932	0.932	0.932	0.900	0.858	0.819	0.778	0.736	0.692
Road traffic accidents – non pedestrian	0.680	0.680	0.680	0.656	0.626	0.598	0.567	0.537	0.505
Pedestrian traffic accidents	0.658	0.658	0.658	0.636	0.606	0.577	0.549	0.520	0.489
Water transport accident	0.680	0.680	0.680	0.656	0.626	0.598	0.567	0.537	0.505
Air/space transport accidents	0.680	0.680	0.680	0.656	0.626	0.598	0.567	0.537	0.505
Fall injuries	0.710	0.710	0.710	0.686	0.655	0.623	0.593	0.561	0.528
Work/machine injuries	0.888	0.888	0.888	0.858	0.818	0.781	0.741	0.701	0.660
Firearm injuries	0.658	0.658	0.658	0.636	0.606	0.577	0.549	0.520	0.489
Drowning	0.658	0.658	0.658	0.636	0.606	0.577	0.549	0.520	0.489
Inhalation of gastric contents and ingestion	0.971	0.971	0.971	0.937	0.894	0.852	0.809	0.767	0.720
Fire injuries	0.658	0.658	0.658	0.636	0.606	0.577	0.549	0.520	0.489

	11 - 15 years	16 – 17 years	18 - 24 years	25 - 34 years	35 - 44 years	45 - 54 years	55 - 64 years	65 - 74 years	75 +
Accidental excessive cold	0.658	0.658	0.658	0.636	0.606	0.577	0.549	0.520	0.489
Intentional self-harm	0.464	0.464	0.464	0.447	0.428	0.407	0.386	0.367	0.344
Assault	0.705	0.705	0.705	0.679	0.650	0.618	0.587	0.557	0.522
General population	0.971	0.971	0.971	0.937	0.894	0.852	0.809	0.767	0.720

APPENDIX D: ALTERNATIVE ELASTICITY MATRICES USED IN SENSITIVITY ANALYSES

Table D.1: Estimated own- and cross- price elasticities of off- and on- trade beer, cider, wine, spirit and RTD in the UK (excluding cross-price elasticities)

		Purchase									
		Off-beer	Off-cider	Off-wine	Off-spirit	Off-RTD	On-beer	On-cider	On-wine	On-spirit	On-RTD
Price	Off-beer	-0.980*									
	Off-cider		-1.268*								
	Off-wine			-0.384*							
	Off-spirit				-0.082						
	Off-RTD					-0.585*					
	On-beer						-0.786*				
	On-cider							-0.591*			
	On-wine								-0.871*		
	On-spirit									-0.890*	
	On-RTD										-0.187

Remarks *: p-value <0.05

Table D.2: Estimated own- and cross- price elasticities of off- and on- trade beer, cider, wine, spirit and RTD in the UK (excluding non-significant elasticities)

		Purchase									
		Off-beer	Off-cider	Off-wine	Off-spirit	Off-RTD	On-beer	On-cider	On-wine	On-spirit	On-RTD
Price	Off-beer	-0.980*									
	Off-cider		-1.268*								
	Off-wine		0.736*	-0.384*							
	Off-spirit										
	Off-RTD					-0.585*				-0.179*	
	On-beer						-0.786*		1.042*	1.169*	
	On-cider							-0.591*		0.237*	
	On-wine								-0.871*		
	On-spirit									-0.890*	0.809*
	On-RTD										

Remarks *: p-value <0.05

Table D.3: Estimated own- and cross- price elasticities of off- and on- trade beer, cider, wine, spirit and RTD in the UK for moderate drinkers

		Purchase									
		Off-beer	Off-cider	Off-wine	Off-spirit	Off-RTD	On-beer	On-cider	On-wine	On-spirit	On-RTD
Price	Off-beer	-0.439*	-0.353	0.324	-0.133	-0.611	-0.153	-0.493	0.290	-0.452	0.165
	Off-cider	-0.015	-0.677*	0.092	-0.066	-0.296	-0.036	0.126	0.132	-0.187	0.031
	Off-wine	-0.093	0.208	-0.418*	-0.455	0.270	-0.066	-0.217	-0.063	-0.051	0.327
	Off-spirit	-0.013	-0.193	0.066	-0.296*	0.416*	0.041	0.014	-0.010	0.014	0.084
	Off-RTD	-0.099	-0.110	-0.080	0.421*	-0.355*	-0.131*	0.368*	-0.064	-0.048	-0.056
	On-beer	0.364	-0.933	-0.080	0.100	0.006	-0.380	-0.388	0.108	0.660	-0.214
	On-cider	-0.205	-0.408*	-0.176	-0.104	0.399	0.001	-0.484*	-0.176	-0.008	-0.093
	On-wine	0.133	0.043	0.315*	0.202	0.347	-0.073	0.053	-0.213	-0.162	-0.341
	On-spirit	-0.242	0.164	-0.046	0.268	0.116	-0.020	-0.030	0.309*	-0.183	0.154
	On-RTD	-0.125	0.064	0.046	-0.330	0.654*	0.145	0.004	0.063	-0.163	0.229

Remarks *: p-value <0.05

Table D.4: Estimated own- and cross- price elasticities of off- and on- trade beer, cider, wine, spirit and RTD in the UK for hazardous and harmful drinkers

		Purchase									
		Off-beer	Off-cider	Off-wine	Off-spirit	Off-RTD	On-beer	On-cider	On-wine	On-spirit	On-RTD
Price	Off-beer	-1.094*	-0.120	-0.141	-0.085	-0.409	-0.058	1.638	0.164	0.818*	0.313
	Off-cider	0.006	-1.222*	-0.038	0.033	-0.131	-0.139	-0.382	0.047	-0.339	0.237
	Off-wine	0.443*	0.907	0.358	-0.128	1.508*	-0.272	0.463	0.273	-0.801	-0.523
	Off-spirit	-0.075	-0.165	-0.028	0.048	0.533	0.046	0.304	-0.134	0.127	-0.269
	Off-RTD	-0.056	-0.180	0.043	0.030	-0.889*	0.064	0.033	0.035	-0.019	0.369
	On-beer	0.045	-0.621	-0.063	-0.246	0.321	-0.833*	1.049	0.263	0.816	-1.405
	On-cider	-0.054	0.268	-0.034	-0.121	0.078	0.019	-0.462	-0.031	0.384*	0.232
	On-wine	-0.102	0.243	0.048	-0.038	-1.055*	-0.067	0.321	0.052	0.539*	0.510
	On-spirit	-0.169	-0.540	-0.010	-0.199	-0.247	-0.385*	-0.479	0.009	-1.102*	0.563*
	On-RTD	0.072	-0.155	-0.101	0.069	-0.366	-0.047	-0.395	0.049	-0.128	-0.800*

Remarks *: p-value <0.05

Table D.5: Estimated own- and cross- price elasticities of off- and on- trade beer, cider, wine, spirit and RTD in the UK for low income population

		Purchase									
		Off-beer	Off-cider	Off-wine	Off-spirit	Off-RTD	On-beer	On-cider	On-wine	On-spirit	On-RTD
Price	Off-beer	-0.883*	-0.443	-0.350	-0.186	-2.677*	-0.306	-1.011	-0.820*	-1.245*	0.594
	Off-cider	0.191	-1.751*	0.024	-0.361	-0.588	-0.050	0.085	-0.117	-0.290	-0.523*
	Off-wine	-0.094	0.483	-0.472	-0.111	0.449	0.037	-0.851	0.436*	-0.778	0.210
	Off-spirit	-0.024	0.480	0.335	-0.256	0.868	0.307*	1.057*	0.079	0.310	-0.093
	Off-RTD	-0.032	-0.416*	0.009	-0.062	0.204	-0.081	0.293	0.021	-0.133	-0.036
	On-beer	0.041	-0.311	0.865*	-0.703	1.456	-0.504	3.785*	0.903	1.698*	-3.893*
	On-cider	-0.169	0.311	0.008	0.223	-0.625	0.242	0.611	-0.208	0.057	0.058
	On-wine	-0.311	-0.427	0.080	-0.405	0.773	0.006	-1.129	-0.664*	1.021	0.088
	On-spirit	0.111	0.295	0.029	-0.152	1.176	0.166	0.063	0.324	-1.108*	1.126*
	On-RTD	0.223	0.241	-0.014	-0.305	-0.532	0.187	-0.081	0.373*	0.382	0.543

Remarks *: p-value <0.05

Table D.6: Estimated own- and cross- price elasticities of off- and on- trade beer, cider, wine, spirit and RTD in the UK for higher income population

		Purchase									
		Off-beer	Off-cider	Off-wine	Off-spirit	Off-RTD	On-beer	On-cider	On-wine	On-spirit	On-RTD
Price	Off-beer	-0.914*	-0.033	0.194	-0.448	-0.923	0.044	0.110	0.419	0.311	0.673
	Off-cider	0.046	-1.217*	0.170	-0.079	-0.159	-0.060	0.085	0.093	-0.140	-0.178
	Off-wine	-0.017	0.775	-0.417*	0.359	-0.138	-0.331	-0.020	-0.097	-0.085	0.019
	Off-spirit	0.129	-0.046	0.133	0.098	-0.077	0.142	0.312	0.096	0.061	0.341
	Off-RTD	-0.024	-0.110	0.004	0.086	-0.730*	-0.058	-0.018	0.058	-0.202	0.180
	On-beer	0.157	-0.317	0.024	0.050	0.694	-0.897*	0.563	0.908*	1.079*	0.297
	On-cider	-0.117	0.041	0.045	-0.001	0.367	0.031	-0.797*	0.091	0.232	0.245
	On-wine	-0.188	0.183	-0.203	-0.021	-0.045	-0.275	0.053	-0.858*	-0.105	-0.288
	On-spirit	0.025	-0.212	-0.036	-0.347	-0.386	-0.039	-0.499	0.057	-0.783*	0.898*
	On-RTD	0.033	-0.104	-0.113	0.021	0.429	0.094	-0.510	-0.073	-0.172	-0.236

Remarks *: p-value <0.05

Table D.7: Estimated own- and cross- price elasticities of off- and on- trade beer, wine and spirit in the UK using time series data from 1964 to 2011

		Purchase					
		On-beer	Off-beer	On-spirit	Off-spirit	On-wine	Off-wine
Price	On-beer	-0.28	0.31*	-1.98**	-0.39	-0.13	-0.08
	Off-beer	0.06	-0.93**	0.79**	-0.28	0.80*	-0.07
	On-spirit	-0.59**	-0.58**	-1.20**	0.05	-2.07**	-0.28**
	Off-spirit	0.81**	-0.43**	-0.54	-0.91**	-0.05	-1.04**
	On-wine	0.00	0.08	0.40**	-0.21	-0.30	0.00
	Off-wine	-0.09	0.76**	0.33	0.73	0.99	0.64**

Remarks *: p-value <0.05; **: p-value<0.01. Time series data is not available for cider and RTD, therefore elasticities were only estimated for beer, wine and spirit.

Table D.8: Own- and cross- price elasticities of off- and on- trade beer, cider, wine, spirit and RTD used in SAPM2.5 based on elasticities estimated in Table D.7

		Purchase									
		Off-beer	Off-cider	Off-wine	Off-spirit	Off-RTD	On-beer	On-cider	On-wine	On-spirit	On-RTD
Price	Off-beer	-0.93	0.00	-0.08	-0.28	0.00	0.06	0.00	-0.13	0.79	0.00
	Off-cider	0.00	-0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Off-wine	0.76	0.00	0.64	0.73	0.00	-0.09	0.00	0.99	0.33	0.00
	Off-spirit	-0.43	0.00	-1.04	-0.91	0.00	0.81	0.00	-0.05	-0.54	0.00
	Off-RTD	0.00	0.00	0.00	0.00	-0.91	0.00	0.00	0.00	0.00	0.00
	On-beer	0.31	0.00	-0.08	-0.39	0.00	-0.28	0.00	-0.13	-1.98	0.00
	On-cider	0.00	0.00	0.00	0.00	0.00	0.00	-0.28	0.00	0.00	0.00
	On-wine	0.08	0.00	0.00	-0.21	0.00	0.00	0.00	-0.30	0.40	0.00
	On-spirit	-0.58	0.00	-0.28	0.05	0.00	-0.59	0.00	-2.07	-1.20	0.00
	On-RTD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.20

Table D.9: Own- and cross- price elasticities of off- and on- trade beer, cider, wine, spirit and RTD used in SAPM2.5 based on elasticities estimated by HMRC in 2012

		Purchase									
		Off-beer	Off-cider	Off-wine	Off-spirit	Off-RTD	On-beer	On-cider	On-wine	On-spirit	On-RTD
Price	Off-beer	-1.07	-0.08	-0.02	0.02	-0.03	-0.17	0.03	-0.08	-0.07	-0.01
	Off-cider	-0.01	-1.13	0.02	-0.03	0.02	-0.01	-0.20	0.08	-0.10	-0.19
	Off-wine	0.05	0.14	-0.22	-0.01	0.18	-0.01	-0.02	0.08	-0.08	0.04
	Off-spirit	-0.02	-0.01	0.02	-0.41	0.01	-0.06	-0.10	0.01	-0.08	-0.01
	Off-RTD	0.01	0.01	0.02	0.02	-0.57	0.01	0.05	0.07	0.03	0.17
	On-beer	0.07	0.06	0.09	0.04	-0.02	-0.44	0.00	0.09	0.37	0.06
	On-cider	0.04	-0.07	0.00	0.04	0.13	0.02	-0.28	-0.06	-0.10	-0.04
	On-wine	0.03	0.06	0.03	0.04	0.08	-0.02	-0.08	-0.24	0.09	-0.02
	On-spirit	-0.03	-0.01	0.06	0.00	-0.02	-0.13	-0.01	0.01	-1.01	-0.01
	On-RTD	-0.05	-0.08	0.02	0.01	0.23	-0.09	0.05	0.20	-0.12	-0.18