Model-based appraisal of the comparative impact of Minimum Unit Pricing and taxation policies in Scotland

An adaptation of the Sheffield Alcohol Policy Model version 3

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1 EXECUTIVE SUMMARY

1.1 MAIN CONCLUSIONS

Estimates from an updated version of the Scottish adaptation the Sheffield Alcohol Policy Model suggest:

1. A 50p minimum unit price would be effective in reducing alcohol consumption among hazardous and, particularly, harmful drinkers. These consumption reductions would lead to reductions in alcohol-related mortality and hospitalisations.
2. Moderate drinkers would experience only small impacts on their alcohol consumption and spending as a result of introducing a 50p minimum unit price. This is because they tend to buy alcohol which would be subject to little or no increase in price following introduction of the policy.
3. To achieve the same reduction in alcohol-related deaths among hazardous and harmful drinkers as a 50p minimum unit price, a 28% increase in alcohol taxation would be required. Compared to a 50p minimum unit price, a 28% increase in alcohol taxes would lead to slightly larger reductions in alcohol consumption among moderate and hazardous drinkers but smaller reductions in consumption among harmful drinkers and, particularly, harmful drinkers in poverty. Harmful drinkers in poverty are the group at greatest risk from their alcohol consumption.
4. Increases in consumer spending on alcohol would be modest under a 50p MUP and spending would decline for harmful drinkers in poverty. Larger changes in consumer spending would be seen under a 28% tax increase and spending would increase in all groups including among harmful drinkers in poverty.

1.2 RESEARCH QUESTIONS

This report was commissioned in 2015 by the Scottish Government in order to appraise the potential impact of different minimum unit prices for alcohol and increases in alcohol taxation on levels of alcohol consumption, spending on alcohol, Exchequer and retailer revenue and alcohol-related health outcomes in Scotland among population subgroups defined baseline level of drinking and income.

The specific policies analysed in this report are minimum unit price (MUP) policies with thresholds of 30p, 40p, 50p, 60p and 70p per unit of alcohol and alcohol tax increases based on the duty and VAT rates effective from 23rd March 2015. Levels of tax increases were identified which would achieve the same reduction in the following outcomes as a 50p MUP price:

1. Annual deaths due to alcohol;
2. Annual deaths due to alcohol among hazardous and harmful drinkers;
3. Annual deaths due to alcohol among harmful drinkers;
4. Annual deaths due to alcohol among hazardous and harmful drinkers in poverty;
5. Annual deaths due to alcohol among harmful drinkers in poverty.

1.3 SUMMARY OF MODEL FINDINGS

1.3.1 Baseline alcohol consumption, related harm and purchasing in Scotland

M1. Analysis of current consumption patterns shows that, within the Scottish population, 14.9% do not drink, 60.5% are moderate drinkers, 19.1% are hazardous drinkers and 5.4% are harmful drinkers. Of all alcohol drunk in Scotland, hazardous drinkers consume 41.5% and harmful drinkers consume 29.4%.

M2. A smaller proportion of those in poverty are hazardous and harmful drinkers compared to those not in poverty (18.6% vs. 25.6%). However, on average, hazardous and harmful drinkers in poverty consume more alcohol than those not in poverty.

M3. Alcohol-related mortality and morbidity is concentrated among those consuming most alcohol and among those with lower incomes.

M4. A 50p minimum unit price would only directly affect products sold for less than 50p per unit. Hazardous and harmful drinkers buy more of this cheap alcohol and it accounts for a greater share of their alcohol purchases. This is particular true for harmful drinkers in poverty who purchase 2,796 units of alcohol per year for less than 50p (62% of their purchases) whereas harmful drinkers not in poverty purchase 1,459 units below this threshold (44% of their purchase).

M5. Harmful drinkers spend a substantial amount of money on alcohol. Harmful drinkers in poverty are estimated to spend £2,484 per annum and those not in poverty are estimated to spend £2,341 per annum. The equivalent figures for hazardous drinkers are £1,102 and £1,204 per annum and for moderate drinkers are £230 and £378.

1.3.2 Modelled effects of minimum unit pricing

M6. Implementing a 50p MUP is estimated to reduce alcohol consumption in Scotland by 3.5% or 26.3 units per drinker per year. Consumption reductions increase steeply with higher levels of MUP (e.g. 0.3% for 30p, 1.4% for 40p, 3.5% for 50p, 6.6% for 60p and 10.6% for 70p). For the remainder of this executive summary we focus on 50p as this has been the focus of public and policy debate.

M7. Consumption reductions under a 50p MUP are estimated to be largest among harmful drinkers (7.0%, 246.2 units per drinker per year) and hazardous drinkers (2.5%, 35.5 units). The smallest effects would be seen among moderate drinkers (1.2%, 3.7 units).

M8. The absolute difference in consumption reductions between those in poverty and those not in poverty are small for moderate drinkers (9.8 vs. 2.7 units per drinker per year). This difference is larger for hazardous drinkers (88.1 vs. 29.7 units) and larger again for harmful drinkers (680.9 vs. 180.9 units).These results demonstrate the importance of separating moderate drinkers in poverty from hazardous and harmful drinkers in poverty when considering the equity implications of minimum unit pricing.

M9. A 50p MUP is estimated to lead to 2,036 fewer deaths and 38,859 fewer hospitalisations during the first 20 years of the policy. After 20 years, when the policy has achieved its full effect, there would be an estimated 121 fewer deaths and 2,042 fewer hospital admissions per year.

M10. Reductions in mortality are estimated to be largest among harmful drinkers in poverty – the group at greatest risk from their drinking. Among this group, at full effect, there would be 15.3% fewer alcohol-related deaths per year compared to 4.4% fewer among harmful drinkers not in poverty. The equivalent reductions among hazardous drinkers are 10.8% and 4.4%.

M11. The impact of a 50p MUP on consumer spending is also estimated to vary by consumption and poverty status. Annual spending among moderate drinkers would be largely unaffected (a 0.5% or £2 increase per annum) and this is the case irrespective of poverty status. Among harmful drinkers spending changes are larger both in relative and absolute terms and differ between harmful drinkers in poverty (a reduction of 3.5% or £88 per annum) and those not in poverty (an increase of 0.8% or £20 per annum).

M12. Revenue to the Exchequer would fall by around £15m or 1.3% under a 50p MUP with £12m of this reduction attributable to the off-trade and £4m attributable to the on-trade.

M13. Revenue to off-trade retailers from alcohol sales would increase by £41m or 9.6% under a 50p MUP and would fall by £7m or 0.7% for on-trade retailers.

1.3.3 Modelled effect of alcohol tax increases

M14. At full effect, a 50p MUP is estimated to lead to 117 fewer alcohol-related deaths per year among hazardous and harmful drinkers. To achieve the same reduction in deaths among hazardous and harmful drinkers, an estimated 28% increase in alcohol taxes is required.

M15. If reductions in alcohol-related harm in specific population groups are sought, then larger tax increases would be required; for example, a 36% tax increase would be required to achieve the same reductions in deaths among harmful drinkers as a 50p MUP. This is because MUP targets large price increases on those at greatest risk from their drinking while tax increases affect all drinkers.

M16. Although achieving the same reduction in deaths among hazardous and harmful drinkers as a 50p MUP, a 28% tax increase would lead to slightly larger reductions in alcohol consumption among moderate and hazardous drinkers but smaller reductions in alcohol consumption among harmful drinkers and, particularly, harmful drinkers in poverty.

M17. Similarly, at full effect, the reductions in deaths under a 28% tax increase would be larger among hazardous drinkers and smaller among harmful drinkers, particularly harmful drinkers in poverty, than under a 50p MUP price.

M18. These differences in how death reductions are distributed across the population mean a 50p MUP is more effective than a 28% tax increase in reducing alcohol-related health inequalities. This is because a 50p MUP better targets the alcohol consumed by harmful drinkers on low incomes who are the group at greatest risk from their drinking.

M19. Increases in consumer spending on alcohol are estimated to be substantially greater under a 28% tax increase than a 50p MUP. For example, among moderate drinkers annual per capita spending would increase by £2 or 0.5% under a 50p MUP and by £17 or 4.7% under a 28% tax increase. For harmful drinkers the annual increases in spending per capita are £6 or 0.2% for a 50p MUP and £152 or 6.4% under a 28% tax increase.

M20. Revenue to the Exchequer is estimated to increase by £209m per annum or 18.4% under a 28% tax increase. This compares to a £15m per annum or 1.3% decrease under a 50p MUP price. The majority of the increase under a 28% tax rise comes from the off-trade (£148m – a 22.2% increase in off-trade alcohol tax revenue).

M21. Revenue to retailers is estimated to decline by £63m per annum or 4.6% under a 28% tax increase. This compares to an increase of £34m per annum or 2.5% under a 50p MUP. The decline in revenue to off-trade retailers under a 28% tax increase is estimated to be £33m per annum or 7.7% and for on-trade retailers the decline in revenue is estimated to be £30m per annum or 3.2%.

2 INTRODUCTION

2.1 BACKGROUND

The Sheffield Alcohol Research Group (SARG) at Sheffield University have developed the Sheffield Alcohol Policy Model (SAPM) over the course of the past decade in order to appraise the potential impact of alcohol policies, including pricing policies such as Minimum Unit Pricing (MUP) and taxation, as well as restrictions on sales promotions and Alcohol Brief Intervention programmes. Whilst SAPM was originally developed for England (1), versions of SAPM have been developed for policy appraisals in other countries including Scotland (2), Wales (3), Ireland (4), Canada (5)and Italy (6).

In 2009 version 2 of SAPM was adapted to Scotland to appraise the impact of MUP (2) and this model was updated with new data in 2010 (7) and 2012 (8). Since this time the methodology which underpins SAPM has been developed and refined significantly, most notably to account for variation in impact between different sociodemographic groups (9,10) and the ability to model a range of taxation policies (11). In order to avoid confusion with previous versions of the model, the current version is referred to as SAPM3 throughout this report.

In 2015 SARG were commissioned by the Scottish Government to adapt SAPM3 (the 'Sheffield Model') to Scotland in order to appraise the potential impact of MUP and increases in alcohol taxation on levels of alcohol consumption in Scotland in different population subgroups defined by income and level of drinking. The current report represents the results of this work.

2.2 RESEARCH QUESTIONS ADDRESSED

The policies analysed in this report are Minimum Unit Price (MUP) policies with thresholds of 30p, 40p, 50p, 60p, 70p per unit of alcohol and taxation interventions based on the duty and VAT rates effective from 23 March 2015 (the rates applicable at the time this work was commissioned). The baseline year in the model is 2014, the latest year for which baseline alcohol consumption and health outcomes data is available. It is therefore assumed that all appraised policies are implemented in 2014 and all baseline data and costs are adjusted to 2014 prices accordingly. The main research questions are concerned with the likely effects of introducing an MUP on alcohol consumption, spending, Exchequer and retailer receipts and health in Scotland and comparison of the relative impact of a 50p MUP and taxation policies on consumption, spending and health across the population. Specifically these analyses seek to examine the degree to which MUP and taxation policies are targeted measures for the reduction of alcohol-related harm.

The specific policy options appraised are:

- MUP of 30p, 40p, 50p, 60p, 70p
- Taxation interventions based on the duty and VAT rates effective from 23 March 2015.
  - Required percentage increase in alcohol taxation rates across all beverages that will achieve the same level of:

    1. Reduction in annual deaths due to alcohol
    2. Reduction in annual deaths due to alcohol among hazardous and harmful drinkers
    3. Reduction in annual deaths due to alcohol among harmful drinkers
    4. Reduction in annual deaths due to alcohol among hazardous and harmful drinkers in poverty
    5. Reduction in annual deaths due to alcohol among harmful drinkers in poverty

    as a 50p MUP policy is estimated to achieve at full effect [1].

[1]Full effect refers to the impact of the policy on health in the 20th year following policy implementation. See Section 3.4.3 for details.

3 METHODS

3.1 OVERVIEW OF SAPM3

The aim of SAPM3 is to appraise pricing 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.

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

1. A model of the relationship between alcohol prices and alcohol consumption which accounts for the relationship between average weekly alcohol consumption, the patterns in which that alcohol is drunk and how these are distributed within the population, considering gender, age, income and consumption level.
2. A model of the relationship between i) both average level and patterns of alcohol consumption and ii) alcohol-related mortality and morbidity and the costs associated with these harms.

Figure 3.1 illustrates this conceptual framework.

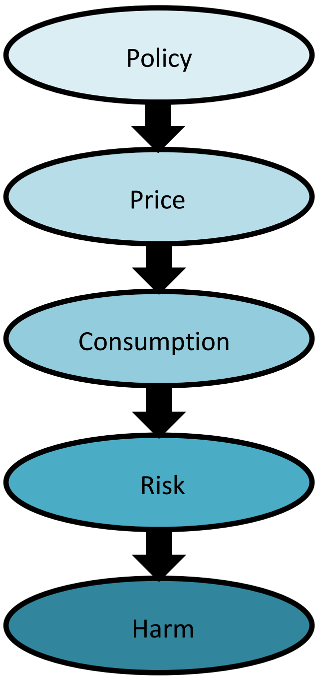

Figure 3.1: High-level conceptual framework of SAPM3

3.2 MODELLING THE LINK BETWEEN INTERVENTION AND CONSUMPTION

3.2.1 Overview

The pricing model uses a simulation framework based on classical econometrics. The fundamental concept is that (i) a current consumption dataset is held for the population; (ii) a policy gives rise to a change in price; (iii) a change in consumption is estimated from the price change using the price elasticity of demand; (iv) the consumption change is used to update the current consumption dataset.

As no single dataset exists in Scotland which contains the necessary data on both prices paid and consumption of alcohol, the link between price and consumption is modelled using different datasets. This section provides an overview of the data sources on alcohol consumption and pricing which were used, before detailing the procedures for modelling the effect that price-based policy interventions have on consumption.

3.2.2 Consumption data

The Scottish Health Survey (SHeS) is an annual survey of around 6,500 individuals, including over 4,500 adults aged 16+, living in Scotland. It records a range of demographic data on respondents, including age, gender, income and mean weekly consumption of alcohol. Alcohol consumption is measured using a series of beverage specific 'quantity-frequency' questions in which respondents are asked how frequently they drink a particular beverage type (e.g. strong beer) and how much of that beverage they drink on a typical occasion. These questions are converted to a mean weekly alcohol consumption for each respondent using assumptions of the alcohol by volume (ABV) of each beverage. For the present analysis ABV estimates from market research specialists Nielsen were provided by NHS Health Scotland. These are used in regular publications tracking trends in alcohol sales in Scotland (e.g. (12,13)) and represent the most up to date estimates available. The use of current ABV data is important as there have been notable changes in the strength of alcoholic products over time, both due to people switching to stronger or weaker products within the same beverage category and also due to changes in the ABVs of the products themselves (such as long-term increases in the average strength of wine (14)). These ABV figures are commercially sensitive and cannot therefore be reproduced here. Figure 3.2 presents the resulting distribution of mean weekly consumption from the SHeS data.

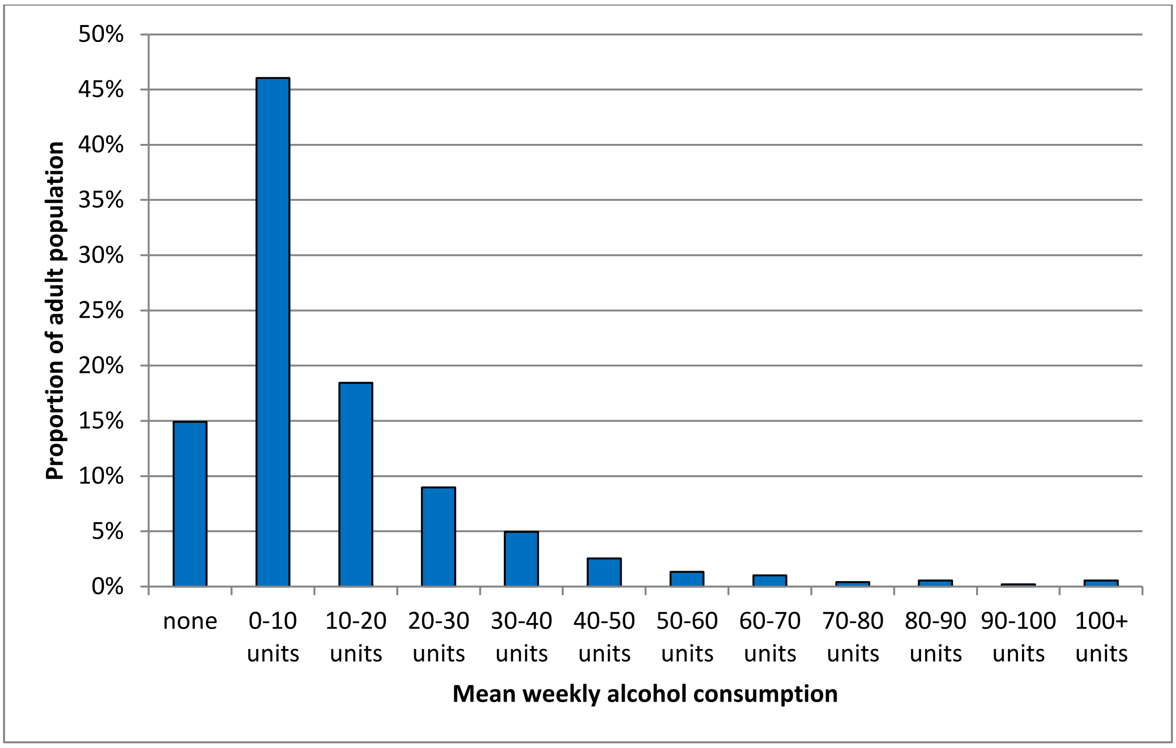

Figure 3.2: Distribution of mean weekly alcohol consumption (SHeS 2014)

This population is divided into abstainers and three drinker groups:

- Moderate drinkers – those whose usual alcohol intake is no more than 21/14 units per week for men/women (1 unit = 8g of ethanol)[2]
- Hazardous drinkers – those drinkers consuming 21-50 units per week for men or 14-35 units per week for women
- Harmful drinkers – drinkers whose usual alcohol intake exceeds 50/35 units per week for men/women.

Overall, 14.9% of the adult population (16+) in Scotland are abstainers, 60.5% are moderate drinkers, 19.1% are hazardous drinkers and 5.4% are harmful drinkers. On average moderate drinkers consume 312 units per year, hazardous drinkers consume 1,402 units and high risk drinkers consume 3,498 units. Figure 3.3 and Figure 3.4 illustrate how consumption patterns differ for the population between those in poverty and not in poverty[3]. From Figure 3.3 we can see that individuals in poverty are more likely to be abstainers (25% vs. 13%) and also marginally less likely to drink at high risk levels (5.1% vs. 5.5%). Figure 3.4 shows that moderate drinkers in poverty drink less, on average, than those not in poverty, consuming 238 units per year compared to 323. In contrast, hazardous and harmful drinkers in poverty drink more on average (1,456 and 4,499 units per year respectively) than their counterparts who aren't in poverty (1,396 and 3,348 units per year respectively).

[2] Note that this work was commissioned before the UK Chief Medical Officers announced new drinking guidelines which recommend that both men and women should not drink more than 14 units of alcohol per week. This change would not substantively affect the results presented in this report, although it would alter the distribution of effects between moderate and hazardous drinkers.

[3] Poverty is defined as an individual having an equivalised household income below 60% of the population median.

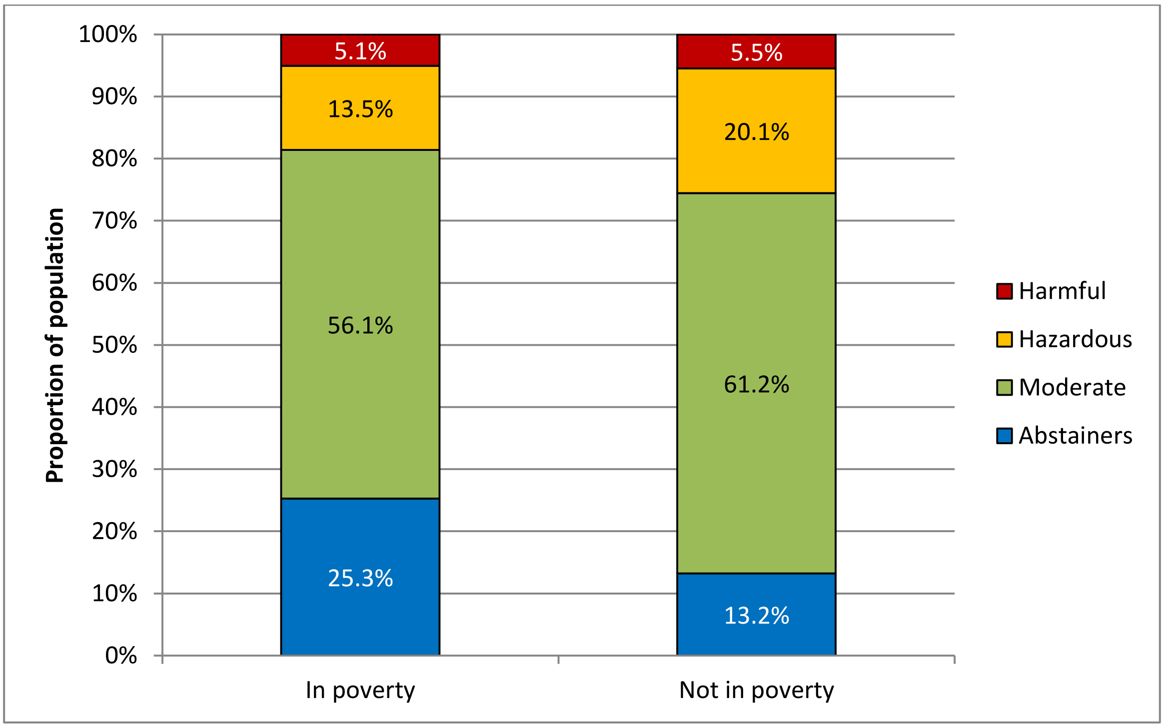

Figure 3.3: Drinker group distribution by income (SHeS 2014)

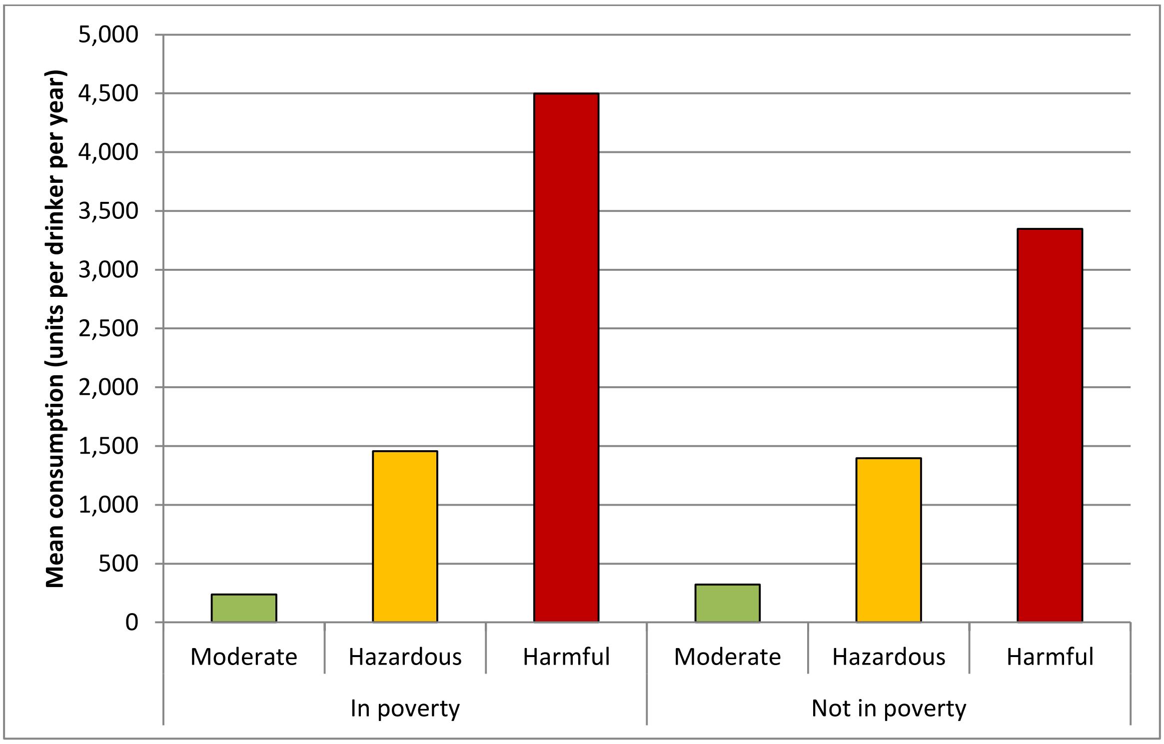

Figure 3.4: Mean consumption by drinker group by income (SHeS 2014)

3.2.4 Patterns of consumption

In addition to mean weekly consumption of alcohol, a significant number of the harms modelled in SAPM3 are a function of intoxication; that is to say that they are related to the patterns in which alcohol is drunk, not just the overall volume consumed. In common with previous versions of SAPM we have used peak day consumption in the previous week in the SHeS as a proxy measure for consumption patterns and relate the measure with wholly attributable acute health conditions. Peak day volume is calculated using similar beverage-specific quantity questions to mean consumption, and responses are converted to units of alcohol using the same ABV assumptions. Figure 3.5 presents the distribution of peak day consumption from the SHeS data.

In addition to peak day consumption in the previous week, a new method has been developed to model individual drinking patterns and their relationship to partially attributable injuries (see Section 3.3.5.3 for an explanation of this method).

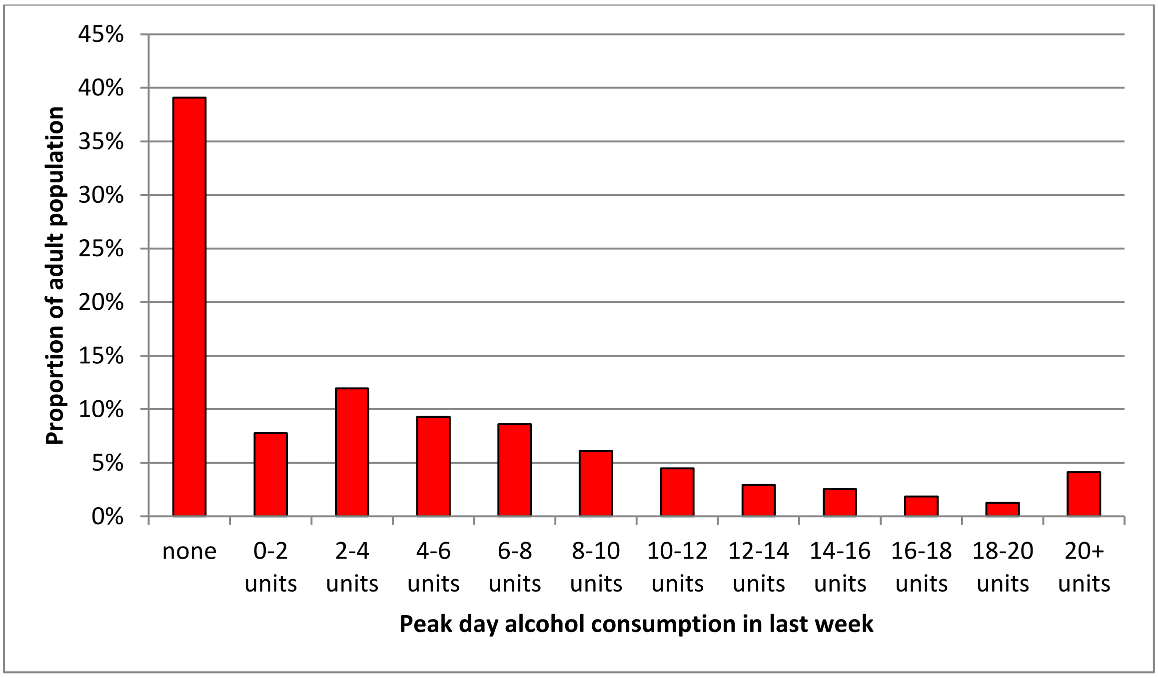

Figure 3.5: Distribution of peak day consumption (SHeS 2014)

3.2.5 Prices

Data on the prices paid for alcohol beverages is taken from the Living Costs and Food Survey (LCF), formerly the Expenditure and Food Survey (EFS). Via a special data request to the Department for the Environment, Food and Rural Affairs (DEFRA) anonymised individual-level diary data on 25 categories of alcohol (e.g. off-trade beers, see Table 3.1 for a full list) detailing both expenditure (in pence) and quantity (in natural volume of product) were made available to the authors. Volumes of product were converted to volumes of ethanol (in units) using the same ABV assumptions as those used in processing the SHeS data. All transactions from Scotland for the period from 2001-2013 were pooled (adjusting prices for inflation using alcohol-specific Retail Price Indices (RPIs) (15)) to give a total sample size of 27,611 purchasing transactions. These transactions were used to construct the baseline empirical price distributions for each modelled subgroup and each of 10 modelled beverage types including beer, cider, wine, spirits and ready-to-drink (RTD) split by off-trade and on-trade.

Table 3.1: Matching of LCF/EFS product categories to modelled categories and ABV estimates

LCF/EFS on /off trade	LCF/EFS category	Modelled category
Off-trade	Beers	off-trade beer
Off-trade	Lagers and continental beers	off-trade beer
Off-trade	Ciders and Perry	off-trade cider
Off-trade	Champagne, sparkling wines and wine with mixer	off-trade wine
Off-trade	Table wine	off-trade wine
Off-trade	Spirits with mixer	off-trade spirits
Off-trade	Fortified wines	off-trade wine
Off-trade	Spirits	off-trade spirits
Off-trade	Liqueurs and cocktails	off-trade spirits
Off-trade	Alcopops	off-trade RTDs
On-trade	Spirits	on-trade spirits
On-trade	Liqueurs	on-trade spirits
On-trade	Cocktails	on-trade spirits
On-trade	Spirits or liqueurs with mixer	on-trade spirits
On-trade	Wine (not sparkling) including unspecified 'wine'	on-trade wine
On-trade	Sparkling wines and wine with mixer (e.g. Bucks Fizz)	on-trade wine
On-trade	Fortified wine	on-trade wine
On-trade	Cider or Perry - half pint or bottle	on-trade cider
On-trade	Cider or Perry - pint or can or size not specified	on-trade cider
On-trade	Alcoholic soft drinks (alcopops) and ready-mixed bottled drinks	on-trade RTDs
On-trade	Bitter - half pint or bottle	on-trade beer
On-trade	Bitter - pint or can or size not specified	on-trade beer
On-trade	Lager or other beers including unspecified 'beer' - half pint or bottle	on-trade beer
On-trade	Lager or other beers including unspecified 'beer' – pint, can or size unspecified	on-trade beer
On-trade	Round of drinks, alcohol not otherwise specified	on-trade beer

Off-trade sales data for Scotland for 2014 from The Nielsen Company (Nielsen) has been published by NHS Health Scotland (13). This data gives the volume of alcohol sold at a range of price bands by beverage type for the off-trade. This was used to adjust the raw price distributions for each beverage in the off-trade taken from the LCF/EFS survey for Scotland. This approach is perceived to give a more accurate measure of price since self-reported survey data can underestimate total expenditure. Similar data for on-trade sales was obtained for 2011 for England from CGA Strategy. This, together with high-level on-trade sales data for Scotland from 2014 from Nielsen (13), was used to adjust the raw on-trade price distributions. A full description of the adjustment methodology can be found in Section 2.1 of Meng et al. 2012 (8). The unadjusted raw LCF/EFS price distributions and the adjusted price distributions are illustrated in the Appendix in Figure 7.1 for the off-trade and Figure 7.2 for the on-trade, split by beer, cider, wine and spirits (RTDs are not presented, however they make up less than 1.5% of the market). These illustrate that, following adjustment, less cheap alcohol was estimated to be sold compared with before adjustment. For example, the raw data shows that 71%, 87%, 44% and 69% of off-trade beer, cider, wine and spirits respectively were sold below 50p/unit in 2014, compared to 64%, 74%, 30% and 63% respectively using the adjusted price distributions. The final (adjusted) price distributions for all beverage types are shown in Figure 3.6.

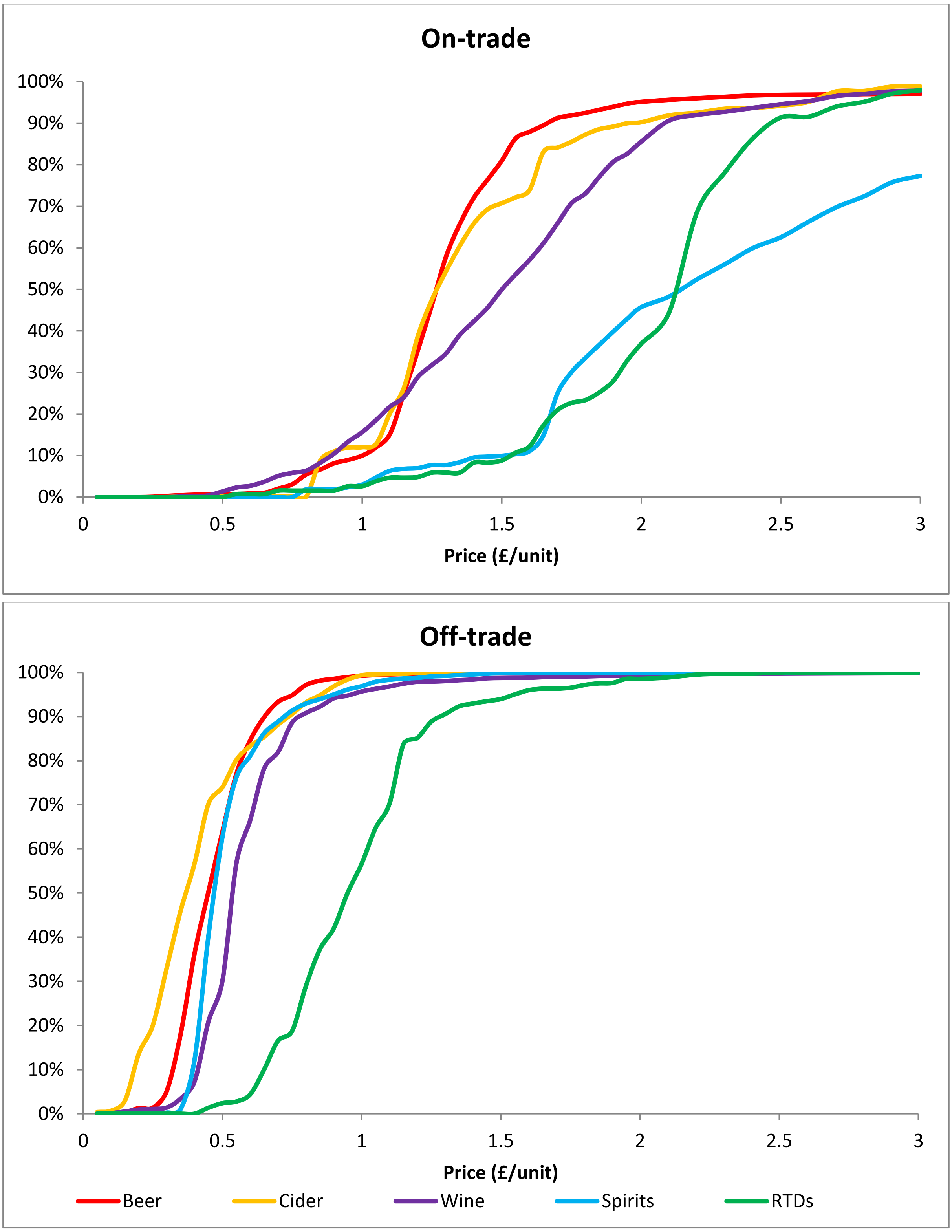

Figure 3.6: Final on- and off-trade price distributions used in SAPM3

3.2.6 Price elasticities of alcohol demand

The Sheffield Alcohol Research Group have recently utilised LCF/EFS data from 2001-2009 for the whole of Great Britain (N=227,933 transactions) to provide new estimates of the own- and cross-price elasticities of demand for 10 types of alcohol beverages including beer, cider, spirits and RTDs separated by off- and on-trade. Price elasticities of alcohol demand represent the percentage change in alcohol demand due to a 1% change in alcohol price. Own-price elasticities indicate the percentage change in the demand for a type of alcohol due to a 1% change in the price of that same type of alcohol. Cross-price elasticities indicate the percentage change in demand for a type of alcohol due to a 1% change in the price of another type of alcohol. The sign of cross-price elasticities indicates whether the two types of alcohol of interest are substitutes (i.e. positive sign) or complements (i.e. negative sign). Full details of the elasticities model have been described elsewhere (16). The subset of the LCF/EFS dataset for Scotland is too small to allow this methodology to be applied to estimate Scotland-specific elasticities and therefore elasticities for the whole of Great Britain (which are estimated, in part, on Scottish data) are utilised in SAPM3.

Table 3.2 summarises the key results of this 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 10 modelled beverage categories. For example, the estimated own-price elasticity for off-trade beer is -0.98, indicating the demand for off-trade beer is estimated to reduce by 9.8% when the price of off-trade beer is increased by 10%, all other things being equal. The estimated cross-price elasticity of demand for on-trade wine with regard to off-trade beer price is 0.25, indicating the demand for on-trade wine increases by 2.5% when the price for off-trade beer is increased by 10% (i.e. a substitution effect).

Table 3.2: Estimated own- and cross-price elasticities for off- and on-trade beer, cider, wine, spirits and RTDs in Great Britain

		Purchase									
		Off-beer	**Off-cider**	**Off-wine**	**Off-spirits**	**Off-RTDs**	**On-beer**	**On-cider**	**On-wine**	**On-spirits**	**On-RTDs**
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-spirits	0.113	-0.024	0.163	-0.082	-0.042	0.167	0.406	0.005	0.084	0.233
	Off-RTDs	-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-spirits	0.019	-0.117	-0.027	-0.280	-0.145	-0.002	-0.284	0.109	-0.890*	0.809*
	On-RTDs	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

3.2.7 Modelling the impact of interventions on price

In order to estimate the impact of taxation and pricing-based interventions on alcohol consumption it is first necessary to estimate the effect of the policy on the beverage-specific price distributions described in Section 3.2.5. This is done by applying appropriate assumptions to the adjusted LCF/EFS transaction data as follows:

3.2.7.1 Impact of a minimum unit price on the price distribution

For each price observation that is below the defined minimum price threshold, the price is inflated to the level of the threshold.

3.2.7.2 Impact of increasing duty rates on the price distribution

The duty rates used in SAPM3 are based on the current duty rates at the time this work was commissioned, set by Her Majesty's Revenue and Customs (HMRC) (i.e. those effective from March 2015 (17)). In order to implement these rates within the model, a number of assumptions must be made as: 1) different duty rates are currently used within some modelled beverage types (e.g. there are 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 calculate the mean duty rate paid per unit using Nielsen and CGA sales data to derive estimated sales volumes within each duty rate band. ABV assumptions for cider and wine are based on the average ABV used by HMRC (personal communication with HMRC in March 2013). Table 3.3 illustrates the range of duty rates and bands within each beverage type and the duty rates per unit used in SAPM3.

Table 3.3: Actual and modelled duty rates by beverage type

Beverage type		Alcoholic strength (ABV)	Applicable duty rate (effective March 2015)	Estimated average duty rate (pence per unit)
Beer		1.2%-2.8%	£8.10 per litre of ethanol	18.49
		2.8%-7.5%	£18.37 per litre of ethanol	
		7.5%+	£23.85 per litre of ethanol	
Cider (incl. perry)	**Still**	1.2%-7.5%	£38.87 per 100 litres of product	7.97
		7.5%-8.5%	£58.75 per 100 litres of product	
	Sparkling	1.2%-5.5%	£38.87 per 100 litres of product	
		5.5%-8.5%	£264.61 per 100 litres of product	
Wine	**Still**	1.2%-4%	£84.21 per 100 litres of product	22.43
		4%-5.5%	£115.80 per 100 litres of product	
		5.5%-15%	£273.31 per 100 litres of product	
		15%-22%	£364.37 per 100 litres of product	
		22%+	£27.66 per litre of ethanol	
	Sparkling	5.5%-8.5%	£264.61 per 100 litres of product	
		8.5-15%	£350.07 per 100 litres of product	
Spirits & spirits based RTDs		All	£27.66 per litre of ethanol	27.66

Given an increase in duty rate of $x\%$ is applied to all beverage types, in order to operationalise the effect on price the main ingredient required is the increase in duty per unit relative to the current system. Mathematically, for a given beverage type i, this can be expressed as follows:

$$\delta_i^* = x \times \delta_i \times (1 + VAT\ rate), \qquad \textit{Equation 1}$$

where the current VAT is 20% and the parameters δ_i^* and δ_i denote duty plus VAT per unit increase and current duty per unit respectively.

The rate to which increases in alcohol duty and VAT are passed through to consumers in supermarkets has been shown to vary by beverage type and baseline price (18). That is, the proportion of a duty increase that is passed on to consumers varies depending on different price points of the baseline price distribution. Importantly when considering the impact of taxation as a mechanism to increase the prices of the cheapest alcohol, this evidence shows that cheaper products are under-shifted (i.e. pass-through is less than duty increase) while products sold above the median unit price are over-shifted (i.e. pass-through is more than duty increase). This gradient is observed across all beverage types. It is also notable that beer and spirits see lower rates of pass-through across the entire price distribution than wine. Figure 3.7 shows the pass-through rates by beverage type across the price distribution identified by Ally et al. 2014 (from Table S1).

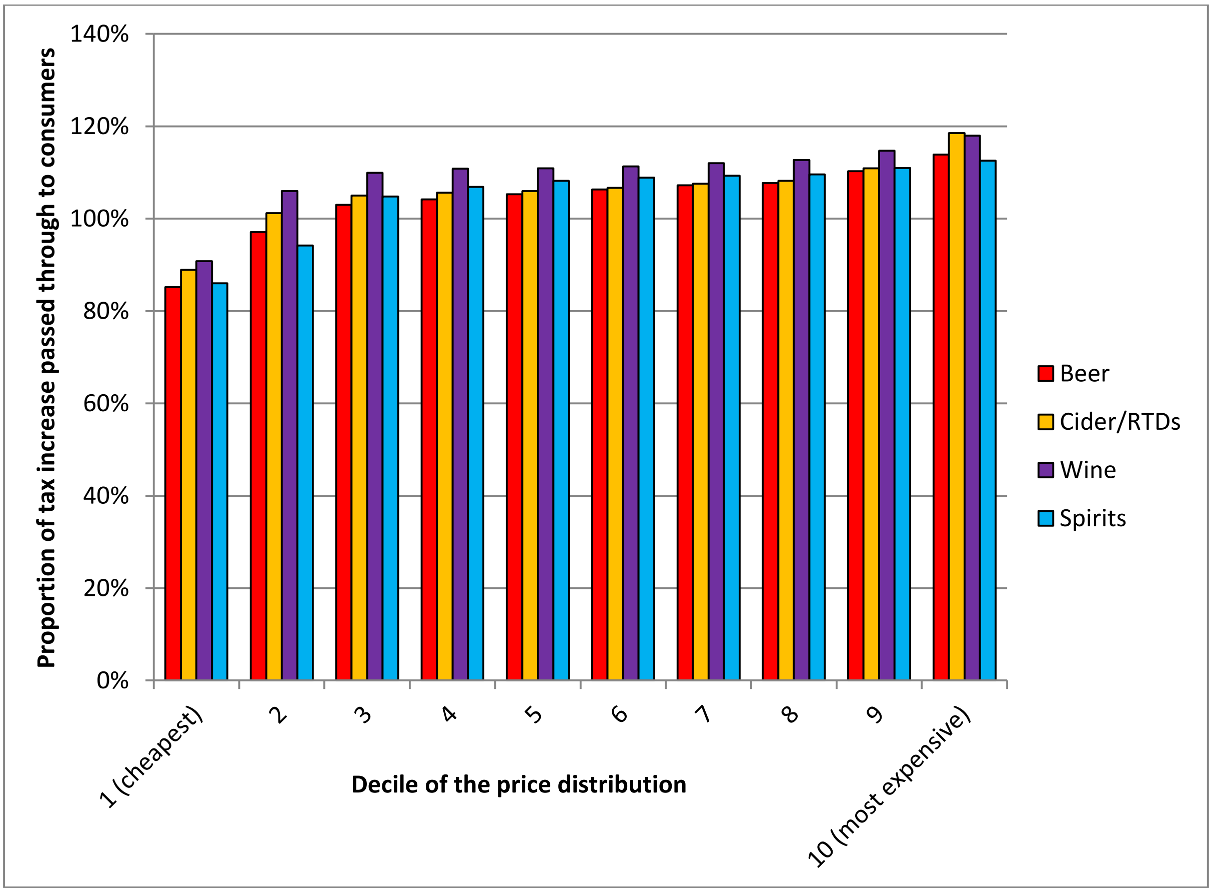

Figure 3.7: Off-trade tax pass-through rates taken from Ally et al. 2014

This evidence is incorporated in SAPM3 by first sifting through off-trade transaction level prices of each beverage type (i) and determining the price per unit band, on the price distribution, at which the beverage price falls in. Thereafter, a post duty increase per unit price (p_i^*) is calculated by summing the baseline per unit price (p_i) of beverage i and the product of duty plus VAT per unit increase (δ_i^*) and corresponding pass-through rate:

$$p_i^* = p_i + \delta_i^* \times (passthrough\, rate). \qquad \textit{Equation 2}$$

For instance, if the baseline price of beer sold in the off-trade is in the lowest decile of prices per unit then a pass-through rate of 0.852 would be applied to any duty increase.

No equivalent evidence could be identified on pass-through rates in the on-trade. Given the significant differences in prices paid, products sold and business models we do not believe it is reasonable to assume that off-trade pass-through rates can be applied equally to the on-trade. For all on-trade products it is therefore assumed that the pass-through rate is 1. That is, duty increases are fully passed on to consumers.

3.2.8 Modelling the impact of price on consumption

After adjusting the price distributions, the final step to estimating the impact of the intervention on alcohol consumption is to apply the price elasticities. For each modelled subgroup the impact of the change in prices caused by the policy on mean weekly alcohol consumption is estimated using the elasticity matrix described in Table 3.2. The formula used to apply the elasticity matrix is shown below:

$$\%\Delta C_i = (1 + e_{ii}\%\Delta p_i)(1 + \sum_{j \neq i}^{\forall j} e_{ij}\%\Delta p_j) - 1 \qquad \textit{Equation 3}$$

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*.

3.3 MODELLING THE RELATIONSHIP BETWEEN CONSUMPTION AND HARM

3.3.1 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 (both of mortality and morbidity) are a fundamental component of this ‘consumption to harm’ model.

3.3.2 A note on terminology

There is much confusion around the terminology used to refer to alcohol and its relationship with health. Terms such as alcohol-specific, alcohol-related and alcohol-attributable can all be used in different contexts to refer to different outcomes – see Section 7 of this report from the Office for National Statistics for a discussion of some of these issues (19). Throughout this report we use the following terms and definitions:

<u>Alcohol-specific condition:</u> Any condition which is wholly-attributable to alcohol, i.e. alcohol is the sole cause. Equivalently, any conditions for which the Alcohol Attributable Fraction (see Section 3.3.4) is 1.

<u>Alcohol-related condition:</u> Any health condition which is at least partially attributable to alcohol. See Table 3.4 for a full list, noting that this is different from the definition used by the ONS.

<u>Alcohol-related mortality:</u> All deaths from conditions which are alcohol-related which are directly attributable to alcohol (i.e. would not have happened if the individual did not drink).

3.3.3 Alcohol-related health conditions

The model aims to capture the policy impact for the large number of health conditions for which there is evidence that alcohol plays a contributory role. Table 3.4 presents a list of all conditions included in the model, which has been adapted from recent global meta-analyses and burden of disease studies (20,21). These conditions are divided into four categories of attribution:

1) Wholly attributable chronic – meaning that the harm cannot occur in the absence of alcohol consumption, and risk of occurrence changes with chronic (i.e. long-term) exposure to alcohol (e.g. alcoholic liver disease, ICD10 code = K70).
2) Wholly attributable acute – meaning that the harm cannot occur without alcohol consumption, and risk of occurrence changes with acute (i.e. short-term) exposure to alcohol including intoxication (e.g. Ethanol poisoning, ICD10 code = T51.0).
3) Partially attributable diseases – meaning that the harm can occur without alcohol but the risk of occurrence changes with chronic exposure to alcohol (e.g. malignant neoplasm (cancer) of the oesophagus, ICD10 code = C15). There are three conditions within this category – ischaemic heart disease, ischaemic stroke, and type II diabetes – in which alcohol, at low levels, may have an overall protective effect. A fourth condition, hypertension, has an estimated overall protective effect for women only and at low levels of consumption (<14g/day).
4) Partially attributable injuries – meaning that the harm can occur without alcohol but the risk of occurrence changes with acute exposure to alcohol (e.g. falls, ICD10 code = W00-W19, or assault, ICD10 = X85-Y09).

Table 3.4: Health conditions included in the model

Main category	Sub category	Disease or injury	ICD-10 codes	Source of risk functions
Wholly attributable to alcohol (17)	Chronic (10)	Alcohol-induced pseudo-Cushing's syndrome	E24.4	By definition AAF=1 and no defined relative risk functions. See Section 3.3.5.1 for details.
		Degeneration	G31.2	
		Alcoholic polyneuropathy	G62.1	
		Alcoholic myopathy	G72.1	
		Alcoholic cardiomyopathy	I42.6	
		Alcoholic gastritis	K29.2	
		Alcoholic liver disease	K70.0-K70.4, K70.9	
		Acute pancreatitis (alcohol induced)	K85.2	
		Chronic pancreatitis (alcohol induced)	K86.0	
		Maternal care for (suspected) damage to foetus from alcohol	O35.4	
	Acute (7)	Mental and behavioural disorders due to use of alcohol	F10	
		Excessive Blood Level of Alcohol	R78.0	
		Toxic effect of alcohol	T51.0, T51.1, T51.8, T51.9	
		Accidental poisoning by exposure to alcohol	X45	
		Intentional self-poisoning by and exposure to alcohol	X65	
		Poisoning by and exposure to alcohol, undetermined intent	Y15	
		Evidence of alcohol involvement determined by blood alcohol level	Y90	
Partially attributable to alcohol (23)	Diseases (overall detrimental) (14)	Tuberculosis	A15-A19, B90	Lonnroth *et al* 2008 (22)
		Malignant neoplasm of lip, oral cavity and pharynx	C00-C14	Tramacere *et al* 2010 (23)
		Malignant neoplasm of oesophagus	C15	Rota *et al* 2009 (24)
		Malignant neoplasm of colon and rectum	C18-C21	Fedirko *et al* 2011 (25)
		Malignant neoplasm of liver and intrahepatic bile ducts	C22	Corrao *et al* 2004 (26)
		Malignant neoplasm of larynx	C32	Islami *et al* 2010 (27)
		Malignant neoplasm of breast	C50	Key *et al* 2006 (28)
		Epilepsy and status epilepticus	G40-G41	Samokhvalov *et al* 2010 (29)
		Hypertensive diseases	I10-I14	Taylor *et al* 2009 (30)
		Cardiac arrhythmias	I47-I48	Kodama *et al* 2011 (31)
		haemorrhagic and other non-ischaemic stroke	I60-I62, I69.0-I69.2	Patra *et al* 2010 (32)
		Lower respiratory infections: pneumonia	J09-J22, J85, P23	Samokhvalov *et al* 2010 (33)
		Cirrhosis of the liver (excluding alcoholic liver disease)	K70 (excl. K70.0-K70.4, K70.9), K73-K74	Rehm *et al* 2010 (34)
		Acute and chronic pancreatitis	K85-K86 excl. K85.2, K86.0	Irving *et al* 2009 (35)
	Injuries (9)	Transport injuries (including road traffic accidents)	V01-V98, Y85.0	Based on Taylor *et al* 2011 (36). See Section 3.3.5.3 for more details.
		Fall injuries	W00-W19	
		Exposure to mechanical forces (including machinery accidents)	W20-W52	
		Drowning	W65-W74	
		Other Unintentional Injuries	W75-W99, X30-X33, X50-X58	
		Accidental poisoning by exposure to noxious substances	X40-X49 excl. X45	
		Intentional self-harm	X60-X84, Y87.0 excl. X65	
		Assault	X85-Y09, Y87.1	
		Other intentional injuries	Y35	
Diseases (overall protective) (3)		Diabetes mellitus (type II)	E10-E14	Baliunas *et al* 2009 (37)
		Ischaemic heart disease	I20-I25	Roerecke and Rehm 2012 (38)
		Ischaemic stroke	I63-I67, I69.3	Patra *et al* 2010 (32)

3.3.4 Alcohol-attributable fractions and potential impact fractions

The methodology is similar to that used in Gunning-Scheper's Prevent model (39), 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 consumed 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 4

where, RR_i is the relative risk (RR) due to exposure to alcohol at consumption state i, p_i 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 (40,41) and that there may be no overall protective effects on all-cause mortality from moderate alcohol consumption (42,43).

The PIF is a generalisation of the AAF based on 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 5*

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 SHeS. 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 6*

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.

3.3.5 Applying potential impact fractions

The impact of a change in consumption on health harms was examined using the potential impact fraction framework and by three different methods for implementation:

1. Direct application of consumption measures to calculate potential impact fractions for wholly attributable chronic and acute conditions.
2. Relative risk functions from the published literature for partial attributable chronic diseases.
3. Relative risk functions from the published literature and derived individual annualised risk for partial attributable injuries.

3.3.5.1 Wholly attributable chronic and acute conditions

Wholly attributable chronic and acute conditions, by definition, have an AAF=1 and no relative risk function can be defined since the reference group has no risk. In order to apply the potential impact fraction, relative risk in Equation 6 is replaced with alcohol consumption that is likely to lead to increased risk for the health condition, denoted by $RiskAlc_i$. For wholly attributable chronic conditions, $RiskAlc_i$ is defined as the difference between mean daily consumption and recommended daily consumption in the UK (3/2 units for men/women[4]) or 0 if mean daily consumption is below the threshold. For wholly attributable acute conditions, $RiskAlc_i$ is defined as the difference between peak day consumption and the cut-off thresholds of 4/3 units for men/women at which we assume the acute risk starts to increase or 0 if peak day consumption is below the threshold.

[4] As discussed in Section 3.2.2 these relate to the previous UK drinking guidelines

3.3.5.2 Partially attributable chronic conditions

The relative risk functions for all chronic conditions that are partially attributable to alcohol are taken from published meta-analyses and used in Equation 6. Table 3.4 gives the sources for these risk functions. For Ischaemic Heart Disease we also incorporate more recent evidence which suggests that heavy episodic, or 'binge' drinking, may attenuate or remove entirely any protective effects (44). This is operationalised by removing any protective effects for individuals in the SHeS who drink at a level such that they must meet the definition of heavy episodic drinking used in the study (>60g ethanol per day). This is in line with the approach taken in other international studies (45) and is likely to be conservative as we do not remove the protective effects for SHeS individuals who may be drinking above the 60g threshold infrequently (and thus have a mean daily consumption of less than 60g).

3.3.5.3 Partially attributable acute conditions

Partially attributable acute conditions include various traffic and non-traffic injuries. The identified relative risk functions for these conditions are different from the relative risk functions for partially attributable chronic conditions and cannot be used directly in Equation 6. The input and outcome of the relative risk functions for partially attributable chronic conditions are usual alcohol consumption and relative risk over a certain period of time, however, the input and outcome of the identified relative risk functions for traffic and non-traffic injuries are levels of drinking on the occasion prior to the injury and the relative risk for the drinking occasion (36). As SAPM3 works on annual cycles, relative risk in Equation 6 is implicitly defined as annual relative risk. Therefore, to apply Equation 6, single drinking occasion based relative risk needs to be converted to long-term (e.g. annual) relative risk of an individual in the survey.

A new method to estimate annualised relative risk of alcohol-attributable traffic- and non-traffic injuries has been developed. Briefly, three measures are defined to represent drinking pattern based on single drinking occasions which are the frequency of drinking occasions (defined as n, or number of drinking occasions per week), mean level of alcohol consumption for a given drinking occasion (defined as μ, or units of alcohol) and the variability of alcohol consumption for a given drinking occasion (defined as σ, or standard deviation of units of alcohol consumed in drinking occasions). Using the ONS' National Diet and Nutrition Survey (NDNS), regression models were fitted to relate the three measures with mean consumption and a range of independent variables (e.g. age, gender, education, ethnicity, etc.) (46). These regression models are used to impute the three measures for each individual in the Scottish Health Survey. For each individual, alcohol consumption on a given drinking occasion is assumed to follow a normal distribution with mean of μ and standard deviation of σ; and the duration of intoxication for a given drinking occasion is calculated by applying the equation for estimating blood alcohol content. Finally, a series of integrations was performed to calculate the annualised relative risk for traffic and non-traffic accidents. Detailed description of the method can be found elsewhere (47). The annualised relative risk is used in Equation 6 to estimate the potential impact factor for partially attributable acute conditions.

3.4 CONSUMPTION TO HEALTH HARMS MODEL

3.4.1 Mortality model structure

A simplified version of the model structure for mortality is presented in Figure 3.8. The model is developed to represent the population of Scotland in a life table. Separate life tables have been implemented for males and females.

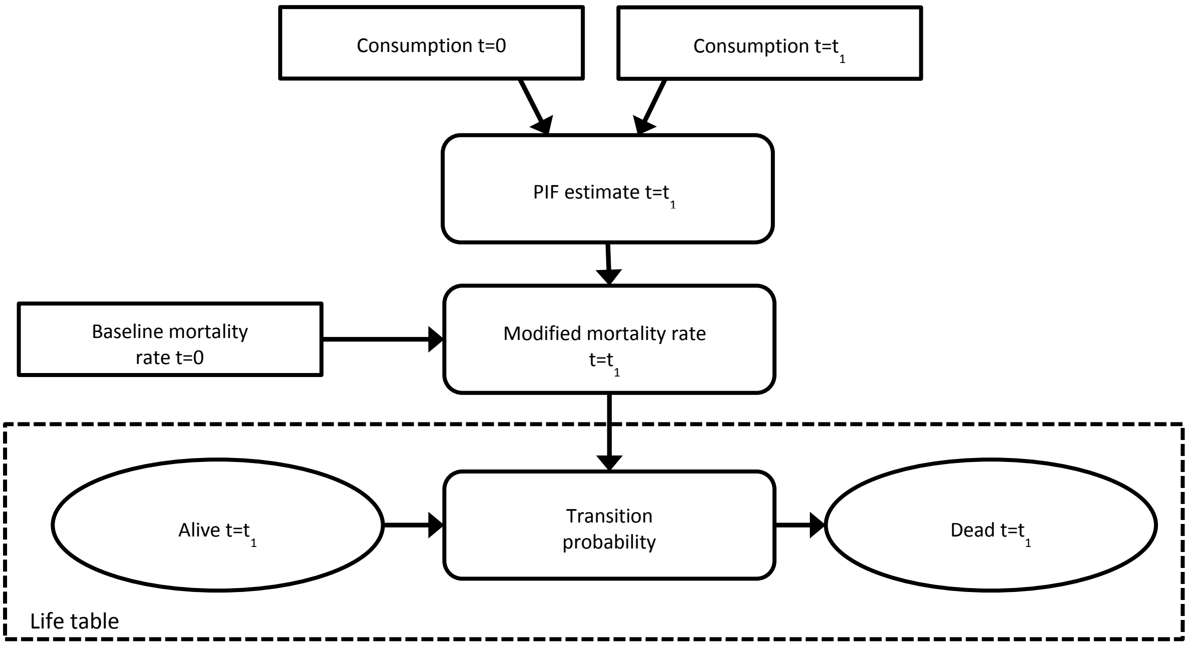

Figure 3.8: Simplified structure of the mortality model

The life table is implemented as a linked set of simple Markov[5] 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 over time:

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

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

[5] A state transition model where individuals can exist in a set number of states at any time period and transition between states using a set of transition probabilities which are conditional on the current state of the individual.

Note that the PIF can be decomposed to enable different population groups at baseline – for example, moderate, increasing risk and high risk drinkers or individuals in poverty and not in poverty– 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 (i.e. the change in alcohol prices) 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.

3.4.2 Morbidity model structure

A simplified schematic of the morbidity model is shown in Figure 3.9. The model focuses on the expected disease prevalence for population cohorts. 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 required.

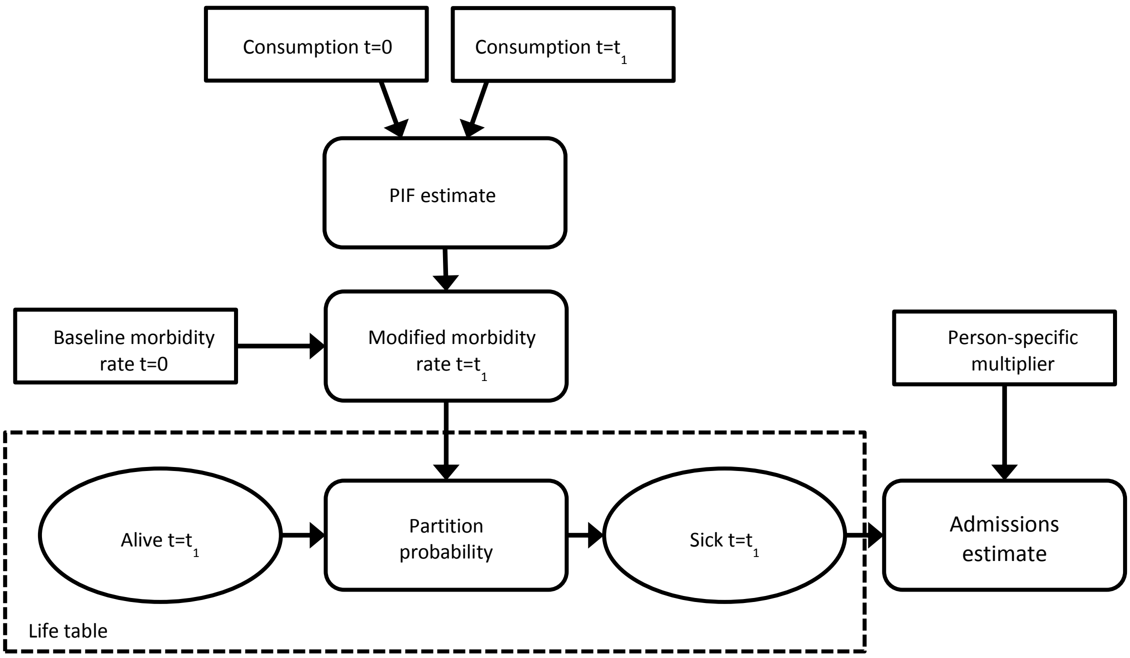

Figure 3.9: Simplified structure of the morbidity model

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 43 alcohol-related conditions (and a 44^{th} condition representing overall population health, not attributable to alcohol).

As in the mortality model, the PIF is calculated based on the consumption distribution at time *0* and *t*. The PIF is then used to modify the partition rate (i.e. the distribution of the 43 conditions for alive individuals) to produce person-specific sickness volumes.

3.4.3 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 relationship between changes in consumption levels and changes in risk of harm. Data on this relationship is necessary for the modelling of future outcomes from chronic conditions where the development of diseases often occurs over many years.

A recent systematic review by members of the Sheffield Alcohol Research Group identified the best available published evidence on time lags for all 27 modelled chronic health conditions (48). Figure 7.3 in the Appendix illustrates the findings of this review for a range of chronic health conditions. This evidence shows that, for some health conditions, notably alcohol-related cancers, the full effects of changes in consumption on health can take up to 20 years to be realised. We therefore refer to 20 years as 'full effect' in our modelling and the majority of results are presented for the 20th year following policy implementation. See Table 2 in Holmes et al. (48) for further details of these relationships as implemented in the model.

3.4.4 Mortality model parameters

Baseline population data, used to populate the initial life tables for Scotland, was obtained from ONS mid-year population estimates for 2014 (49). Age and gender subgroup-specific mortality rates for each of the 43 modelled health conditions were provided by National Records of Scotland. As SAPM3 requires mortality rates to be further split by poverty/not in poverty, but data on income is not included in the mortality register, this data was instead partitioned into individuals living in the most deprived 14% of the country as defined by the Scottish Index of Multiple Deprivation (SIMD) (where 14% corresponds to the proportion of the population who were in poverty in 2013/4 (50)) and those living in the remaining 86%. It is worth noting that deprivation is not an exact match for poverty although the two are strongly correlated. SIMD is a measure of multiple deprivation based partially on income but also on employment, health, education, geographical access to services, community safety, physical environment and housing. The overall and poverty category-specific mortality rates for all modelled health conditions are shown in the Appendix Table 7.1, which shows generally higher death rates for those in poverty both from the 43 modelled alcohol-related health conditions and from other causes.

3.4.5 Morbidity model parameters

3.4.5.1 Morbidity prevalence rates

Morbidity data for Scotland was provided by ISD Scotland based on Scottish hospital admission data for 2014. For each modelled health condition the total number of admissions in the year for each age-gender subgroup in the model was provided, with these numbers further separated by whether the admittee was in poverty or not, using the same SIMD-based method as described for mortality in Section 3.4.4. A second analysis was also performed by ISD Scotland in order to estimate the number of unique patients admitted over the year within each subgroup for each condition (i.e. removing repeat admissions from the same individual). Both analyses used the same methodology for alcohol-attribution and counting of repeat admissions as has been used in previous Scottish adaptations of SAPM (8) and elsewhere (51). SAPM3 is a prevalence-based model and this unique patient analysis is used to provide the estimated baseline morbidity for each health condition for each modelled age-gender-income subgroup. However, whilst the model operates on the basis of estimating morbidity, hospital admissions are likely to be a more relevant outcome to most stakeholders and we therefore require a means of estimating admissions from prevalence. This mapping from morbidity to hospitalisations is performed using condition-specific 'multipliers', which were calculated from the ISD data by dividing the total admissions by the estimated number of unique patients admitted over the year for each condition. These multipliers, which represent the mean number of hospital admissions per year for a person admitted at least once with a given alcohol-related condition, are presented in Appendix Table 7.2 together with estimated annual morbidity overall and by poverty category. These figures show similar patterns to the mortality data in Table 7.1, with higher rates amongst those in poverty for almost all alcohol-related health conditions.

3.5 SENSITIVITY ANALYSES

Best practice for policy modelling suggests reporting a single base case estimate, supported by a range of sensitivity analyses in order to explore the impact of key uncertainties in the evidence base (52). We have focused this approach on three aspects of the model: underreporting of alcohol consumption in surveys, price elasticities and the protective effects of drinking on health. In order to explore the potential uncertainties in these areas we have undertaken three distinct sensitivity analyses in which we test the impact of alternative assumptions in these areas on the modelled impact of a 50p MUP.

3.5.1 Adjusting for underreporting (SA1)

Alcohol consumption as estimated in population surveys routinely underreports known alcohol consumption taken from sales or excise clearance data by around 40% (i.e. the survey consumption accounts for only 60% of all alcohol sold) (12,53). There may be many explanations for this discrepancy, both in the survey, including missing or under-represented populations, recall bias in respondents and a tendency to underestimate the size or alcohol content of home-poured drinks and in the sales or clearance data, including illicit alcohol and wastage. See Meier et al. 2013 and Robinson et al. 2012 for a full discussion of these issues (53,54).

A range of methods have been proposed to account for this observed underreporting, from simple adjustment factors to more complex methods which retain the distributional characteristics of the drinking distribution. We implement here a variation on the 'gamma-shifting' method of Rehm et al. which has previously been applied to SHeS data (8,55). Full details of the method can be found in Meng et al. 2012 Section 2.6.2.3, but in summary: the beverage-specific distribution of alcohol consumption within the population is parameterised as a gamma distribution. The mean of this distribution is then 'upshifted' to match the mean consumption of that beverage per adult from 2014 taken from Nielsen sales data (13). For every individual in the SHeS, their beverage-specific consumption is then adjusted by the ratio between their centile's value in the original and the upshifted gamma distributions. This is repeated for all beverage categories in the SHeS.

3.5.2 Alternative elasticity estimates (SA2)

Her Majesty's Revenue and Customs (HMRC) have recently published estimates of the price elasticity of alcohol which, in common with the elasticities of Meng et al. described in Section 3.2.6, account for differential price-responsiveness across a range of beverage types, including the on- and off-trade, and accounting for the full range of compliment and substitution effects (16,56). These are derived using a different methodology to those of Meng et al., and, although the own-price estimates are broadly similar, there are a number of differences in the cross-price elasticities. We have therefore incorporated these elasticities into SAPM to explore the impact of using this alternative source.

3.5.3 Protective effects of alcohol on health (SA3)

The finding that alcohol has a protective effect on health, both for specific health conditions, as discussed in Section 3.3.3, and on overall mortality (e.g. (57)) has been widely discussed in the academic literature and there is no clear consensus on whether these observed protective effects are genuine or an artefact of the design of the primary studies (41,58). Whilst the SAPM base case is to include these effects as identified in the most recent high quality systematic reviews and meta-analyses, we have tested here the impact of removing all protective effects from the model entirely. That is to say that the relative risk of harm is set to 1 wherever the risk functions discussed in Section 3.3.3 would otherwise suggest a relative risk of below 1.

4 RESULTS

SAPM3 produces estimates of the impact of a wide range of policies on a wide range of outcomes. The synthesis of data used in the model also provides insights into the baseline (i.e. current) consumption and spending patterns across the population as well as the distribution of alcohol-related harm. These findings are presented here, followed by model results in 3 main sections:

1) Estimated impacts of a 30p, 40p, 50p, 60p and 70p MUP policy
2) Estimation of the taxation increases required to achieve the same impact on mortality as a 50p MUP, and the estimated differences in scale and distribution of impacts of these policies
3) Results of the sensitivity analyses on estimates of impact of a 50p MUP

For all policies examined we present the impact on alcohol consumption, spending, exchequer and retailer revenue, alcohol-related mortality and alcohol-related hospital admissions. When comparing a 50p MUP with equalised taxation policies we also present the differential impacts on alcohol-related health inequalities.

4.1 BASELINE DATA

4.1.1 Alcohol consumption and spending

Table 4.1 presents the baseline distribution of the population between drinker groups, together with the mean consumption and mean spending of drinkers. The variation in abstention rate by poverty group is shown in Table 4.2. Table 4.3 breaks the consumption and spending figures down further by drinker and poverty group. These tables illustrate that that abstention rates are higher amongst those in poverty (25% vs 13%), moderate drinkers in poverty consume and spend less than their counterparts who are not in poverty (240 vs. 320 units per year and £230 vs. £380 per year respectively). This pattern is reversed for harmful drinkers, with harmful drinkers in poverty drinking substantially more on average (4,500 vs. 3,350 units per year) and spending slightly more (£2,500 vs. £2,350) than harmful drinkers who are not in poverty.

Table 4.1: Baseline alcohol consumption and spending patterns by drinker group

	Population	**Moderate**	**Hazardous**	**Harmful**
Drinker population	3,740,472	2,659,329	841,805	239,337
% of total drinkers	100%	71%	23%	6%
Baseline consumption per drinker per year (units)	761	312	1,402	3,498
Baseline spending per drinker per year	£675	£359	£1,194	£2,360

Table 4.2: Baseline abstention rates by poverty group

	Abstention rate
Population	14.9%
In poverty	25.3%
Not in poverty	13.2%

Table 4.3: Baseline alcohol consumption and spending patterns by drinker and poverty group

	Moderate		Hazardous		Harmful	
	In poverty	Not in poverty	In poverty	Not in poverty	In poverty	Not in poverty
Drinker population	345,308	2,314,021	83,404	758,402	31,248	208,089
% of total drinkers	9%	62%	2%	20%	1%	6%
Baseline consumption per drinker per year (units)	238	323	1,456	1,396	4,499	3,348
Baseline spending per drinker per year	£230	£378	£1,102	£1,204	£2,484	£2,341

When we consider the proportion of all alcohol consumed and of total spending on alcohol by drinker group, as illustrated in Figure 4.1, we see that harmful drinkers, who account for only 6% of all drinkers and 5% of the population, drink 29% of all the alcohol drunk and account for 22% of all spending on alcohol in Scotland. Hazardous and harmful drinkers combined account for a quarter of the population (25%), yet they drink over two thirds of the alcohol (71%) and account for over three fifths of the total value of alcohol sales (62%).

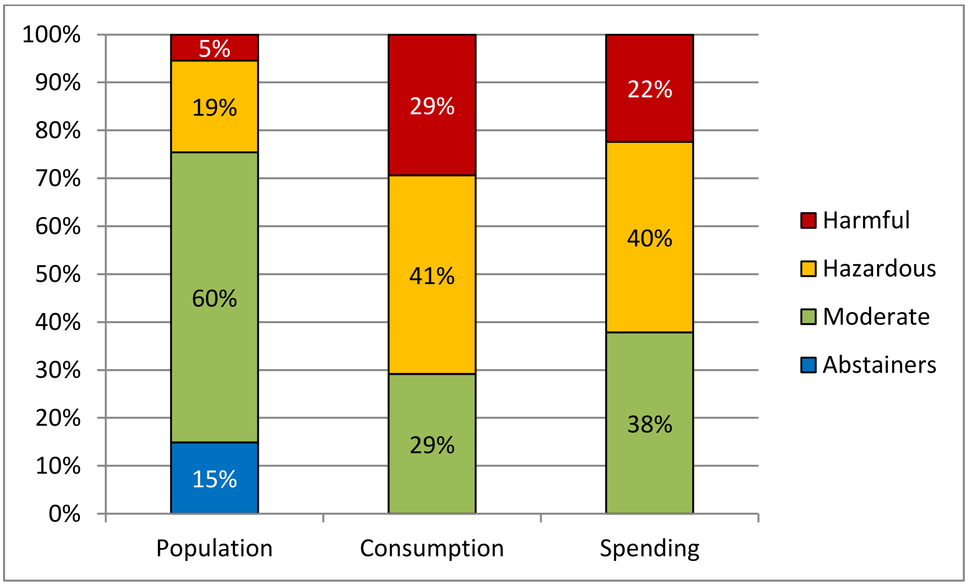

Figure 4.1: Distribution of population, total alcohol consumption and total spending on alcohol by drinker group

Figure 4.2 and Figure 4.3 illustrate findings from the synthesis of the SHeS consumption data and LCF/EFS pricing data, showing the breakdown of alcohol consumed by beverage type and sector (on- vs. off-trade) and how these vary by drinker and poverty group. These variations are key to understanding the differences in impact of MUP and taxation policies, which have significantly different impacts on prices across different beverage types and sectors. Figure 4.2 shows that overall, more alcohol is drunk as wine than any other beverage type, followed by beer and spirits. This changes for drinkers in poverty, who consume a markedly greater proportion of their alcohol as spirits and cider, and considerably less as wine than those not in poverty. Beverage preferences are similar across the drinker spectrum, with harmful drinkers drinking a greater proportion of their alcohol as cider and somewhat less as wine, although they still drink absolutely more wine on average than hazardous or moderate drinkers (1,140 units/year vs. 550 and 120 respectively).

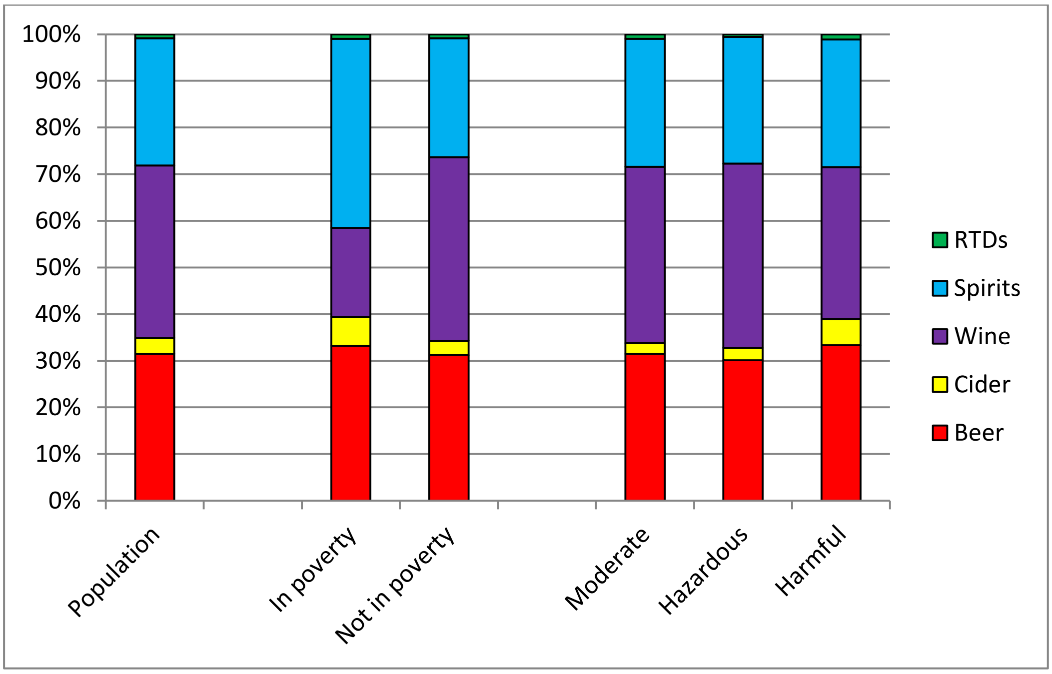

Figure 4.2: Beverage preferences by poverty and drinker group

Figure 4.3 shows a slight increase in preference among drinkers in poverty for drinking alcohol bought in the off-trade compared to those not in poverty. A steeper gradient is observed across the drinker spectrum, with hazardous and harmful drinkers consuming proportionately more of their alcohol in the off-trade than moderate drinkers.

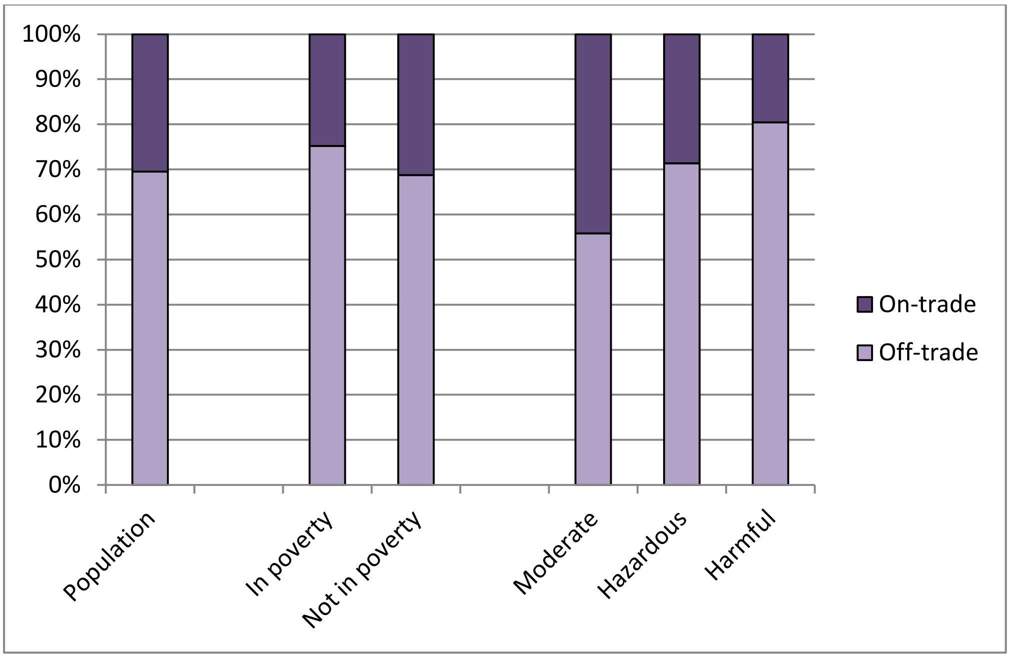

Figure 4.3: On- and off-trade consumption preferences by poverty and drinker group

Figure 4.4 presents the variation in mean prices paid per unit of alcohol across beverage types and drinker groups. This illustrates that heavier drinkers pay less across all beverage types, with moderate drinkers paying markedly more on average for spirits and harmful drinkers paying markedly less on average for cider. As can be seen clearly in Figure 3.6, prices in the off-trade are substantially lower than in the on-trade and the gradients in Figure 4.4 are therefore a combination of the fact that heavier drinkers drink a greater proportion of their alcohol in the off-trade (as seen in Figure 4.3) and the fact that they chose cheaper products on average within each sector.

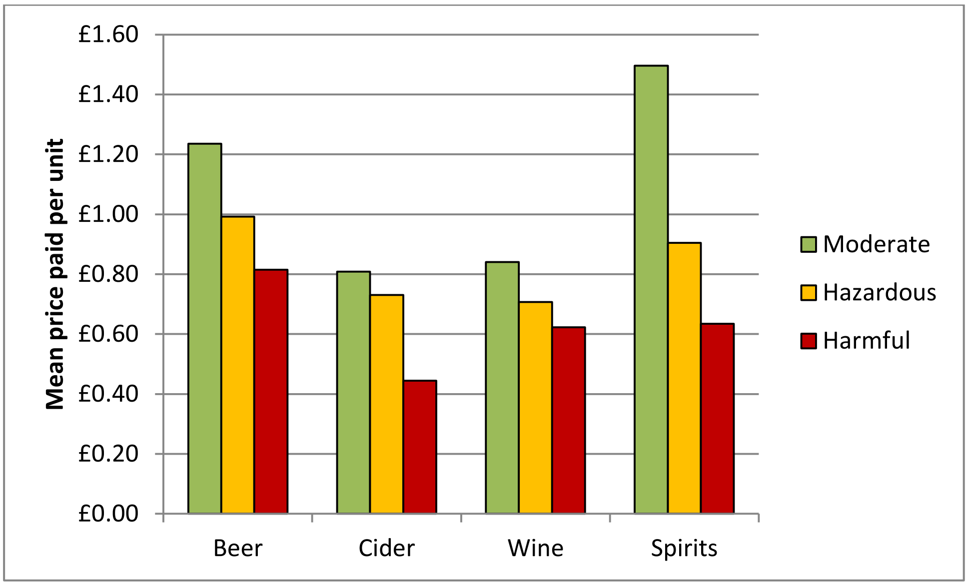

Figure 4.4: Mean prices paid by beverage type and drinker group

Figure 4.5 shows the overall distribution of consumption across the 10 beverage and sector categories, separating out purchasing below 50p per unit. This highlights several important findings:

- Almost no alcohol sold in the on-trade will be affected by a 50p MUP
- The greatest absolute number of units bought below 50p per unit are bought as spirits in the off-trade
- Although it makes up a small proportion of overall consumption (2.7%), the vast majority of alcohol sold as off-trade cider is sold at below 50p per unit.

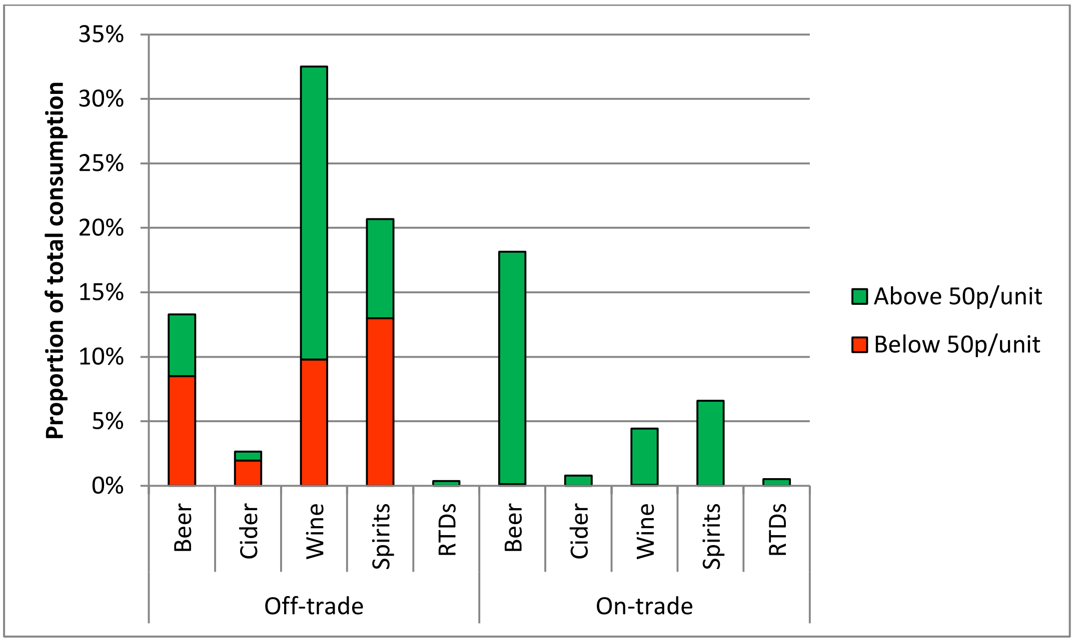

Figure 4.5: Overall consumption preferences including purchasing of units below 50p per unit

The final graph in this section, Figure 4.6, shows how purchasing prices vary by drinker group. For each group it shows mean alcohol consumption (the bars), and the proportion of each group's consumption which is alcohol bought at below 50p per unit (the orange section of each bar). The graph also shows the mean price paid for all alcohol by that group (the blue lines). A more detailed version of this graph further broken down by poverty group (Figure 7.4) can be found in the Appendix. These graphs highlight several more key patterns in baseline alcohol consumption:

- Mean consumption is similar for those in poverty and those not in poverty across all except the heaviest-drinking decile, where those in poverty drink notably more
- The heavier the drinker, the more units they purchase below 50p
- Drinkers in poverty purchase more units for less than 50p than those not in poverty, particularly amongst the heaviest drinkers
- Heavier drinkers pay less per unit for their alcohol, with drinkers in poverty paying less than those not in poverty across the entire drinker distribution.

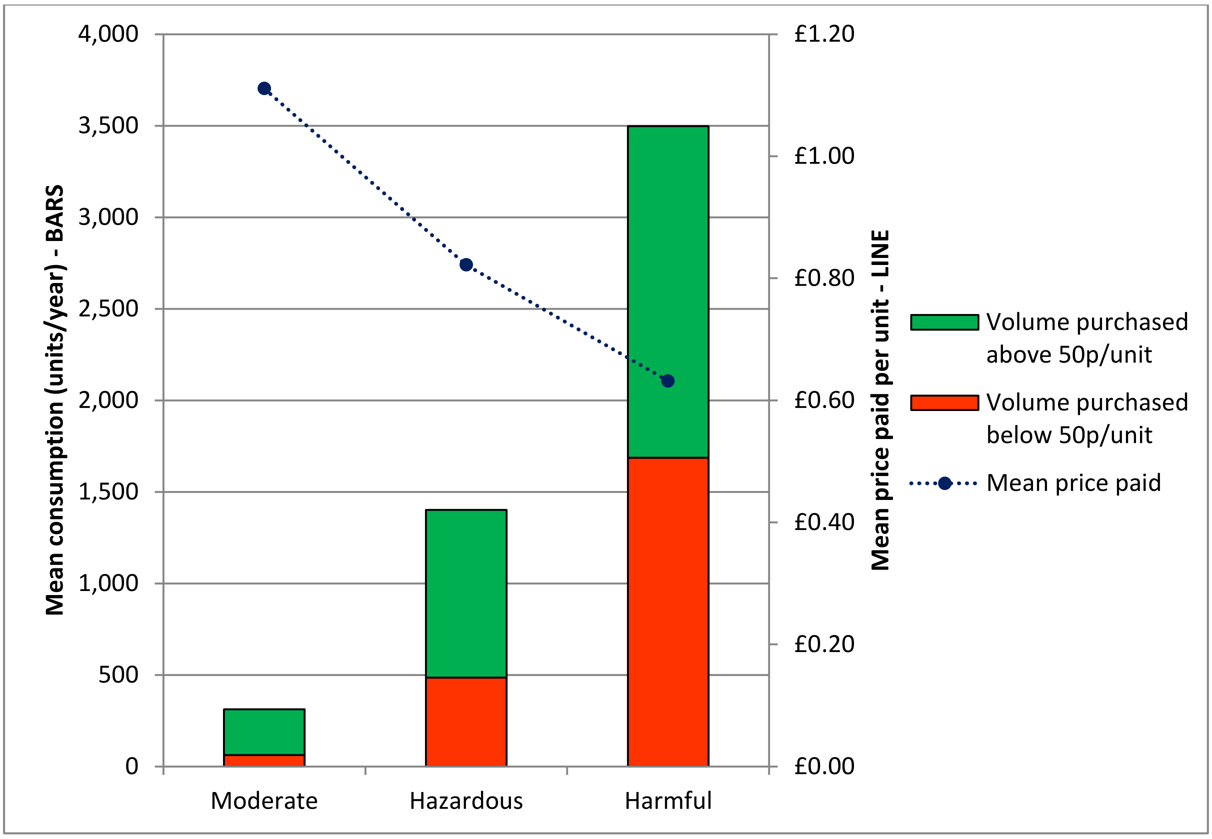

Figure 4.6: Mean consumption, units purchased below 50p per unit and mean prices paid by consumption group

4.1.2 Alcohol-related harm

Table 4.4 separates out and presents the total number of deaths and hospital admissions per year at baseline which are estimated to be alcohol-related, i.e. only those which are attributable to alcohol and would not have occurred if the entire population were abstainers. This shows that cancer is the single biggest cause of deaths due to alcohol, followed by alcoholic liver disease, but that the cardioprotective protective effects of alcohol at low levels of consumption (which are disputed – see Section 3.5.3) also prevent a substantial number of deaths (seen as negative numbers in the Table). A slightly different pattern is observed in hospital admissions, with mental and behavioural disorders due to alcohol being the largest single cause of alcohol-related hospital admissions, followed by cancers, hypertension and alcoholic liver disease. Again, there is estimated to be a significant number of admissions averted from cardiovascular disease due to cardioprotective effects.

Table 4.4: Estimated baseline alcohol-related deaths and hospital admissions per year by cause

	Baseline alcohol-related deaths per year	Baseline alcohol-related hospital admissions per year
Alcoholic liver disease	546	3,758
Mental and behavioural disorders due to use of alcohol	257	12,344
Other wholly-attributable chronic conditions	29	702
Wholly-attributable acute conditions	59	2,083
Cancers	836	7,933
Hypertension	61	4,890
Stroke	-174	277
Other cardiovascular conditions	-497	-12,131
Other partially-attributable chronic conditions	83	-1,193
Transport injuries	61	1,175
Falls	125	5,797
Other partially-attributable acute conditions	241	4,232

Table 4.5 presents the overall baseline annual mortality and admission rates per 100,000 drinkers broken down by drinker and poverty group; showing the steep gradients in harm, with heavier drinkers and those in poverty suffering more harm. Most notably, we see that death rates in harmful drinkers in poverty are over twice as high as in harmful drinkers not in poverty. This finding is shown clearly in Figure 4.7 which illustrates baseline death rates by drinker and poverty group. A further graph illustrating the breakdown of mortality rates by condition type and poverty group can be found in the Appendix, Figure 7.5.

Table 4.5: Baseline alcohol-related death and hospital admission rates by drinker and poverty group

		Baseline deaths per 100,000 drinkers	Baseline hospital admissions per 100,000 drinkers
Consumption breakdown			
All drinkers		43	798
Moderate		-7	-100
Hazardous		95	1,839
Harmful		424	7,120
Income group breakdown			
All drinkers	In poverty	91	1,689
	Not in poverty	37	674
Moderate	In poverty	1	103
	Not in poverty	-8	-130
Hazardous	In poverty	206	4,563
	Not in poverty	83	1,539
Harmful	In poverty	781	11,555
	Not in poverty	371	6,454

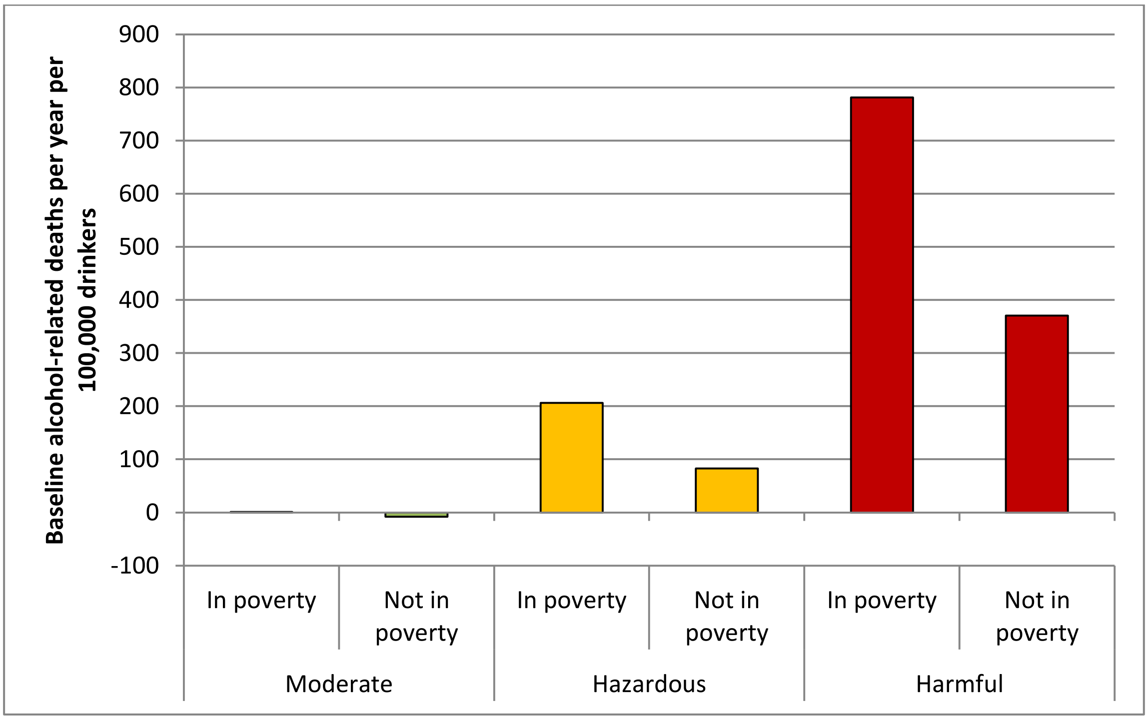

Figure 4.7: Baseline alcohol-related deaths by drinker and poverty group

The four graphs which make up Figure 4.8 illustrate some of the key conclusions from Section 4.1, which are crucial to understanding many of the patterns seen in the model results. They show the findings that harmful drinkers in poverty drink markedly more than those not in poverty and spend marginally more. This is in contrast to moderate drinkers in poverty who drink and spend less than moderate drinkers not in poverty. Drinkers in poverty pay less for every unit of alcohol they buy than those not in poverty, with harmful drinkers in poverty paying the least, on average, for their drink. Finally, alcohol-related mortality is concentrated in harmful drinkers, particularly those in poverty, who drink a third more on average than those not in poverty, but have alcohol-related death rate which is more than twice as high.

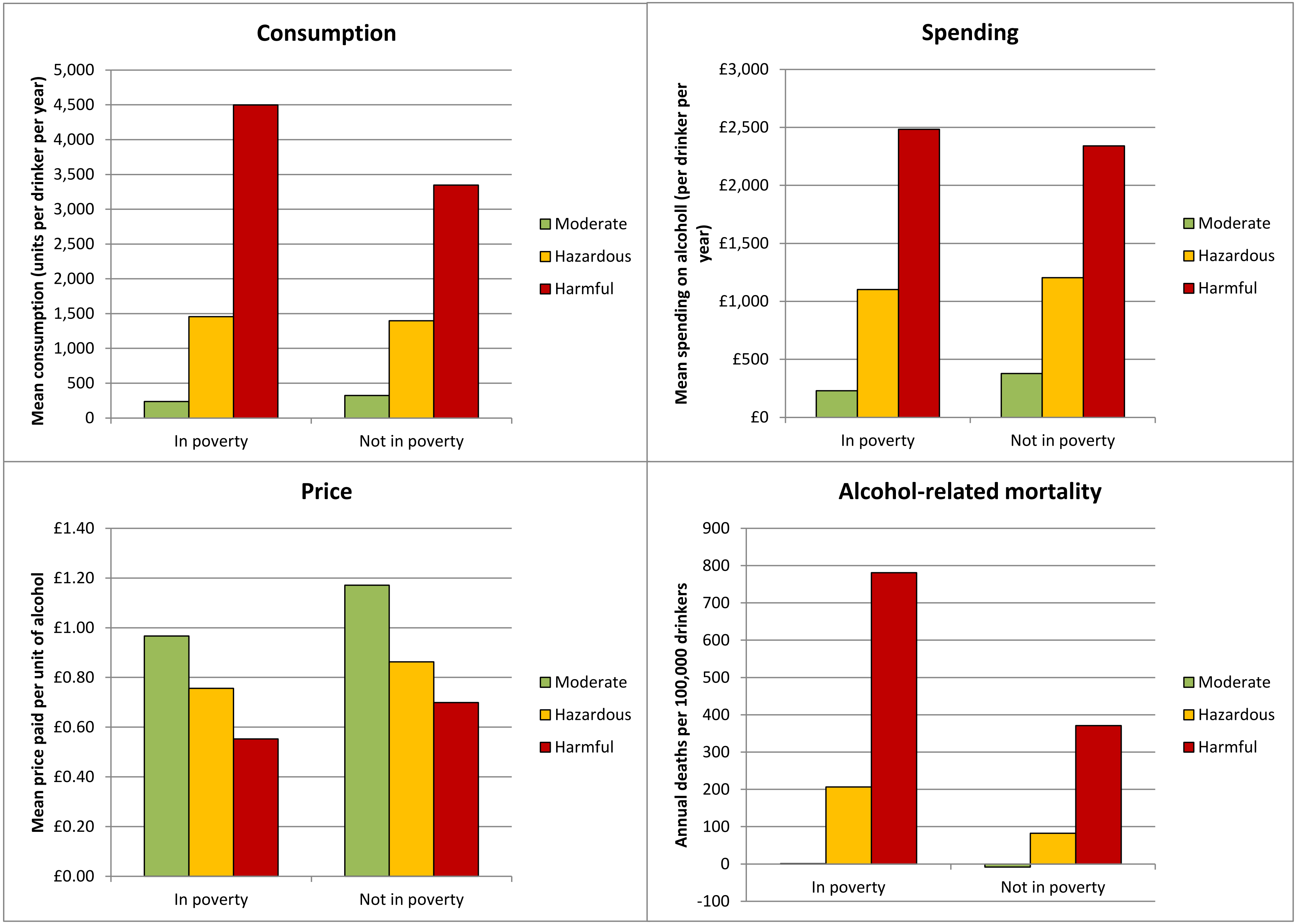

Figure 4.8: Baseline consumption, spending, price and mortality by drinker group

4.2 EVALUATION OF THE IMPACT OF A RANGE OF MUP THRESHOLDS

4.2.1 Estimated impact of MUP on alcohol consumption

The modelled impact of MUP policies from 30p to 70p per unit on alcohol consumption is shown in detail in Table 4.6, which presents estimates of absolute and relative changes in consumption at the population level and broken down by drinker group. Table 4.7 breaks these results down further to illustrate the differential impact by drinker and poverty group. Figure 4.9 and Figure 4.10 illustrate the absolute and relative changes in consumption across all modelled MUP policies by drinker group, while Figure 4.11 shows absolute changes for a 50p MUP by drinker and income group. A similar graph showing the drinker and poverty group impacts of all modelled MUP policies can be found in the Appendix, Figure 7.6

These results show that all modelled MUP policies have only small impacts on the consumption of moderate drinkers (-3.7 units per year, roughly equivalent to two pints of beer for a 50p MUP), but a much larger effect, both relatively and absolutely, on the consumption of harmful drinkers (-246 units per year, roughly equivalent to 8 bottles of vodka or 25 bottles of wine). As might be expected, given they pay less for alcohol on average, hazardous and harmful drinkers in poverty see larger reductions in consumption than those not in poverty, with effects particularly targeted at harmful drinkers in poverty, especially at higher MUPs. For example, a 50p MUP is estimated to reduce consumption of harmful drinkers in poverty by 681 units per year on average compared to 181 units per year for harmful drinkers not in poverty.

Table 4.6: Estimated impacts of MUP policies on consumption by drinker group

		Population	Moderate	Hazardous	Harmful
Drinker population		3,740,472	2,659,329	841,805	239,337
Baseline consumption per person per year (including abstainers) (units)		648	250	1,402	3,498
Baseline consumption per drinker per year (units)		761	312	1,402	3,498
Absolute change per drinker per year (units)	**30p MUP**	-2.7	-0.4	-3.5	-24.6
	40p MUP	-10.9	-1.6	-13.4	-105.4
	50p MUP	-26.3	-3.7	-35.5	-246.2
	60p MUP	-49.9	-8.1	-72.0	-437.4
	70p MUP	-80.8	-15.0	-122.6	-665.2
Relative change per drinker per year	**30p MUP**	-0.3%	-0.1%	-0.3%	-0.7%
	40p MUP	-1.4%	-0.5%	-1.0%	-3.0%
	50p MUP	-3.5%	-1.2%	-2.5%	-7.0%
	60p MUP	-6.6%	-2.6%	-5.1%	-12.5%
	70p MUP	-10.6%	-4.8%	-8.7%	-19.0%

Table 4.7: Estimated impacts of MUP policies on consumption by drinker and poverty group

		Moderate		Hazardous		Harmful	
		In poverty	Not in poverty	In poverty	Not in poverty	In poverty	Not in poverty
Drinker population		345,308	2,314,021	83,404	758,402	31,248	208,089
Baseline consumption per person per year (including abstainers) (units)		164	266	1,456	3,417,182	3,417,182	1,456
Baseline consumption per drinker per year (units)		238	323	1,456	1,396	4,499	3,348
Absolute change per drinker per year (units)	**30p MUP**	-1.6	-0.2	-9.0	-2.9	-117.8	-10.6
	40p MUP	-4.3	-1.2	-34.4	-11.1	-347.0	-69.1
	50p MUP	-9.8	-2.7	-88.1	-29.7	-680.9	-180.9
	60p MUP	-19.4	-6.4	-159.2	-62.4	-1128.6	-333.6
	70p MUP	-30.6	-12.7	-243.8	-109.3	-1635.9	-519.5
Relative change per drinker per year	**30p MUP**	-0.7%	-0.1%	-0.6%	-0.2%	-2.6%	-0.3%
	40p MUP	-1.8%	-0.4%	-2.4%	-0.8%	-7.7%	-2.1%
	50p MUP	-4.1%	-0.8%	-6.1%	-2.1%	-15.1%	-5.4%
	60p MUP	-8.1%	-2.0%	-10.9%	-4.5%	-25.1%	-10.0%
	70p MUP	-12.9%	-3.9%	-16.7%	-7.8%	-36.4%	-15.5%

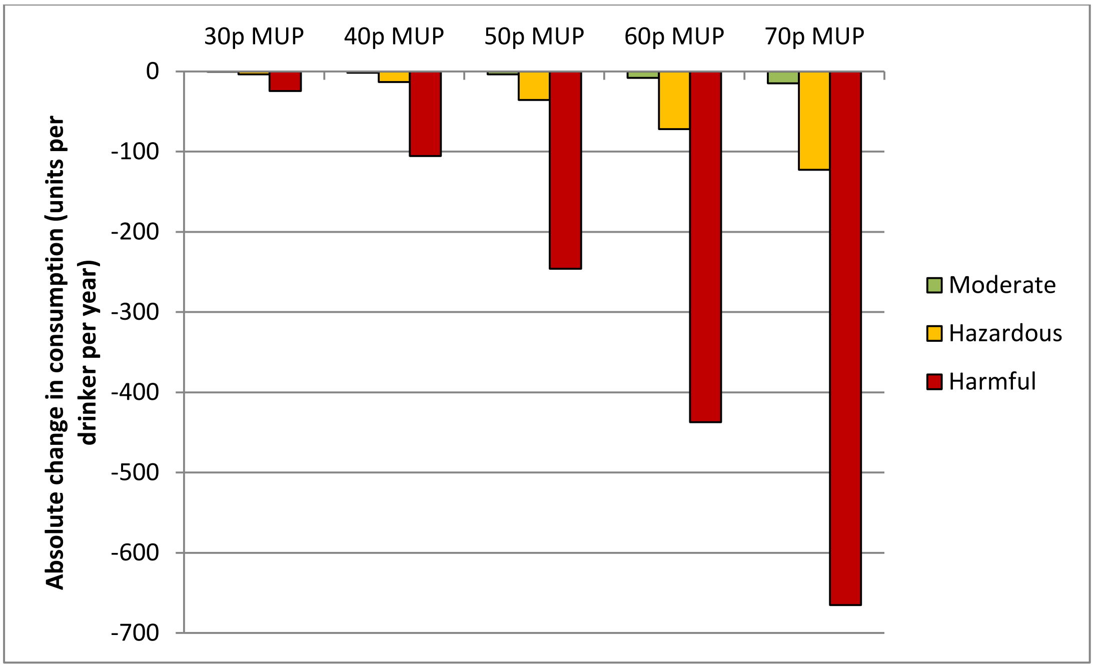

Figure 4.9: Absolute changes in consumption under MUP policies by drinker group

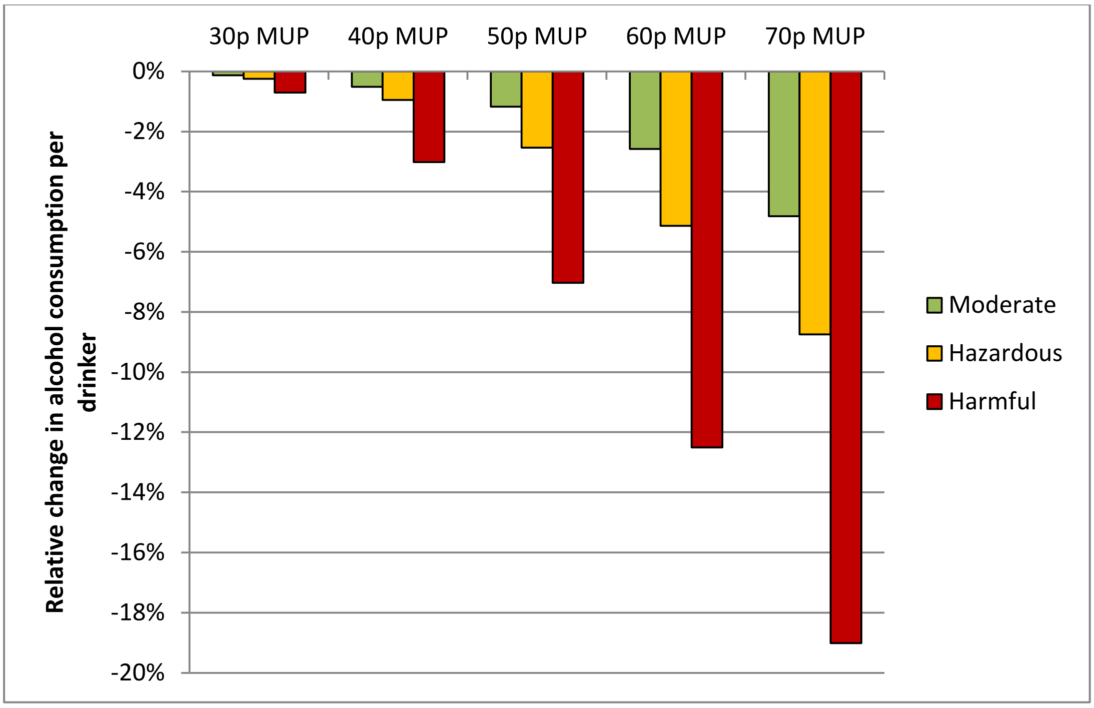

Figure 4.10: Relative changes in consumption under MUP policies by drinker group

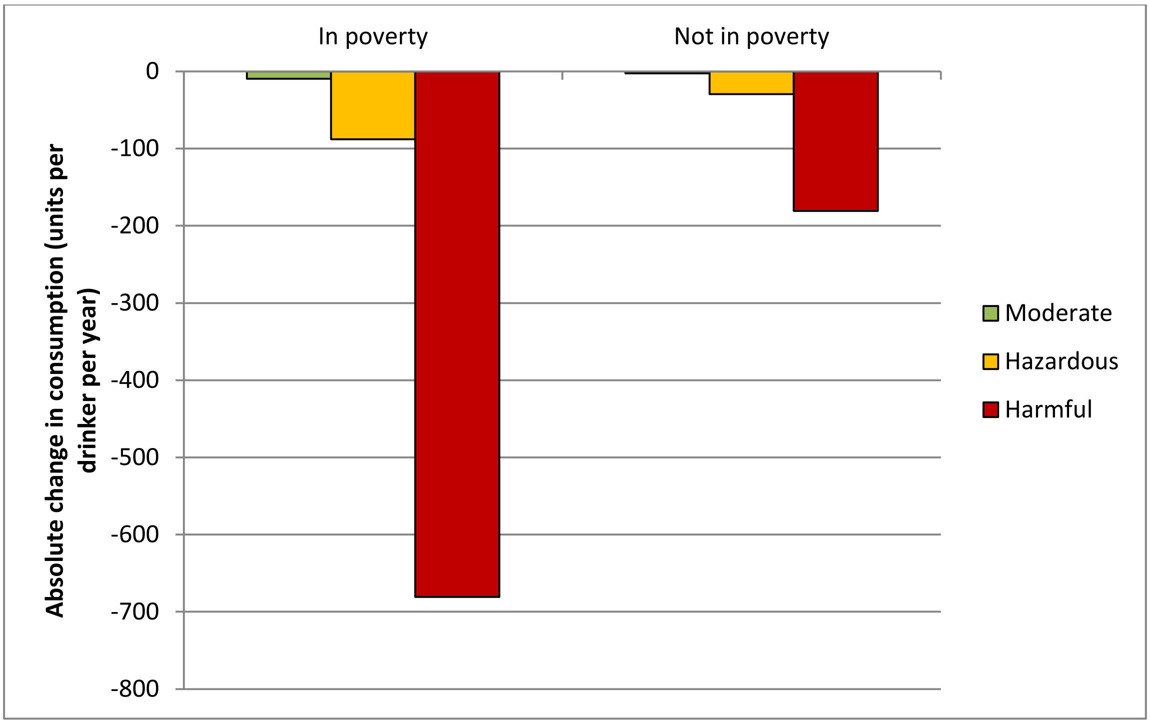

Figure 4.11: Absolute changes in consumption under a 50p MUP by drinker and poverty group

4.2.2 Estimated impact of MUP on consumer spending

Table 4.8 and Table 4.9 show the estimated impact of all modelled MUP policies on spending by drinker group (Table 4.8) and drinker and poverty group (Table 4.9). Figure 4.12 illustrates results for absolute spending changes by drinker group, while Figure 4.13 shows the full breakdown by income and poverty group for a 50p MUP. A similar graph showing the impact of all modelled MUP policies can be found in the Appendix, Figure 7.7.

Overall the pattern of impact is more mixed than that on consumption, with 30p and 40p MUPs estimated to reduce spending across all drinker groups, while MUPs of 50p and above increase it. The impact of a 50p MUP on the spending of harmful drinkers overall is small (a £6 increase per year), however Figure 4.13 shows that the impacts are very different for harmful drinkers in poverty (who are estimated to spend £88 a year less on alcohol) compared to those not in poverty (who are estimated to spend £20 more per year). Similar patterns can be seen for higher levels of MUP.

Table 4.8: Estimated impact of MUP policies on consumer spending by drinker group

		Population	Moderate	Hazardous	Harmful
Drinker population		3,740,472	2,659,329	841,805	239,337
Baseline spending per drinker per year		£675	£359	£1,194	£2,360
Absolute change per drinker per year	**30p MUP**	-£1	£0	-£2	-£4
	40p MUP	-£2	-£1	-£2	-£17
	50p MUP	£5	£2	£15	£6
	60p MUP	£20	£8	£50	£55
	70p MUP	£35	£15	£85	£81
Relative change per drinker per year	**30p MUP**	-0.1%	-0.1%	-0.2%	-0.2%
	40p MUP	-0.3%	-0.2%	-0.1%	-0.7%
	50p MUP	0.7%	0.5%	1.2%	0.2%
	60p MUP	3.0%	2.2%	4.2%	2.3%
	70p MUP	5.2%	4.1%	7.2%	3.4%

Table 4.9: Estimated impact of MUP policies on consumer spending by drinker group and poverty group

		Moderate		Hazardous		Harmful	
		In poverty	Not in poverty	In poverty	Not in poverty	In poverty	Not in poverty
Drinker population		345,308	2,314,021	83,404	758,402	31,248	208,089
Baseline spending per drinker per year		£230	£378	£1,102	£1,204	£2,484	£2,341
Absolute change per drinker per year	**30p MUP**	-£1	£0	-£4	-£2	-£29	£0
	40p MUP	-£2	£0	-£7	-£1	-£83	-£7
	50p MUP	£0	£2	£1	£16	-£88	£20
	60p MUP	£1	£9	£21	£54	-£121	£81
	70p MUP	£2	£17	£30	£92	-£254	£131
Relative change per drinker per year	**30p MUP**	-0.4%	-0.1%	-0.3%	-0.2%	-1.2%	0.0%
	40p MUP	-0.7%	-0.1%	-0.7%	-0.1%	-3.3%	-0.3%
	50p MUP	-0.2%	0.6%	0.1%	1.4%	-3.5%	0.8%
	60p MUP	0.5%	2.3%	1.9%	4.4%	-4.9%	3.5%
	70p MUP	0.7%	4.4%	2.7%	7.6%	-10.2%	5.6%

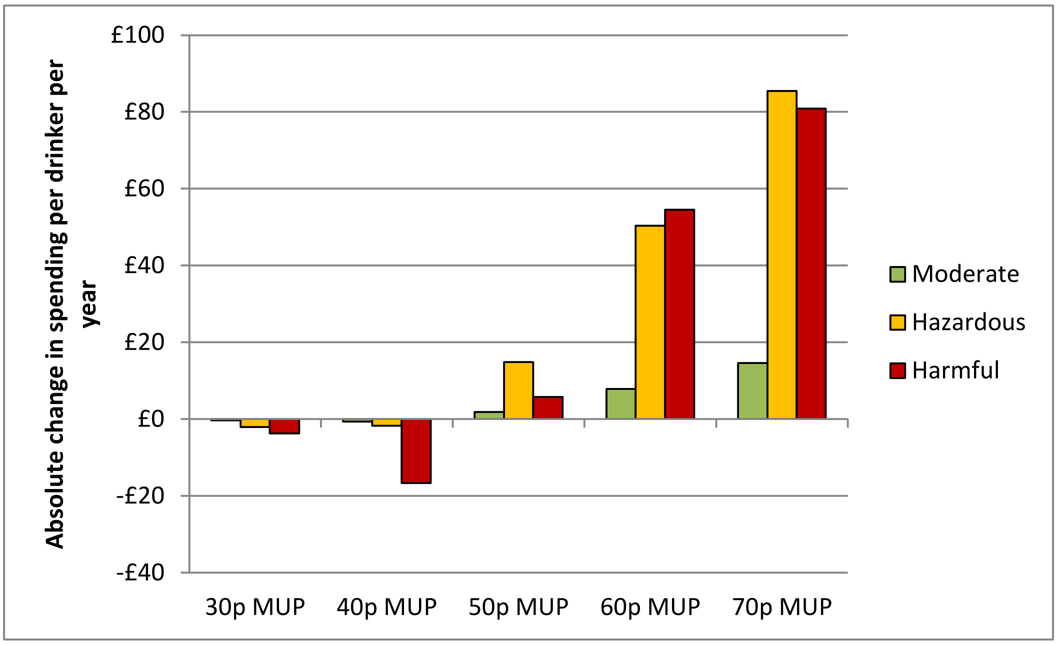

Figure 4.12: Absolute changes in consumer spending under MUP policies by drinker group

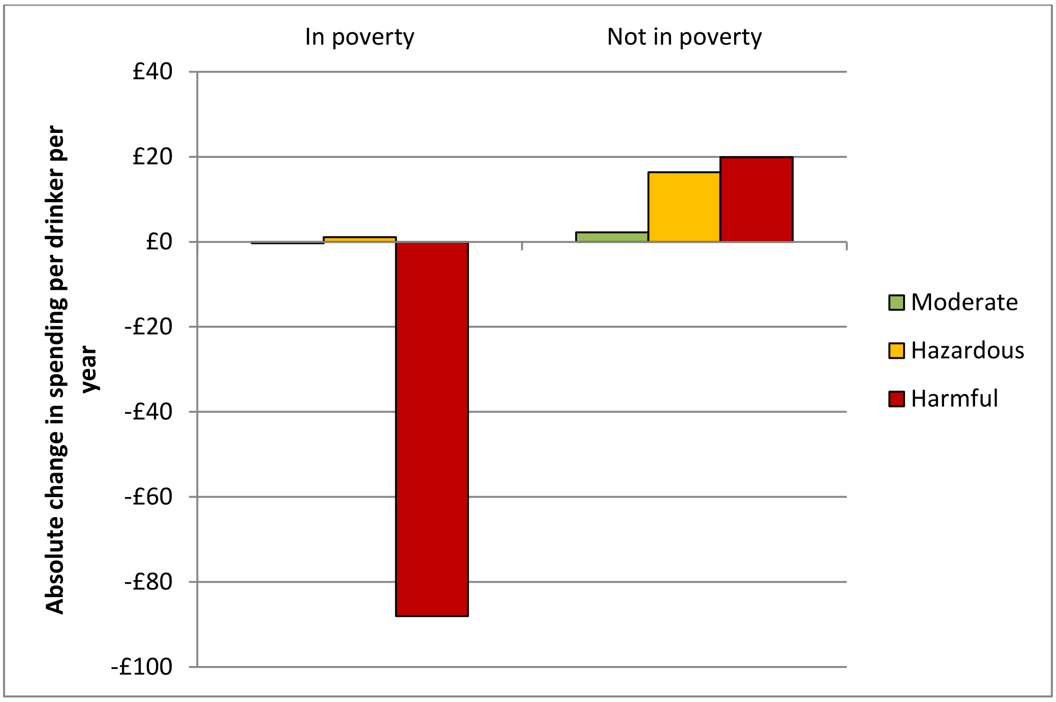

Figure 4.13: Absolute changes in consumer spending under a 50 MUP by drinker and poverty group

4.2.3 Estimated impact of MUP on exchequer and retailer revenue

The estimated impact of all modelled MUP policies on annual revenue to the exchequer from alcohol taxation and on annual revenue to retailers from alcohol sales, after accounting for tax, separated into the on- and off-trades is presented in Table 4.10. Exchequer impact is shown visually in Figure 4.14, with retailer revenue shown similarly in Figure 4.15.

These results show a clear pattern across all modelled MUP thresholds. At all levels revenue to the exchequer is expected to decrease (e.g. a £15m reduction per year for a 50p MUP), with larger decreases for higher MUPs. The impact on revenue from the on-trade is similar across all MUP thresholds, with the increases coming entirely from off-trade taxation. For all modelled MUP policies above 30p, revenue to retailers is expected to increase overall. Revenue in the on-trade is estimated to decrease slightly (e.g. £7m per year, a 0.7% reduction, for a 50p MUP) while off-trade revenue increases substantially (e.g. £41m per year, a 9.6% increase for a 50p MUP). This is because, although prices in the on-trade are unaffected, the cross-price elasticities in Table 3.2 mean that changes in off-trade prices lead to a slight reduction in total sales volumes. In the off-trade, total sales volumes decrease as consumers purchase less alcohol, however this is offset by the additional revenue gained due to the higher prices following the implementation of the MUP. As for exchequer revenue the impact on the on-trade is similar across all modelled MUP thresholds, while the gains for the on-trade increase significantly at higher MUPs.

Table 4.10: Estimated impact of MUP policies on exchequer revenue and retailer revenue

		Estimated change in duty & VAT revenue to Government			Estimated change in revenue to retailers (after accounting for duty & VAT)		
		Off-trade	**On-trade**	**Total**	**Off-trade**	**On-trade**	**Total**
Baseline receipts (£ million)		666	469	1,136	428	961	1,389
Absolute change in revenue per annum (£ million)	**30p MUP**	-1	-2	-2	2	-3	-1
	40p MUP	-5	-4	-9	8	-7	2
	50p MUP	-12	-4	-15	41	-7	34
	60p MUP	-18	-3	-22	105	-7	98
	70p MUP	-30	-5	-35	175	-10	165
Relative change in revenue per annum	**30p MUP**	-0.1%	-0.4%	-0.2%	0.6%	-0.4%	-0.1%
	40p MUP	-0.8%	-0.8%	-0.8%	2.0%	-0.7%	0.1%
	50p MUP	-1.8%	-0.7%	-1.3%	9.6%	-0.7%	2.5%
	60p MUP	-2.8%	-0.7%	-1.9%	24.6%	-0.7%	7.1%
	70p MUP	-4.5%	-1.1%	-3.1%	40.9%	-1.1%	11.9%

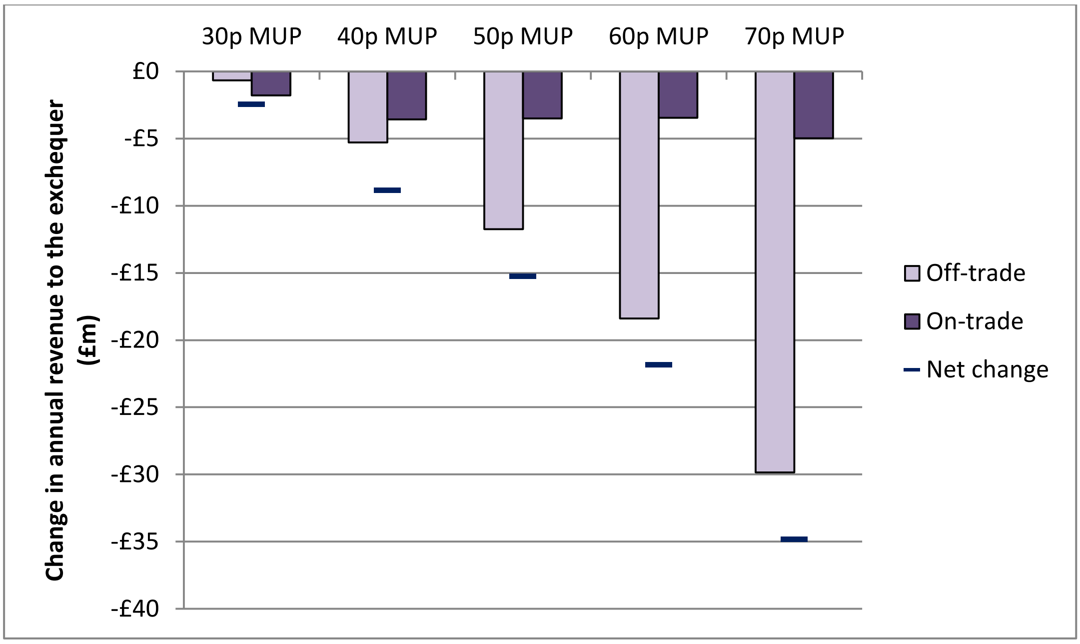

Figure 4.14: Changes in annual exchequer revenue under MUP policies

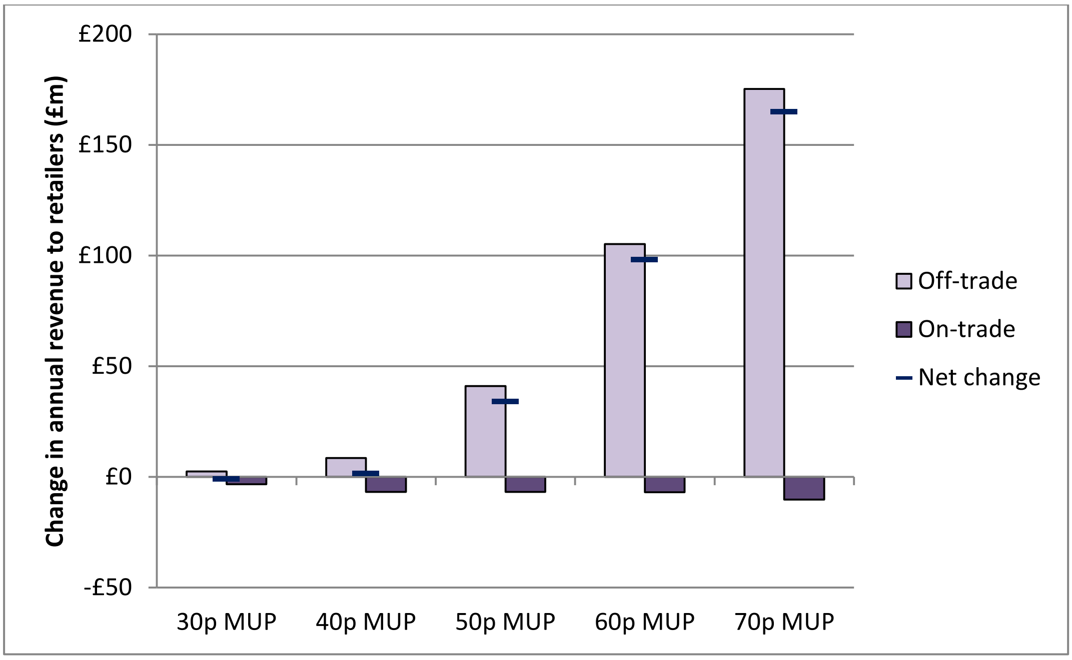

Figure 4.15: Changes in annual retailer revenue under MUP policies

4.2.4 Estimated impact of MUP on health outcomes

The estimated impacts of all modelled MUP policies on alcohol-related mortality and hospital admissions is shown in Table 4.11 and illustrated in Figure 4.16 and Figure 4.17. These results show increasing gains in terms of reduced alcohol-related mortality and hospital admissions as the MUP threshold increases. A 50p MUP is estimated to reduce alcohol-related deaths by 121 per year and alcohol-related hospital admissions by 2,042 at full effect. The majority of deaths averted are those from chronic conditions and the same is true for averted hospital admissions, although the overall proportion of gains which come from chronic conditions is smaller than for deaths.

Table 4.11: Estimated impacts of MUP policies on health outcomes at full effect

		Policy impact on deaths per year (full effect)			Policy impact on hospital admissions per year (full effect)		
		Acute	Chronic	Total	Acute	Chronic	Total
Baseline level of alcohol-attributable harm per year		743	883	1,626	25,631	4,236	29,867
Absolute change	**30p MUP**	-3	-10	-13	-85	-170	-255
	40p MUP	-11	-38	-49	-312	-607	-919
	50p MUP	-28	-93	-121	-779	-1,263	-2,042
	60p MUP	-56	-181	-236	-1,524	-2,288	-3,812
	70p MUP	-90	-303	-393	-2,512	-3,803	-6,315
Relative change	**30p MUP**	-0.4%	-1.1%	-0.8%	-0.3%	-4.0%	-0.9%
	40p MUP	-1.5%	-4.3%	-3.0%	-1.2%	-14.3%	-3.1%
	50p MUP	-3.8%	-10.5%	-7.4%	-3.0%	-29.8%	-6.8%
	60p MUP	-7.5%	-20.5%	-14.5%	-5.9%	-54.0%	-12.8%
	70p MUP	-12.1%	-34.3%	-24.2%	-9.8%	-89.8%	-21.1%

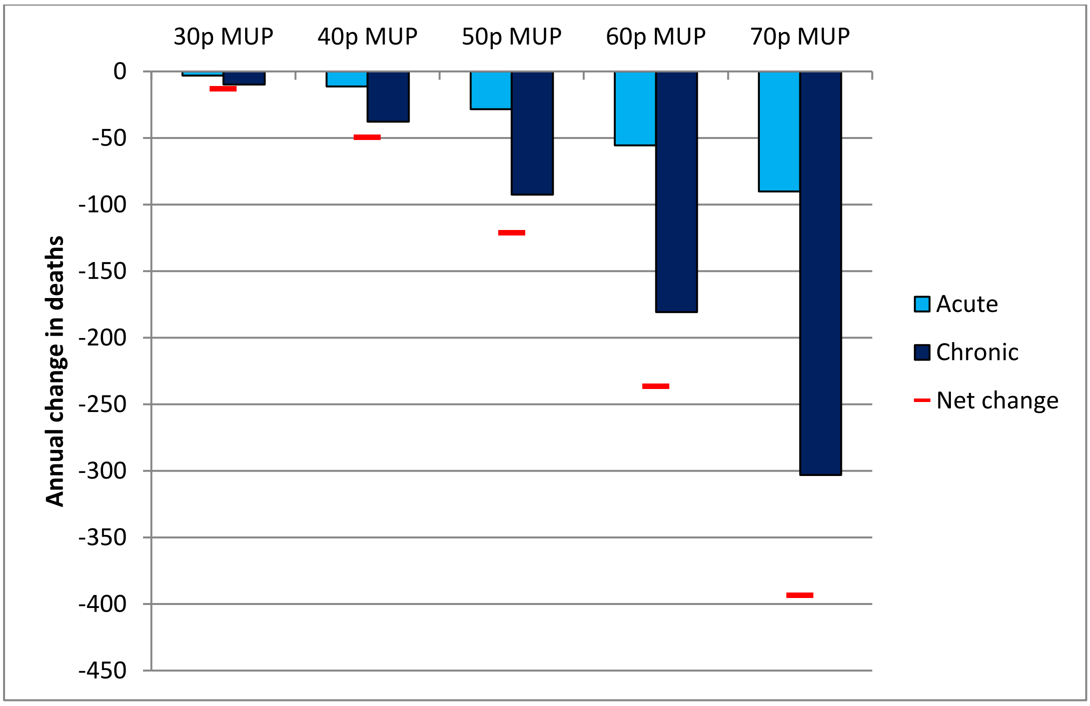

Figure 4.16: Changes in deaths under MUP policies by condition type

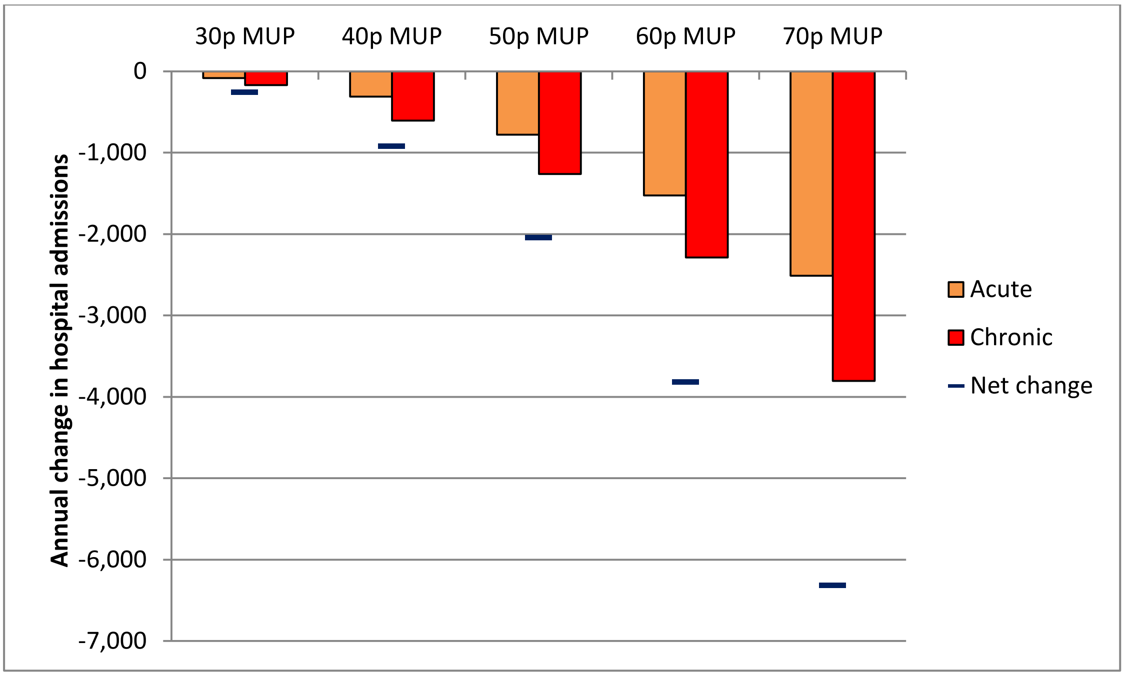

Figure 4.17: Changes in hospital admissions under MUP policies by condition type

Harm reductions are broken down further by drinker group in Table 4.12 and these are illustrated for mortality in Figure 4.18. These show that across all modelled MUP thresholds, reductions in alcohol-related harms are concentrated in the heaviest drinkers. Note that the relative changes in both deaths and admissions for moderate drinkers in Table 4.12 are positive as these represent a reduction from a negative baseline (as alcohol is estimated to have an overall protective effect in moderate drinkers at baseline – see Section 4.1.2).

Table 4.12: Estimated impacts of MUP policies on death and hospital admission rates by drinker group

		Policy impact on deaths per 100,000 drinkers per year (full effect)			Policy impact on hospital admissions per 100,000 drinkers per year (full effect)		
		Moderate	**Hazardous**	**Harmful**	**Moderate**	**Hazardous**	**Harmful**
Baseline level of alcohol-attributable harm per year		-7	95	424	-100	1,839	7,120
Absolute change	**30p MUP**	0	-1	-3	-1	-9	-66
	40p MUP	0	-2	-13	-2	-33	-243
	50p MUP	0	-5	-30	-5	-84	-497
	60p MUP	0	-11	-57	-12	-168	-865
	70p MUP	-1	-18	-93	-22	-285	-1,393
Relative change	**30p MUP**	0.3%	-0.6%	-0.8%	0.8%	-0.5%	-0.9%
	40p MUP	1.0%	-2.2%	-3.0%	2.4%	-1.8%	-3.4%
	50p MUP	2.1%	-5.7%	-7.0%	5.5%	-4.6%	-7.0%
	60p MUP	4.8%	-11.5%	-13.3%	12.3%	-9.1%	-12.2%
	70p MUP	8.3%	-19.4%	-22.0%	21.8%	-15.5%	-19.6%

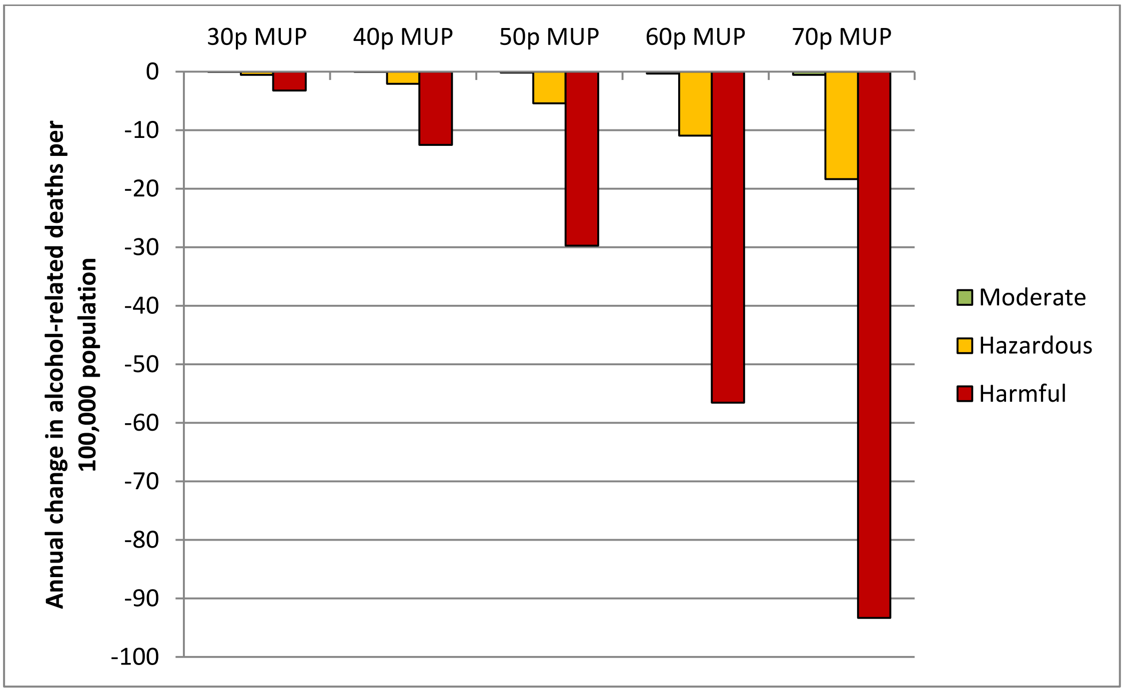

Figure 4.18: Changes in death rates under MUP policies by drinker group

Estimates of the impact of MUP policies on deaths and hospital admissions broken down by drinker and poverty group are given in Table 4.13 and Table 4.14, with results for deaths for a 50p MUP illustrated in Figure 4.19. These show that health gains are greatest in hazardous and particularly harmful drinkers in poverty, with an estimated 119 deaths per year averted per 100,000 harmful drinkers in poverty under a 50p MUP, compared to 16 deaths averted per 100,000 harmful drinkers not in poverty. Similar patterns are observed for hospital admissions. Graphs illustrating the impact on deaths and admissions of all modelled MUP policies can be found in the Appendix, Figure 7.8 and Figure 7.9.

Table 4.13: Estimated impacts of MUP policies on death rates by drinker and poverty group

		Moderate		**Hazardous**		**Harmful**	
		In poverty	**Not in poverty**	**In poverty**	**Not in poverty**	**In poverty**	**Not in poverty**
Baseline alcohol-attributable deaths per year per 100,000 drinkers		1	-8	206	83	781	371
Absolute change in deaths per 100,000 drinkers per year	**30p MUP**	0	0	-2	0	-19	-1
	40p MUP	0	0	-8	-1	-59	-6
	50p MUP	-1	0	-22	-4	-119	-16
	60p MUP	-1	0	-40	-8	-202	-35
	70p MUP	-2	0	-60	-14	-314	-60
Relative change in deaths per 100,000 drinkers per year	**30p MUP**	-19.0%	0.1%	-0.9%	-0.5%	-2.4%	-0.3%
	40p MUP	-41.3%	0.4%	-4.1%	-1.7%	-7.6%	-1.5%
	50p MUP	-83.0%	0.9%	-10.8%	-4.4%	-15.3%	-4.4%
	60p MUP	-161.8%	2.5%	-19.6%	-9.3%	-25.8%	-9.4%
	70p MUP	-211.2%	5.2%	-29.0%	-16.7%	-40.2%	-16.3%

Table 4.14: Estimated impacts of MUP policies on hospital admission rates by drinker and poverty group

		Moderate		Hazardous		Harmful	
		In poverty	Not in poverty	In poverty	Not in poverty	In poverty	Not in poverty
Baseline alcohol-attributable hospital admissions per year per 100,000 drinkers		103	-130	4,563	1,539	11,555	6,454
Absolute change in admissions per 100,000 drinkers per year	**30p MUP**	-4	0	-31	-7	-289	-33
	40p MUP	-11	-1	-138	-21	-822	-156
	50p MUP	-22	-3	-359	-54	-1,440	-356
	60p MUP	-44	-7	-653	-115	-2,292	-651
	70p MUP	-65	-15	-985	-208	-3,570	-1,066
Relative change in admissions per 100,000 drinkers per year	**30p MUP**	-4.3%	0.2%	-0.7%	-0.4%	-2.5%	-0.5%
	40p MUP	-10.3%	0.9%	-3.0%	-1.4%	-7.1%	-2.4%
	50p MUP	-21.9%	2.2%	-7.9%	-3.5%	-12.5%	-5.5%
	60p MUP	-43.1%	5.8%	-14.3%	-7.5%	-19.8%	-10.1%
	70p MUP	-62.9%	11.8%	-21.6%	-13.5%	-30.9%	-16.5%

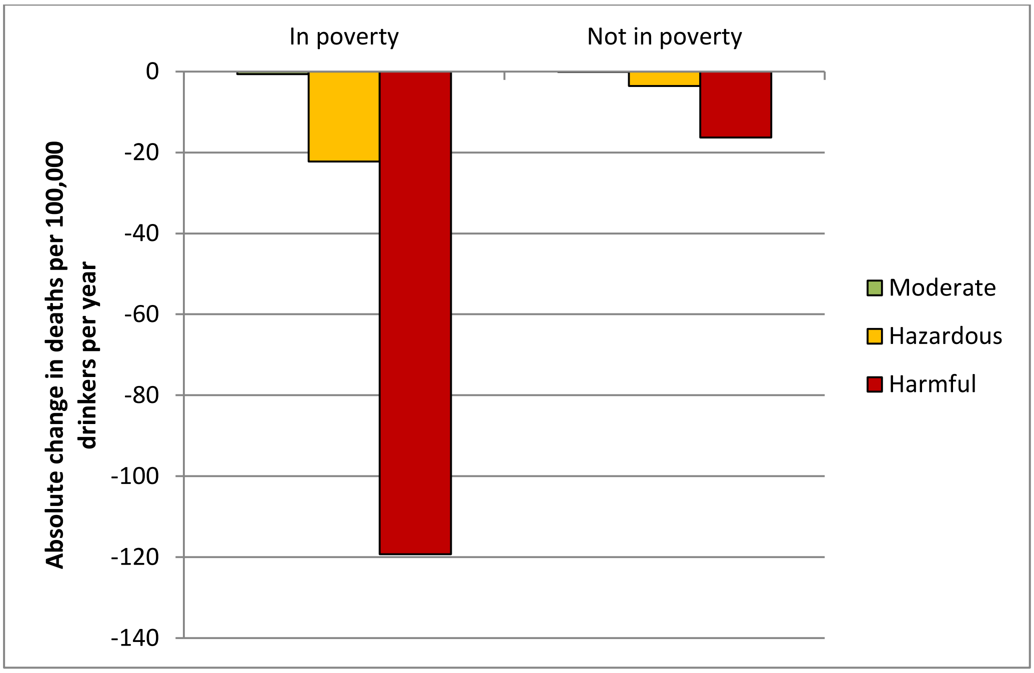

Figure 4.19: Changes in hospital admission rates under a 50p MUP by drinker and poverty group

As discussed in Section 3.4.3, the full effect of a MUP is not expected to be realised until 20 years following policy implementation. Table 4.15 shows the estimated 'partial effects' in terms of reductions in deaths and hospital admissions estimated in years 1, 5, 10, 15 and 20. Figure 4.20 shows the estimated change in deaths by condition type across the 20 years prior to full effect. These results show that, for a 50p MUP, 58 deaths are estimated to be avoided in the year immediately following policy implementation, 93 in the 5th year, 102 in the 10th and 115 in the 15th. Equivalently, 77% of the full impact of the policy on deaths and 93% of the full impact on hospital admissions is estimated to be achieved by the 5th year following implementation. Figure 4.20 highlights differences in the types of harms averted over time, with gains in acute conditions expected to accrue immediately, while those from chronic conditions take longer to develop due to the 'time lags' between reductions in consumption and reductions in corresponding risks of harm.

Table 4.15: Estimated 'partial effects' - impacts of MUP policies on deaths and hospital admissions in years 1, 5, 10, 15 and 20

	Change in deaths per year					Change in hospital admissions per year				
	Year 1	Year 5	Year 10	Year 15	Year 20	Year 1	Year 5	Year 10	Year 15	Year 20
30p MUP	-7	-11	-12	-13	-13	-158	-245	-263	-264	-255
40p MUP	-24	-39	-42	-47	-49	-564	-865	-934	-941	-919
50p MUP	-58	-93	-102	-115	-121	-1,299	-1,893	-2,033	-2,071	-2,042
60p MUP	-112	-180	-197	-223	-236	-2,463	-3,526	-3,769	-3,856	-3,812
70p MUP	-181	-293	-323	-369	-393	-4,012	-5,774	-6,195	-6,365	-6,315

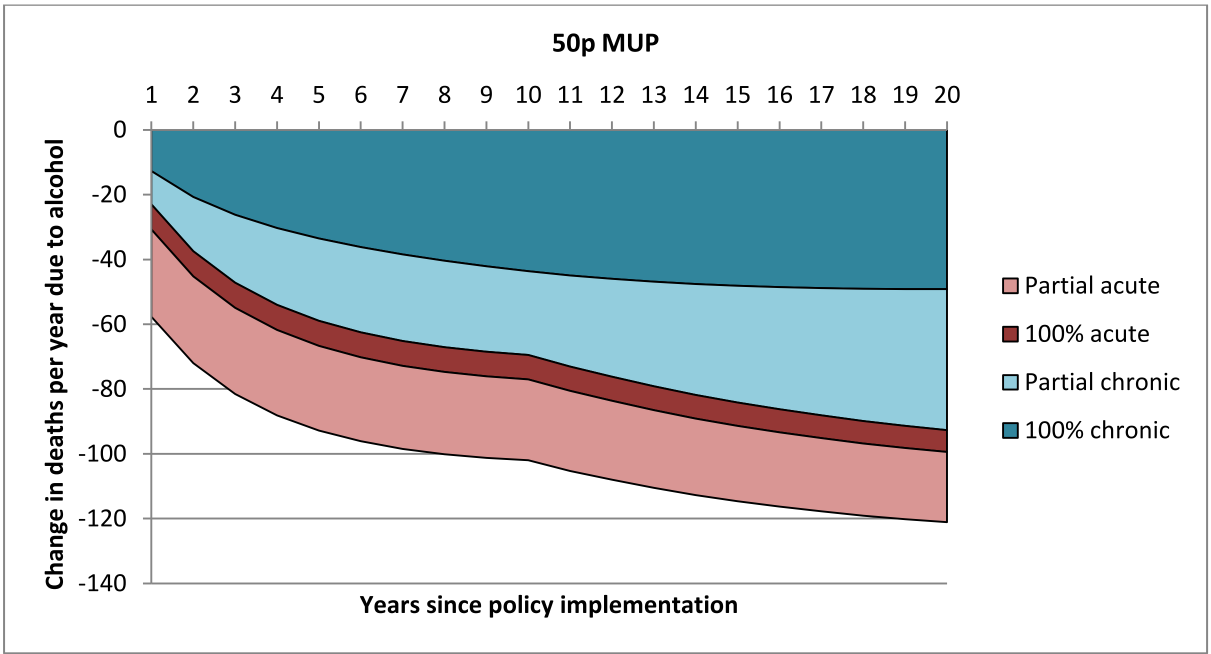

Figure 4.20: Impact of a 50p MUP on annual deaths over 20 years by condition type

Finally, Table 4.16 presents the cumulative impact across 5, 10, 15 and 20 years of all modelled MUP policies in terms of reductions in alcohol-related deaths and hospital admissions. These highlight the full extent of the estimated impact of MUP policies on health harms over time, with a 50p MUP estimated to avoid 392 alcohol-related deaths and 8,254 hospital admissions over the first 5 years following implementation and 2,036 deaths and 38,859 admissions over 20 years.

Table 4.16: Estimated cumulative changes in deaths and hospital admissions under MUP policies

	Cumulative change in alcohol-related deaths following policy implementation				**Cumulative change in alcohol-related hospital admissions following policy implementation**			
	5 years	**10 years**	**15 years**	**20 years**	**5 years**	**10 years**	**15 years**	**20 years**
30p MUP	-47	-104	-166	-231	-1,050	-2,344	-3,668	-4,961
40p MUP	-163	-370	-596	-839	-3,707	-8,293	-13,008	-17,654
50p MUP	-392	-890	-1,441	-2,036	-8,254	-18,245	-28,575	-38,859
60p MUP	-759	-1,722	-2,792	-3,951	-15,459	-34,014	-53,211	-72,391
70p MUP	-1,234	-2,810	-4,573	-6,497	-25,253	-55,716	-87,348	-119,077

4.3 EVALUATION OF TAXATION POLICIES EQUIVALENT TO A 50P MUP

4.3.1 Equivalisation of taxation increases

The results presented in Section 4.2 show the estimated impact of a range of MUP thresholds. In this section we focus on a 50p MUP and illustrate the increase in alcohol taxation which would be required to achieve the same impact across 5 separate measures:

1. The total number of alcohol-related deaths averted in the population at full effect
2. The total number of alcohol-related deaths averted in hazardous and harmful drinkers at full effect
3. The total number of alcohol-related deaths averted in harmful drinkers at full effect
4. The total number of alcohol-related deaths averted in hazardous and harmful drinkers in poverty at full effect
5. The total number of alcohol-related deaths averted in harmful drinkers in poverty at full effect.

As discussed in Section 3.2.7.2, tax rises are modelled as a flat percentage increase in current tax rates. Table 4.17 presents the results of the equivalisation process, showing the estimated reduction in alcohol-related deaths at full effect in all drinker and poverty groups, with coloured cells representing the equivalised pairs. The respective increases in taxation to achieve the 5 aims listed above would be as follows:

1. 26.8% - henceforth 27%
2. 28.1% - henceforth 28%
3. 35.5% - henceforth 36%
4. 54.8% - henceforth 55%
5. 69.8% - henceforth 70%.

It should be noted that these increases are substantially larger than any changes in alcohol taxation which have taken place in recent history within the UK. Duty rises over the last two decades have rarely exceeded 5% and only once exceeded 10%, when cider duty was increased by over 13% in 2010 – an increase which was reversed a few months later.

Table 4.17: Equivalisation of mortality impacts of taxation increases with a 50p MUP

Drinker group	Income group	Baseline deaths per year	Change in annual deaths attributable to alcohol at full effect					
			50p MUP	**27% tax rise**	**28% tax rise**	**36% tax rise**	**55% tax rise**	**70% tax rise**
Consumption breakdown								
All drinkers	All incomes	**1,626**	-121	-121	-127	-162	-255	-330
Moderate	All incomes	**-188**	-4	-10	-10	-13	-20	-26
Hazardous	All incomes	**798**	-46	-59	-61	-78	-122	-157
Harmful	All incomes	**1,016**	-71	-53	-56	-71	-113	-146
Hazardous and harmful	All incomes	**1,814**	-117	-111	-117	-149	-235	-304
Income group breakdown								
All drinkers	In poverty	**419**	-58	-30	-31	-39	-61	-79
	Not in poverty	**1,207**	-63	-92	-96	-123	-194	-251
Moderate	In poverty	**3**	-2	-3	-3	-4	-6	-7
	Not in poverty	**-190**	-2	-7	-7	-9	-15	-19
Hazardous	In poverty	**172**	-19	-13	-14	-18	-27	-35
	Not in poverty	**626**	-27	-45	-48	-61	-95	-123
Harmful	In poverty	**244**	-37	-14	-14	-18	-29	-37
	Not in poverty	**772**	-34	-39	-41	-53	-84	-109
Hazardous and harmful	In poverty	**416**	-56	-27	-28	-36	-56	-72
	Not in poverty	**1,398**	-61	-85	-89	-114	-179	-232

4.3.2 Comparison of estimated impact of tax and MUP on consumption

Detailed relative and absolute estimates of the comparative impact of a 50p MUP and all 5 modelled taxation policies on alcohol consumption by drinker and poverty groups are given in Table 4.18. Absolute impacts on consumption by drinker group are illustrated in Figure 4.21 and further broken down by drinker and poverty group in Figure 4.22. These results show that a 50p MUP has a smaller impact on consumption of moderate and hazardous drinkers than any of the modelled taxation policies, but a greater impact on the consumption of harmful drinkers than all but the two largest tax increases. If we look further at harmful drinkers in poverty, the group who consume the most and suffer the highest rates of alcohol-related harm, then a 50p MUP is estimated to have a greater impact than any of the modelled taxation policies. Comparing a 50p MUP with a 28% tax rise we see that MUP has a greater impact on the consumption of hazardous drinkers in poverty (-88 vs. -60 units per year) but a lesser impact on hazardous drinkers not in poverty (-30 units vs. -43 per year). The difference is more striking in harmful drinkers in poverty for whom a 50p MUP is estimated to reduce consumption by 681 units per year compared to 253 units under a 28% tax rise. MUP is also expected to have a greater impact on harmful drinkers who are not in poverty, reducing their consumption by 181 units per year compared to 139 under a 28% tax rise.

Table 4.18: Estimated impacts of taxation and MUP policies on consumption by drinker and poverty group

Drinker group	Income group	Baseline consumption per drinker per year	Absolute change in annual units consumed per drinker						Relative change in annual units consumed per drinker					
			50p MUP	27% tax rise	28% tax rise	36% tax rise	55% tax rise	70% tax rise	50p MUP	27% tax rise	28% tax rise	36% tax rise	55% tax rise	70% tax rise
Consumption breakdown														
All drinkers	All incomes	**761**	-26	-25	-26	-33	-52	-67	-3.5%	-3.2%	-3.4%	-4.3%	-6.8%	-8.8%
Moderate	All incomes	**312**	-4	-8	-8	-10	-16	-21	-1.2%	-2.5%	-2.6%	-3.3%	-5.3%	-6.8%
Hazardous	All incomes	**1,402**	-36	-43	-45	-57	-91	-118	-2.5%	-3.1%	-3.2%	-4.1%	-6.5%	-8.4%
Harmful	All incomes	**3,498**	-246	-147	-154	-196	-308	-399	-7.0%	-4.2%	-4.4%	-5.6%	-8.8%	-11.4%
Income group breakdown														
All drinkers	In poverty	**748**	-70	-33	-35	-44	-69	-89	-9.3%	-4.4%	-4.6%	-5.9%	-9.2%	-11.8%
	Not in poverty	**763**	-20	-23	-25	-31	-49	-64	-2.7%	-3.1%	-3.2%	-4.1%	-6.5%	-8.4%
Moderate	In poverty	**238**	-10	-8	-9	-11	-17	-22	-4.1%	-3.5%	-3.7%	-4.7%	-7.3%	-9.4%
	Not in poverty	**323**	-3	-8	-8	-10	-16	-21	-0.8%	-2.4%	-2.5%	-3.2%	-5.0%	-6.6%
Hazardous	In poverty	**1,456**	-88	-57	-60	-76	-119	-153	-6.1%	-3.9%	-4.1%	-5.2%	-8.2%	-10.5%
	Not in poverty	**1,396**	-30	-41	-43	-55	-87	-114	-2.1%	-3.0%	-3.1%	-4.0%	-6.3%	-8.1%
Harmful	In poverty	**4,499**	-681	-241	-253	-321	-503	-648	-15.1%	-5.4%	-5.6%	-7.1%	-11.2%	-14.4%
	Not in poverty	**3,348**	-181	-132	-139	-177	-279	-362	-5.4%	-4.0%	-4.2%	-5.3%	-8.3%	-10.8%

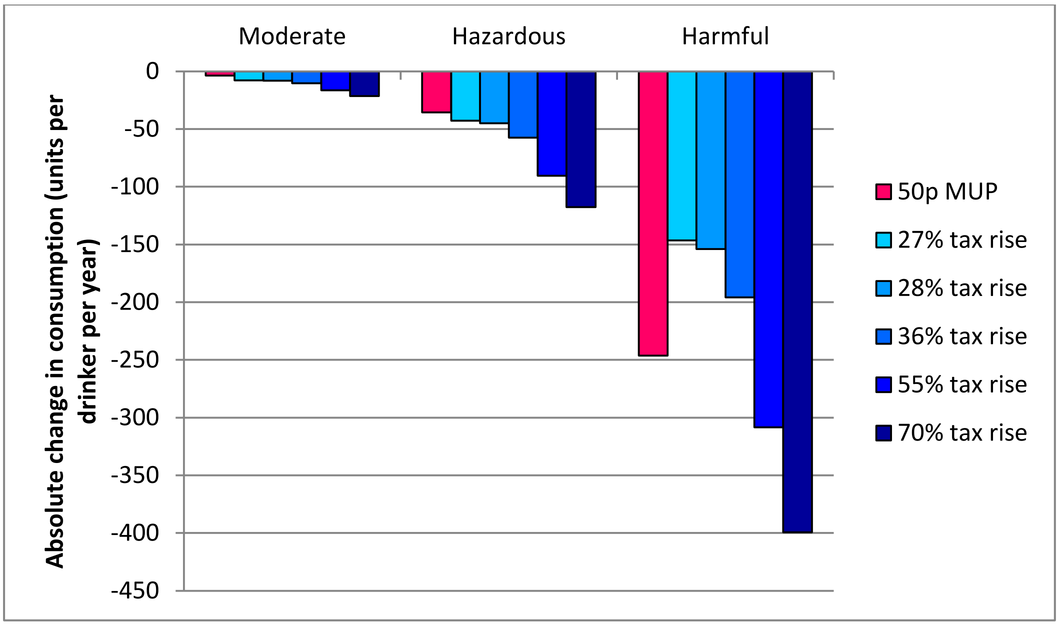

Figure 4.21: Absolute changes in consumption under taxation and MUP policies by drinker group

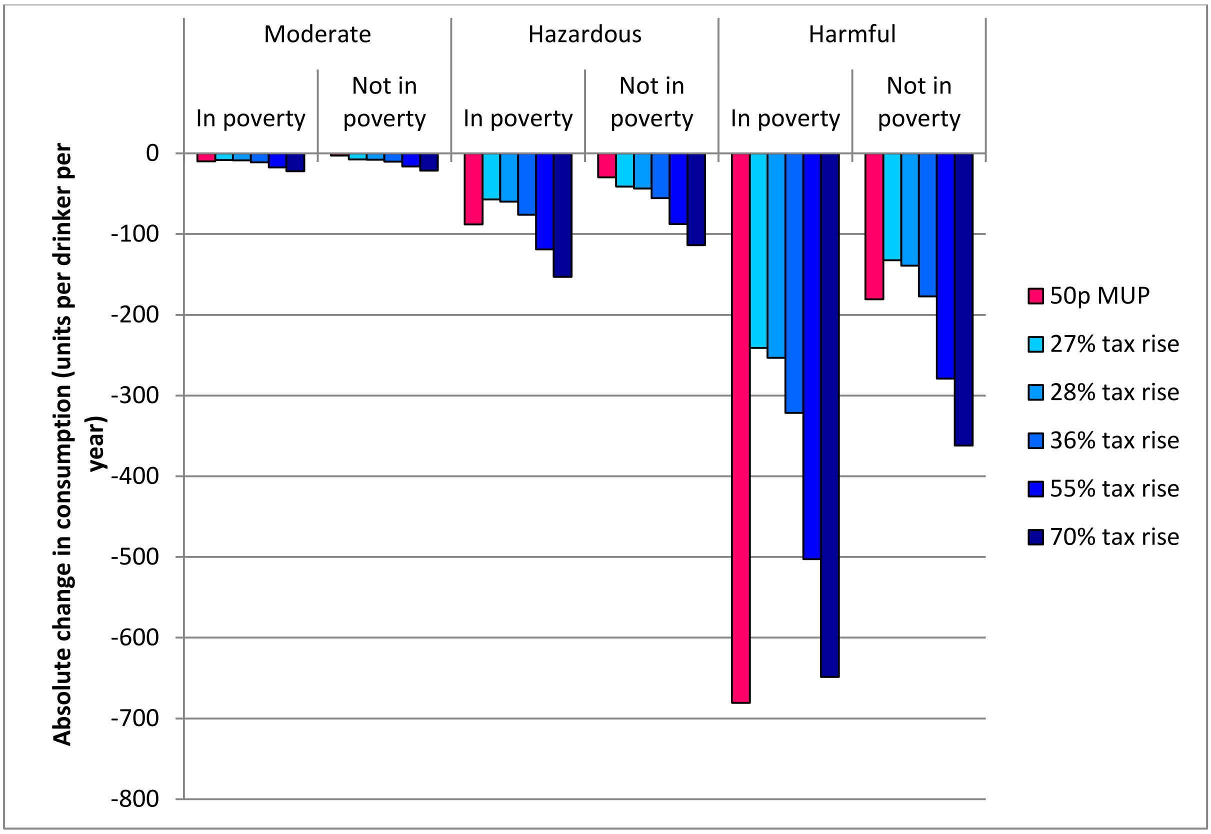

Figure 4.22: Absolute changes in consumption under taxation and MUP policies by drinker and poverty group

4.3.3 Comparison of estimated impact of tax and MUP on prices

Figure 4.23 illustrates the estimated comparative impact of a 50p MUP and modelled tax rises on alcohol prices. Note that these represent the new prices paid before changes in consumption occur as a result of the changes in price. This illustrates that while the 50p MUP has a substantial impact on prices at the cheaper end of the market (where heavier drinkers purchase more of their alcohol, as shown in Section 4.1.1), taxation increases affect the price of all products across the entire price spectrum. The figure also highlights that even under the highest modelled tax increases, very cheap (i.e. below 30p/unit) alcohol is still likely to be available, which is not the case under a 50p MUP.

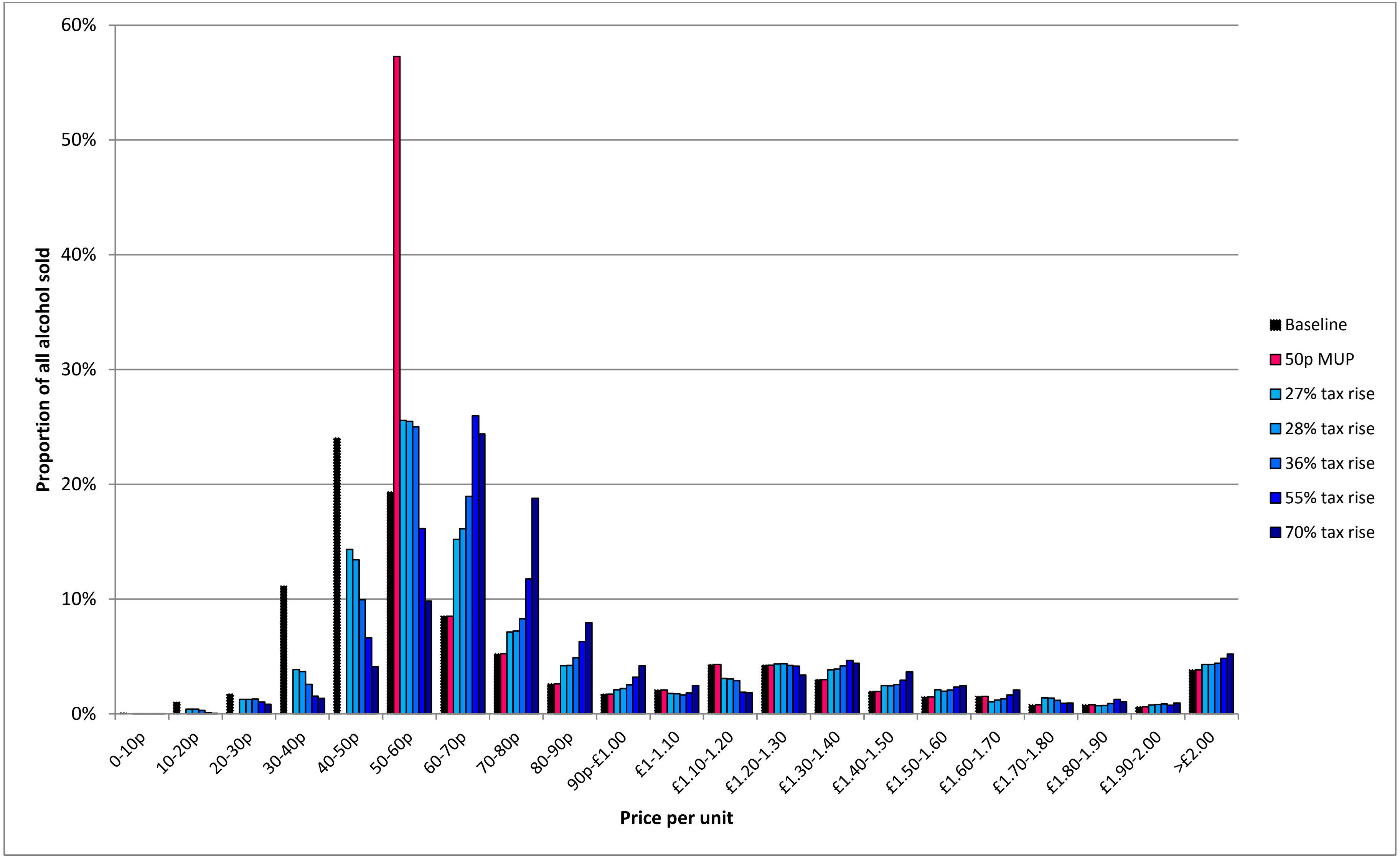

Figure 4.23: Estimated impacts of taxation and MUP policies on alcohol prices

4.3.4 Comparison of estimated impact of tax and MUP on spending

Table 4.19 presents detailed absolute and relative impacts of a 50p MUP and modelled tax increases broken down by drinker and poverty group. These results are illustrated by drinker group in Figure 4.24 and by drinker and poverty group in Figure 4.25. Unlike for a 50p MUP alone (see Section 4.2.2), the conclusions here are clear – all modelled taxation policies increase spending across all groups and these increases are considerably larger than under a 50p MUP (e.g. £17 per year under a 28% tax rise vs. £2 under a 50p MUP for moderate drinkers and £152 per year vs. £6 respectively for harmful drinkers). When we break results down by drinker and poverty group we see an even starker contrast for harmful drinkers in poverty, for whom a 50p MUP is estimated to lead to an £88 reduction in annual spending, compared to a £164 increase under a 28% tax rise. The differences arise from the fact (as seen in Figure 4.23) that taxation increases affect the price of all products and broadly maintain the relative price of different beverage types, while a 50p MUP affects only the price of cheap products, but to a greater extent, and thus changes the relative price of different beverage types.

Table 4.19: Estimated impacts of taxation and MUP policies on consumer spending by drinker and poverty group

Drinker group	Income group	Baseline spending per drinker per year	Absolute change in annual spending on alcohol per drinker						Relative change in annual spending on alcohol per drinker					
			50p MUP	27% tax rise	28% tax rise	36% tax rise	55% tax rise	70% tax rise	50p MUP	27% tax rise	28% tax rise	36% tax rise	55% tax rise	70% tax rise
Consumption breakdown														
All drinkers	All incomes	**£675**	£5	£37	£39	£48	£71	£87	0.7%	5.5%	5.8%	7.2%	10.5%	12.9%
Moderate	All incomes	**£359**	£2	£16	£17	£21	£31	£38	0.5%	4.4%	4.7%	5.8%	8.6%	10.6%
Hazardous	All incomes	**£1,194**	£15	£74	£77	£96	£142	£175	1.2%	6.2%	6.5%	8.1%	11.9%	14.6%
Harmful	All incomes	**£2,360**	£6	£145	£152	£187	£270	£326	0.2%	6.2%	6.4%	7.9%	11.4%	13.8%
Income group breakdown														
All drinkers	In poverty	**£541**	-£6	£30	£32	£39	£56	£68	-1.1%	5.6%	5.9%	7.2%	10.4%	12.6%
	Not in poverty	**£694**	£7	£38	£40	£50	£73	£90	1.0%	5.5%	5.8%	7.2%	10.6%	13.0%
Moderate	In poverty	**£230**	£0	£11	£11	£14	£20	£25	-0.2%	4.7%	4.9%	6.0%	8.9%	10.8%
	Not in poverty	**£378**	£2	£17	£18	£22	£32	£40	0.6%	4.4%	4.6%	5.8%	8.6%	10.6%
Hazardous	In poverty	**£1,102**	£1	£65	£68	£83	£121	£147	0.1%	5.9%	6.1%	7.6%	11.0%	13.3%
	Not in poverty	**£1,204**	£16	£75	£78	£98	£144	£178	1.4%	6.2%	6.5%	8.1%	12.0%	14.8%
Harmful	In poverty	**£2,484**	-£88	£157	£164	£201	£283	£334	-3.5%	6.3%	6.6%	8.1%	11.4%	13.5%
	Not in poverty	**£2,341**	£20	£143	£150	£185	£268	£324	0.8%	6.1%	6.4%	7.9%	11.5%	13.9%

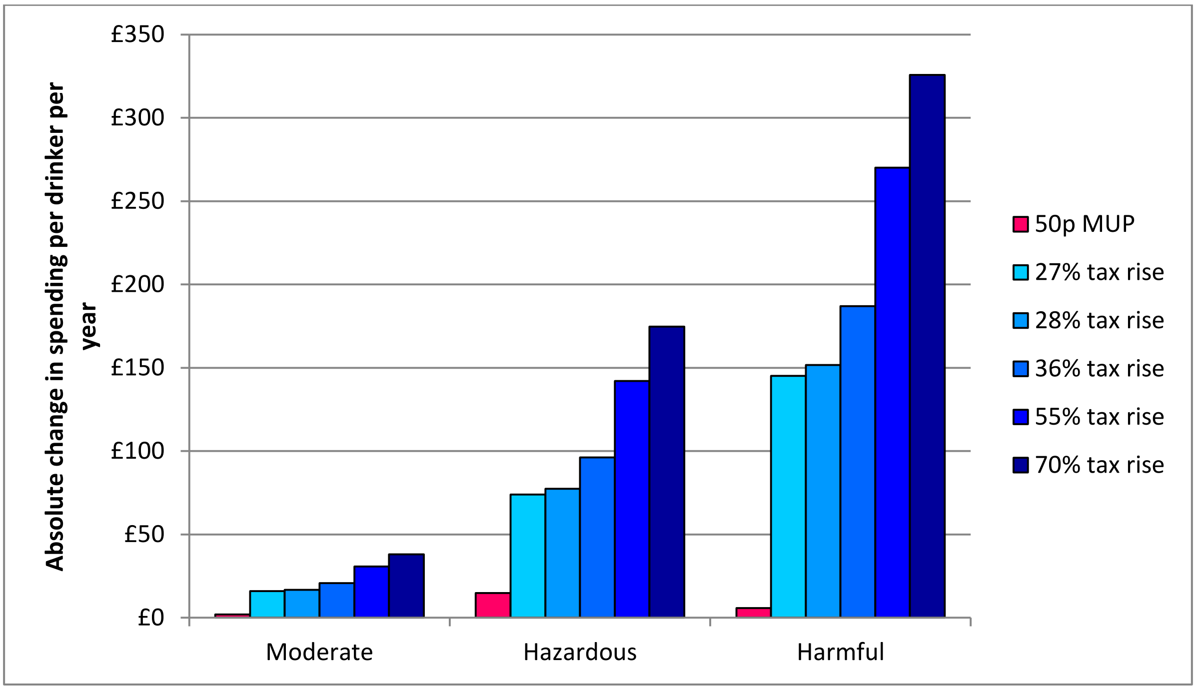

Figure 4.24: Absolute changes in spending under taxation and MUP policies by drinker group

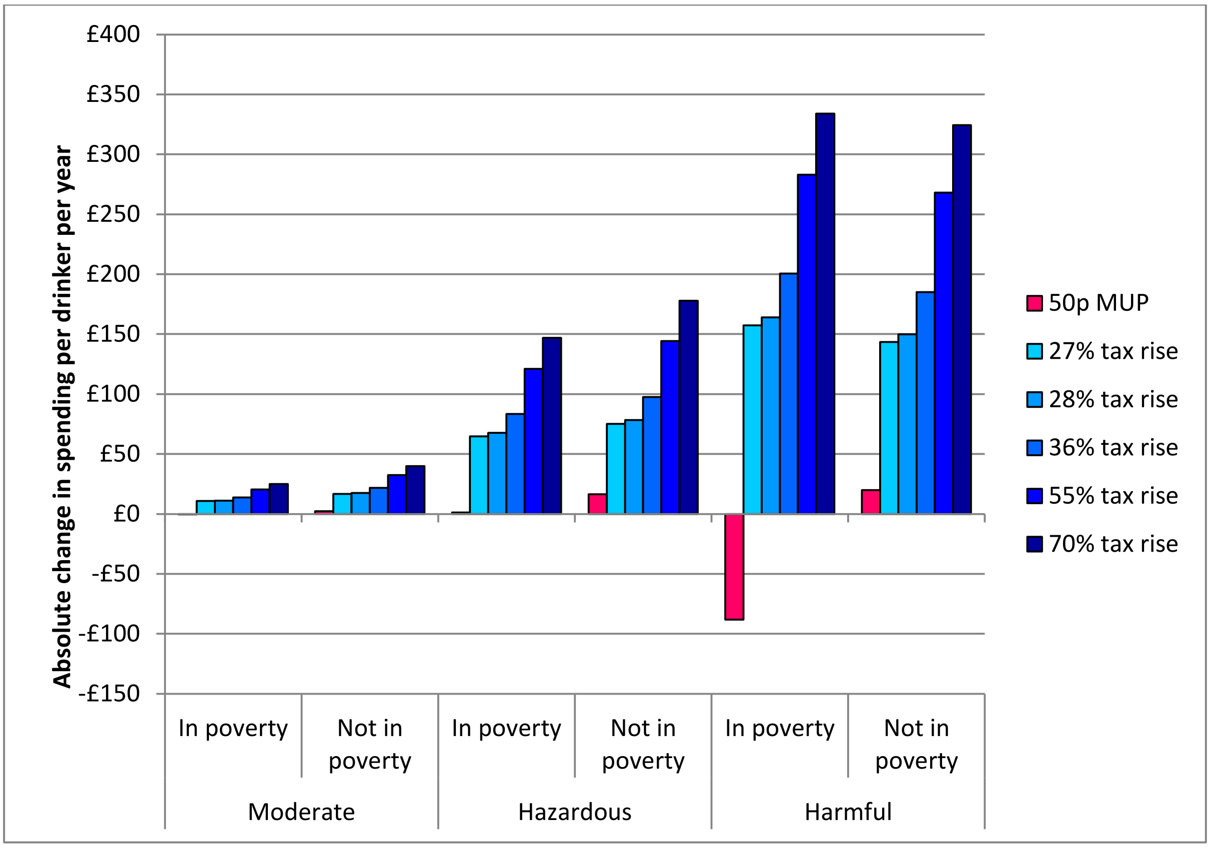

Figure 4.25: Absolute changes in spending under taxation and MUP policies by drinker and poverty group

4.3.5 Comparison of estimated impact of tax and MUP on exchequer and retailer revenue

Table 4.20 shows the comparative impact of a 50p MUP and modelled taxation increases on revenue to the exchequer and retailers, broken down by on-and off-trade revenue. As illustrated in Figure 4.26 for the exchequer and Figure 4.27 for retailers, the differences are striking. A 50p MUP is estimated to lead to a modest reduction in revenue from alcohol taxation to the exchequer of £15m (a 1.3% cut), compared to an increase of £209m (an 18% increase) from a 28% tax rise. In contrast a 50p MUP is estimated to increase retailer revenue by £34m per annum (+2.5%) while a 28% tax rise would reduce it by £63m.

The distribution of impacts on retailer revenue are also significant, with MUP estimated to reduce on-trade revenues slightly (-0.7%) while increasing off-trade revenues (+9.6%). In contrast a tax increase affects both on- and off-trades similarly in absolute terms (-£30m and -£31m for a 28% tax rise), with a larger absolute impact in the off-trade (-7.7% vs. -3.2% for a 28% tax rise). These differences are due to the fundamental differences in the way that the two policies operate. Under a MUP the majority of the increase in price paid for products previously sold below 50p per unit goes to the retailer, and the price of products sold above 50p per unit is unaffected, while a tax rise affects the price of all products and all additional revenue goes to the exchequer.

Table 4.20: Estimated impacts of taxation and MUP policies on exchequer and retailer revenue

		Estimated change in duty & VAT revenue to Government			Estimated change in revenue to retailers (after accounting for duty & VAT)		
		Off-trade	**On-trade**	**Total**	**Off-trade**	**On-trade**	**Total**
Baseline receipts per annum (£ million)		666	469	1,136	428	961	1,389
Absolute change in revenue per annum (£ million)	**50p MUP**	-12	-4	-15	41	-7	34
	27% tax rise	141	16	199	-31	-29	-60
	28% tax rise	148	16	209	-33	-30	-63
	36% tax rise	184	21	261	-41	-38	-79
	55% tax rise	270	31	385	-61	-58	-119
	70% tax rise	335	38	479	-79	-74	-153
Relative change in revenue per annum	**50p MUP**	-1.8%	-0.7%	-1.3%	9.6%	-0.7%	2.5%
	27% tax rise	21.1%	3.3%	17.6%	-7.3%	-3.0%	-4.3%
	28% tax rise	22.2%	3.5%	18.4%	-7.7%	-3.2%	-4.6%
	36% tax rise	27.6%	4.4%	22.9%	-9.6%	-4.0%	-5.7%
	55% tax rise	40.6%	6.5%	33.9%	-14.2%	-6.0%	-8.6%
	70% tax rise	50.3%	8.2%	42.2%	-18.3%	-7.7%	-11.0%

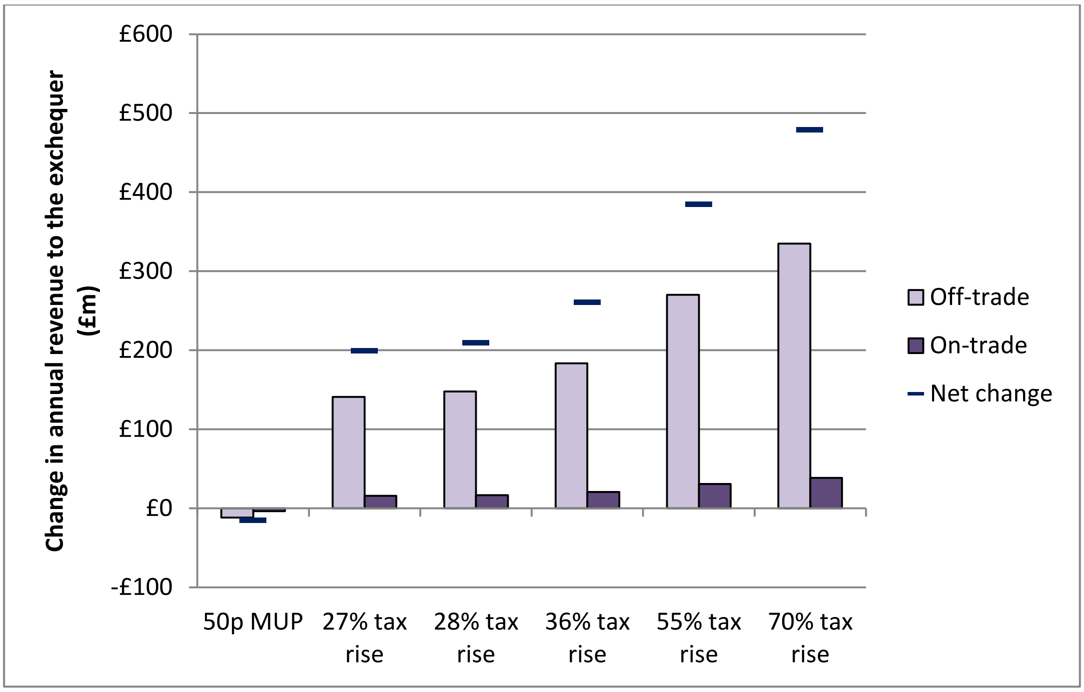

Figure 4.26: Changes in exchequer revenue under taxation and MUP policies

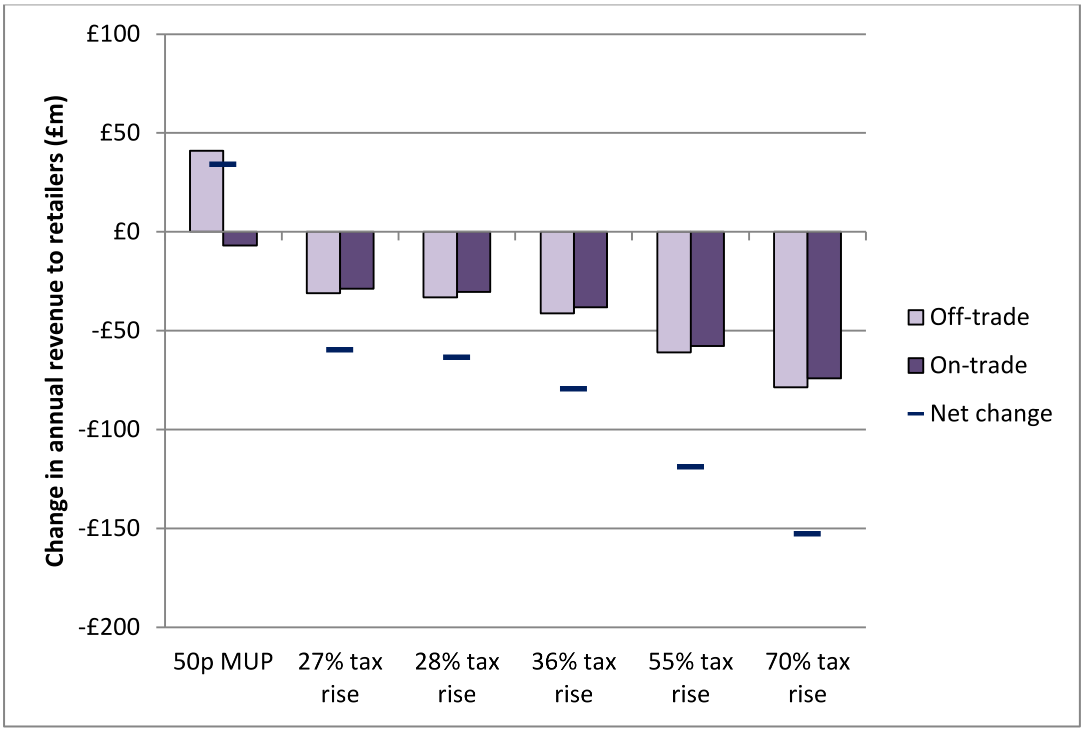

Figure 4.27 Changes in retailer revenue under taxation and MUP policies

4.3.6 Comparison of estimated impact of tax and MUP on health outcomes

Table 4.21 presents detailed estimates of the comparative impacts of a 50p MUP and modelled taxation increases on annual alcohol-related death rates by drinker and poverty group. Figure 4.28 illustrates the comparative impact by drinker group, while Figure 4.29 further breaks this down by drinker and poverty group. Overall we see similar patterns to the consumption results in Section 4.3.2, with MUP having a lesser impact on moderate and hazardous and a greater impact on harmful drinkers, particularly so on harmful drinkers in poverty. Results for hospital admissions are shown in Table 4.22 and show similar patterns, as can be seen in Figure 7.10 in the Appendix.

Table 4.21: Estimated impacts of taxation and MUP policies on mortality rates by drinker and poverty group

		Baseline annual deaths per 100,000 drinkers	**Change in annual deaths attributable to alcohol per 100,000 drinkers at full effect**					
Drinker group	**Income group**		**50p MUP**	**27% tax rise**	**28% tax rise**	**36% tax rise**	**55% tax rise**	**70% tax rise**
Consumption breakdown								
All drinkers	All incomes	**43**	-3	-3	-3	-4	-7	-9
Moderate	All incomes	**-7**	0	0	0	0	-1	-1
Hazardous	All incomes	**95**	-5	-7	-7	-9	-15	-19
Harmful	All incomes	**424**	-30	-22	-23	-30	-47	-61
Income group breakdown								
All drinkers	In poverty	**91**	-13	-6	-7	-9	-13	-17
	Not in poverty	**37**	-2	-3	-3	-4	-6	-8
Moderate	In poverty	**1**	-1	-1	-1	-1	-2	-2
	Not in poverty	**-8**	0	0	0	0	-1	-1
Hazardous	In poverty	**206**	-22	-16	-17	-21	-33	-42
	Not in poverty	**83**	-4	-6	-6	-8	-13	-16
Harmful	In poverty	**781**	-119	-44	-46	-58	-92	-119
	Not in poverty	**371**	-16	-19	-20	-25	-40	-52

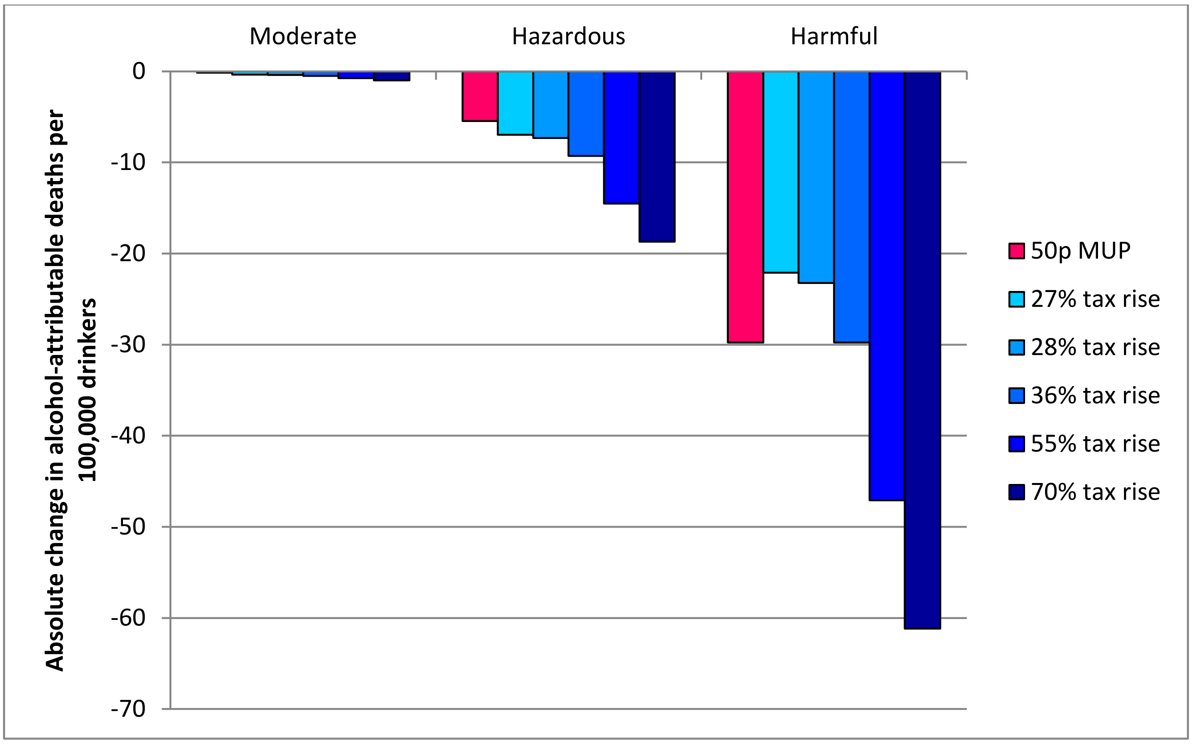

Figure 4.28: Changes in alcohol-related death rates under taxation and MUP policies by drinker group

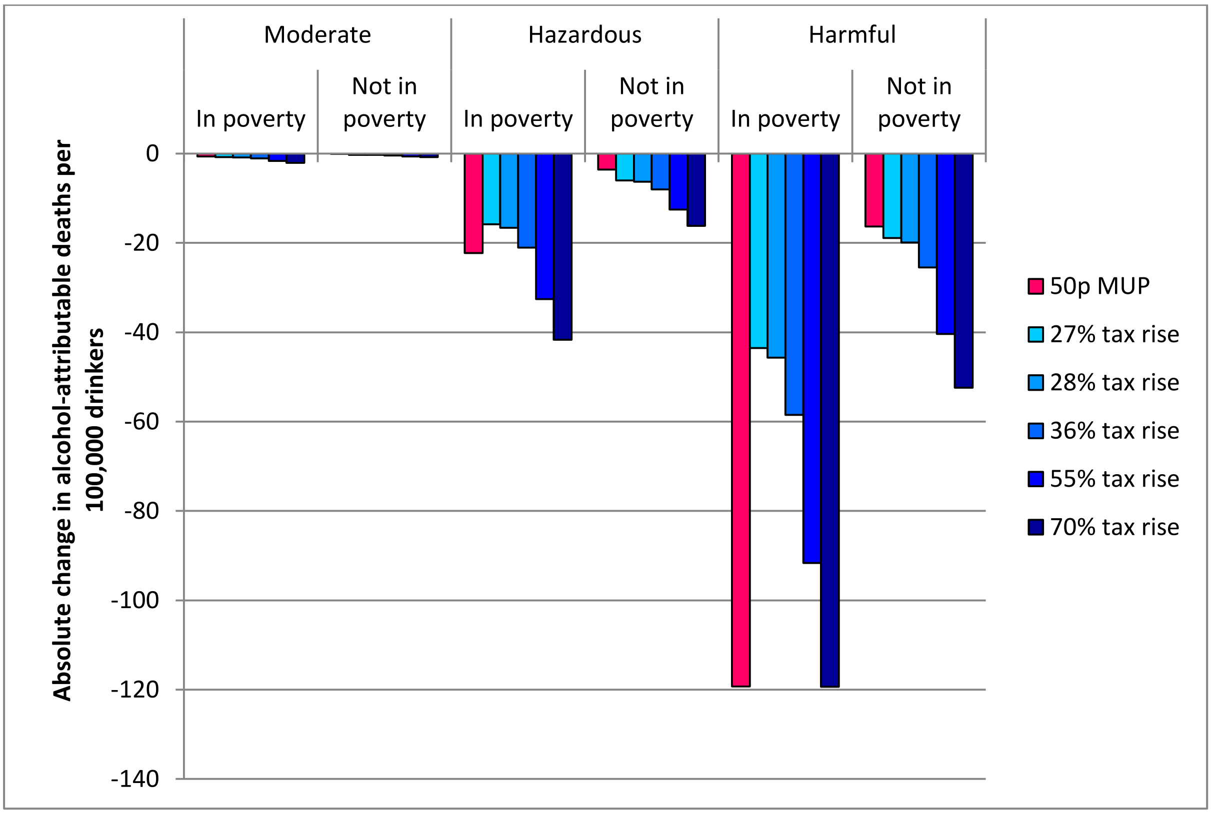

Figure 4.29: Changes in alcohol-related death rates under taxation and MUP policies by drinker and poverty group

Table 4.22: Estimated impacts of taxation and MUP policies on hospital admission rates by drinker and poverty group

Drinker group	Income group	Baseline annual admissions per 100,000 drinkers	Change in annual hospital admissions attributable to alcohol per 100,000 drinkers at full effect					
			50p MUP	27% tax rise	28% tax rise	36% tax rise	55% tax rise	70% tax rise
Consumption breakdown								
All drinkers	All incomes	**798**	-55	-62	-64	-81	-123	-158
Moderate	All incomes	**-100**	-5	-12	-12	-16	-25	-32
Hazardous	All incomes	**1,839**	-84	-103	-108	-138	-217	-281
Harmful	All incomes	**7,120**	-497	-469	-488	-605	-893	-1,123
Income group breakdown								
All drinkers	In poverty	**1,689**	-180	-108	-113	-144	-218	-278
	Not in poverty	**674**	-37	-55	-58	-72	-110	-141
Moderate	In poverty	**103**	-22	-25	-26	-33	-51	-65
	Not in poverty	**-130**	-3	-10	-10	-13	-21	-27
Hazardous	In poverty	**4,563**	-359	-252	-264	-335	-521	-669
	Not in poverty	**1,539**	-54	-87	-91	-116	-184	-238
Harmful	In poverty	**11,555**	-1,440	-641	-667	-861	-1,253	-1,578
	Not in poverty	**6,454**	-356	-443	-462	-567	-839	-1,055

Figure 4.30 illustrates the profile of impact of a 28% tax rise on alcohol-related mortality and shows that this is very similar to the profile for a 50p MUP. There are, however, some differences in the health conditions from which deaths are averted between the two policies, with a 50p MUP having a greater impact on deaths from alcoholic liver disease, while a 28% tax rise leads to greater reductions in cardiovascular mortality. These differences are shown in Figure 7.11 in the Appendix.

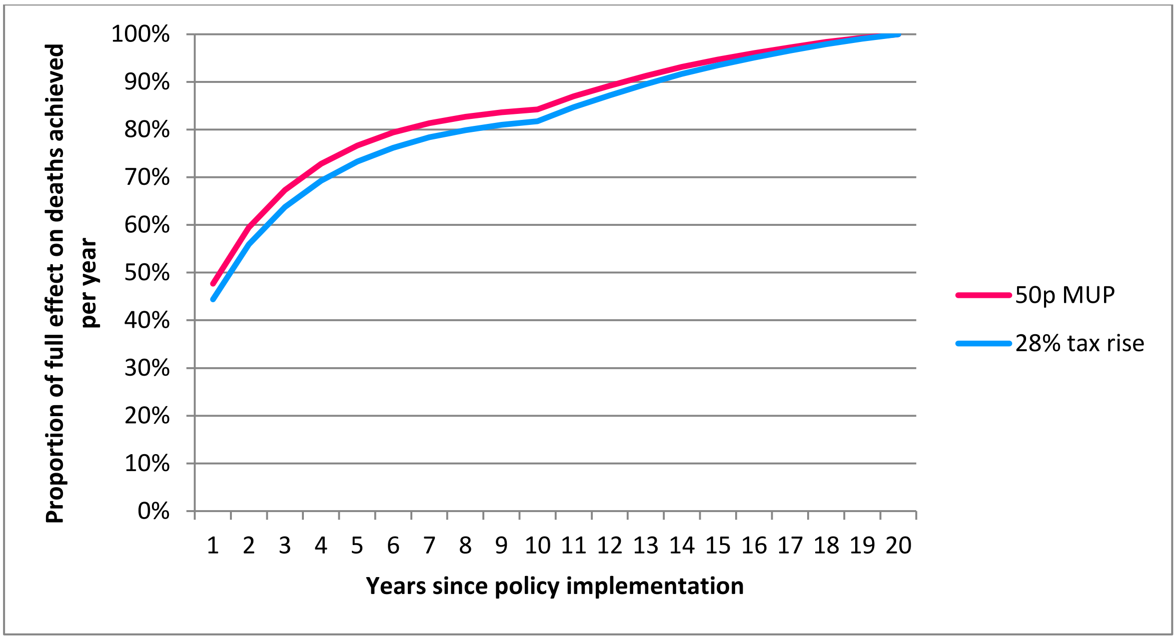

Figure 4.30: Comparison of impact over time of a 50p MUP and a 28% tax rise

4.3.7 Comparison of estimated impact of tax and MUP on health inequalities

As highlighted in Table 4.5, alcohol-related mortality rates amongst those in poverty are at least twice as high as for those not in poverty, across all levels of alcohol consumption. This inequality in health may be improved or exacerbated by policies which alter alcohol consumption. Table 4.23 shows the comparative impact of taxation and 50p MUP policies on these inequalities. Whilst all modelled policies reduce the rates of alcohol-related deaths in both drinkers in poverty and those not in poverty, this illustrates that a 50p MUP has the greatest impact in terms of reducing the 'gap' in alcohol-related mortality rates between those in poverty and those not in poverty. Figure 4.31 presents these results visually, showing that a 50p MUP has a greater impact in terms of reducing inequalities than even the largest modelled tax increase.

Table 4.23: Estimated impacts of taxation and MUP policies on alcohol-related health inequalities

		Drinkers in poverty	Drinkers not in poverty	Inequality 'gap'
Deaths per 100,000 drinkers per year	**Baseline**	91	37	54
	50p MUP	78	35	44
	27% tax rise	85	34	51
	28% tax rise	84	34	50
	36% tax rise	82	33	49
	55% tax rise	78	31	47
	70% tax rise	74	29	45

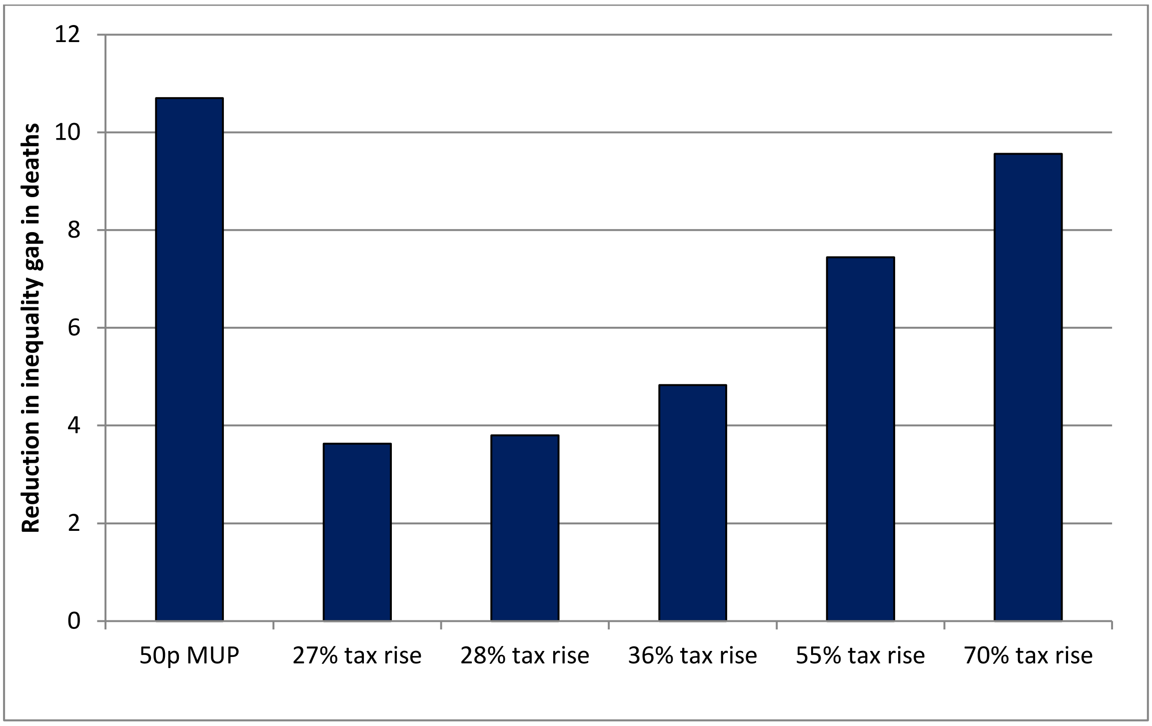

Figure 4.31: Reduction in the size of the 'Inequality gap' in alcohol-related deaths under taxation and MUP policies

4.4 SENSITIVITY ANALYSES

Table 4.24 shows the absolute and relative impact on the estimated effect of a 50p MUP on consumption, spending, alcohol-related deaths and alcohol-related hospital admissions. We can see here that SA1, the adjustment of the SHeS survey data to account for underreporting, affects the baseline levels of consumption and spending as well as the modelled impacts of the policy. We can also see that SA3, where protective effects are removed from the model, affects only the harm outcomes and not the consumption and spending results, as we would expect.

Overall, accounting for underreporting (SA1) and using HMRC elasticities (SA2), both lead to larger estimates of reductions in consumption, both absolutely and relatively. SA1 does not change the spending results substantially, but SA2 reverses the estimated direction of effect, with a 50p MUP now estimated to save drinkers £5.49 per year on average, although the magnitude of this effect is still small (<1%). As for consumption, SA1 and SA2 both increase the estimated absolute and relative reductions in alcohol-related mortality and hospital admissions compared to the base case. SA3, where protective effects are removed from the model, leads to larger estimates of baseline harm than the base case (as alcohol is no longer protecting those drinking at low levels from some health conditions), but marginally smaller absolute (and thus significantly smaller relative) reductions in harm.

Table 4.25 breaks these results down further by drinker group, to explore how the alternative assumptions alter the distribution of effects across the population. These findings are shown visually in Figure 4.32 for consumption (note that SA3 is excluded as the impact on consumption is unchanged from baseline in this scenario), Figure 4.33 for spending (again, SA3 is not shown), Figure 4.34 for mortality and Figure 4.35 for hospital admissions. These results show that the overall distribution of effects across drinker groups is similar under all sensitivity analyses with two main exceptions. The first is the impact of using alternative elasticities on spending (SA2), where spending in all groups is estimated to reduce, with greater reductions in heavier drinkers. The second is the impact of adjusting for underreporting (SA1) on harm reductions, with alcohol-related mortality in harmful drinkers estimated to reduce by twice as much in the base case (62 fewer deaths per year per 100,000 drinkers vs. 30) and a similar conclusion for hospital admissions (1,064 fewer per year per 100,000 drinkers vs. 497). The effect on moderate and hazardous drinkers is considerably smaller and thus under SA1 a 50p MUP is estimated to be substantially more targeted at harmful drinkers in terms of harm reductions (i.e. they make up a greater proportion of the total reduction in harm).

Table 4.24: Impact of alternative assumptions on modelled effects of 50p MUP

	Baseline scenario	SA1 (Adjustment for underreporting)	SA2 (HMRC elasticities)	SA3 (No protective effects)
Baseline consumption (units per drinker per year)	761	1,254	761	761
Absolute change in consumption (units per drinker per year)	-26	-57	-37	-26
Relative changes in consumption per drinker	-3.5%	-4.5%	-4.8%	-3.5%
Baseline spending (per drinker per year)	£675	£1,043	£675	£675
Absolute change in spending (per drinker per year)	£5.06	£5.59	-£5.49	£5.06
Relative change in spending	0.7%	0.5%	-0.8%	0.7%
Baseline alcohol-related deaths (per year)	1,626	2,634	1,626	2,549
Absolute change in alcohol-related deaths (per year)	-121	-215	-196	-117
Relative change in alcohol-related deaths	-7.4%	-8.2%	-12.1%	-4.6%
Baseline alcohol-related hospital admissions (per year)	29,867	47,538	29,867	51,120
Absolute change in alcohol-related hospital admissions (per year)	-2,042	-3,720	-3,586	-1,958
Relative change in alcohol-related hospital admissions	-6.8%	-7.8%	-12.0%	-3.8%

Table 4.25: Impact of alternative assumptions on modelled effects of 50p MUP by drinker group

		Consumption (units per drinker per year)		Spending (per drinker per year)		Alcohol-related deaths per 100,000 drinkers per year		Alcohol-attributable hospital admissions (per 100,000 drinkers per year)	
		Baseline	**Absolute change**	**Baseline**	**Absolute change**	**Baseline**	**Absolute change**	**Baseline**	**Absolute change**
Moderate	**Baseline**	312	-4	359	2	-7	0	-100	-5
	Underreporting (SA1)	363	-5	422	1	-9	0	-161	-5
	HMRC Elasticities (SA2)	312	-8	359	-3	-7	0	-100	-13
	No protective effects (SA3)	312	-4	359	2	17	0	453	-7
Hazardous	**Baseline**	1,402	-36	1,194	15	95	-5	1,839	-84
	Underreporting (SA1)	1,500	-45	1,291	13	94	-7	1,838	-125
	HMRC Elasticities (SA2)	1,402	-65	1,194	-10	95	-11	1,839	-166
	No protective effects (SA3)	1,402	-36	1,194	15	127	-5	2,582	-85
Harmful	**Baseline**	3,498	-246	2,360	6	424	-30	7,120	-497
	Underreporting (SA1)	3,644	-247	2,556	6	866	-62	15,185	-1,064
	HMRC Elasticities (SA2)	3,498	-249	2,360	-19	424	-38	7,120	-773
	No protective effects (SA3)	3,498	-246	2,360	6	425	-28	7,241	-440

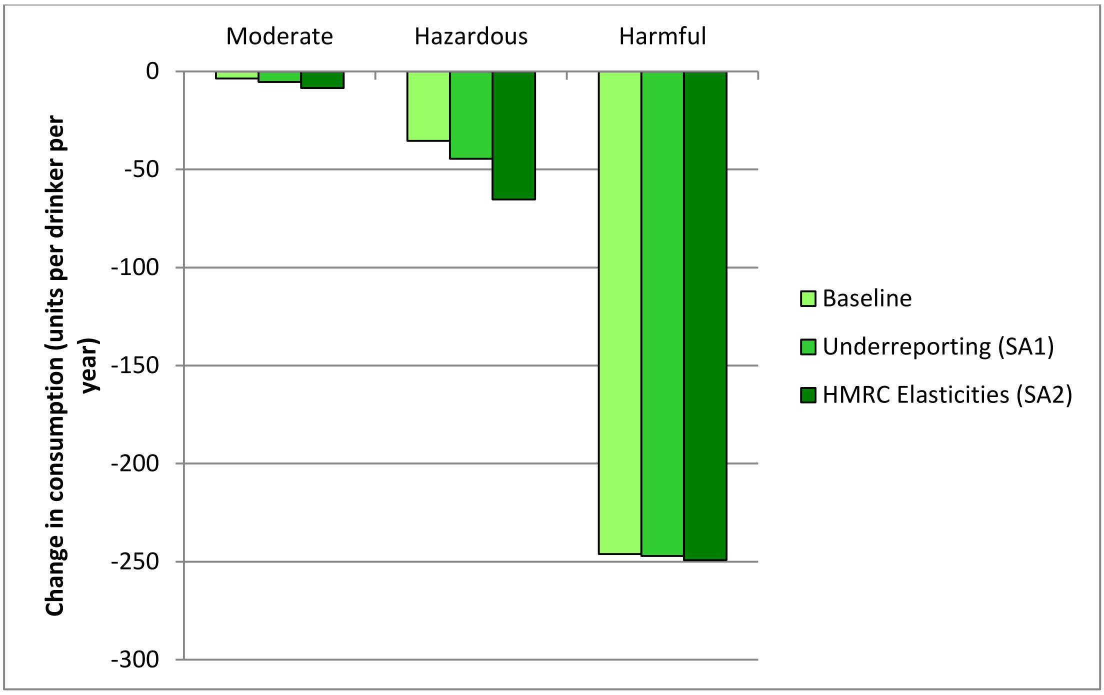

Figure 4.32: Sensitivity analysis effects on consumption impacts of 50p MUP by drinker group

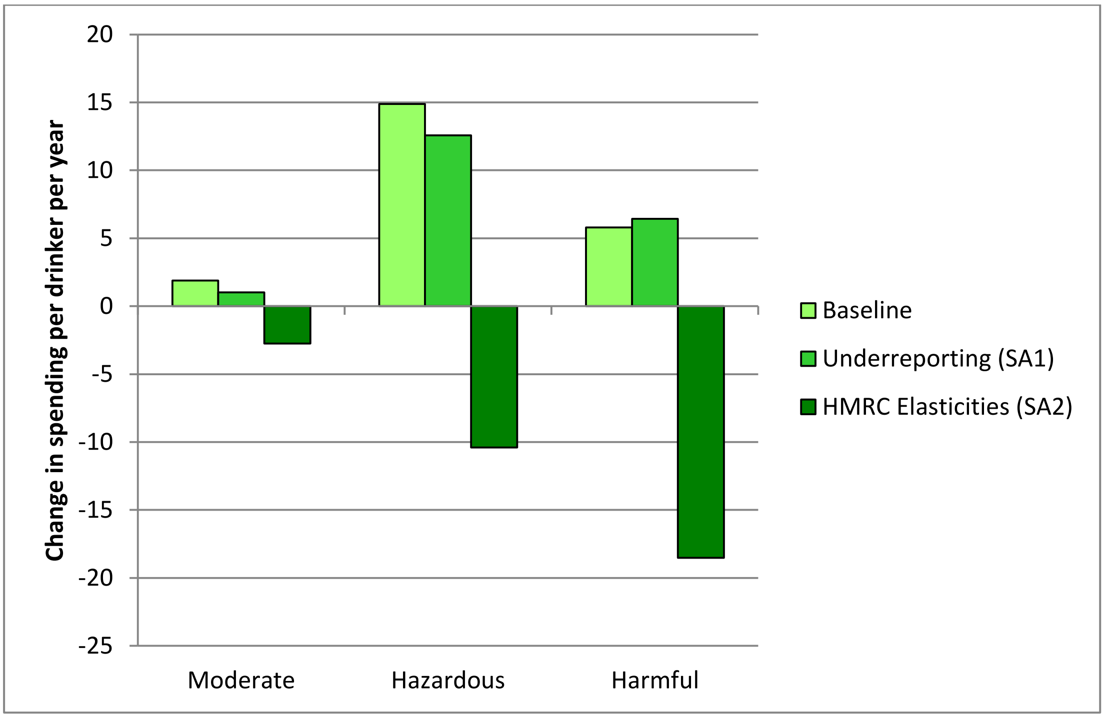

Figure 4.33: Sensitivity analysis effects on spending impacts of 50p MUP by drinker group

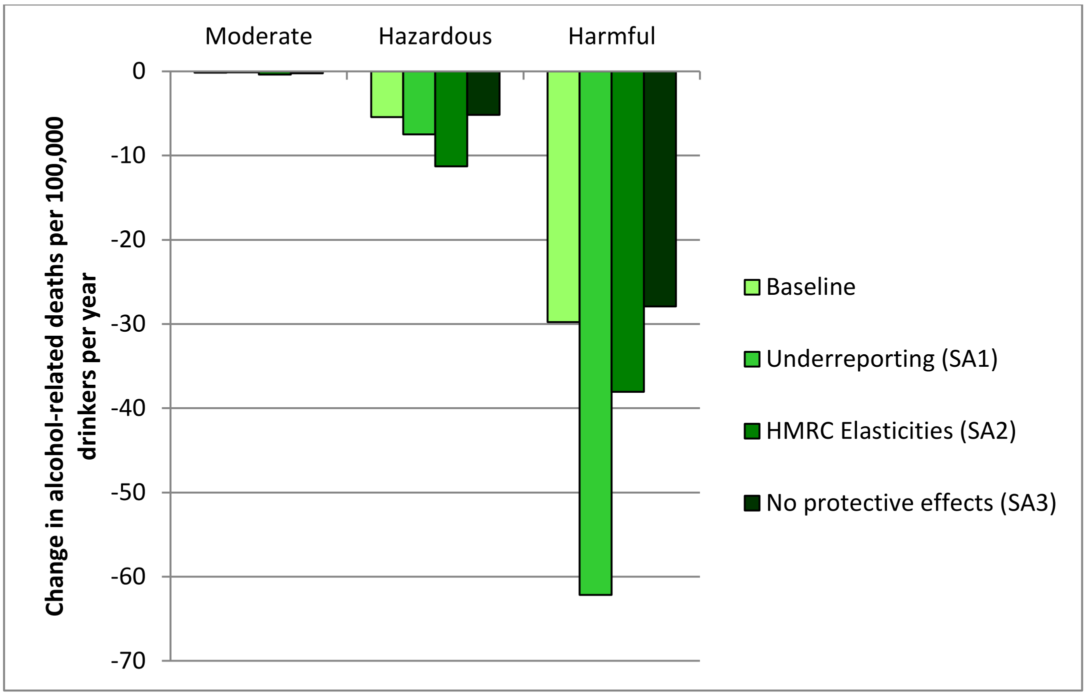

Figure 4.34: Sensitivity analysis effects on mortality impacts of 50p MUP by drinker group

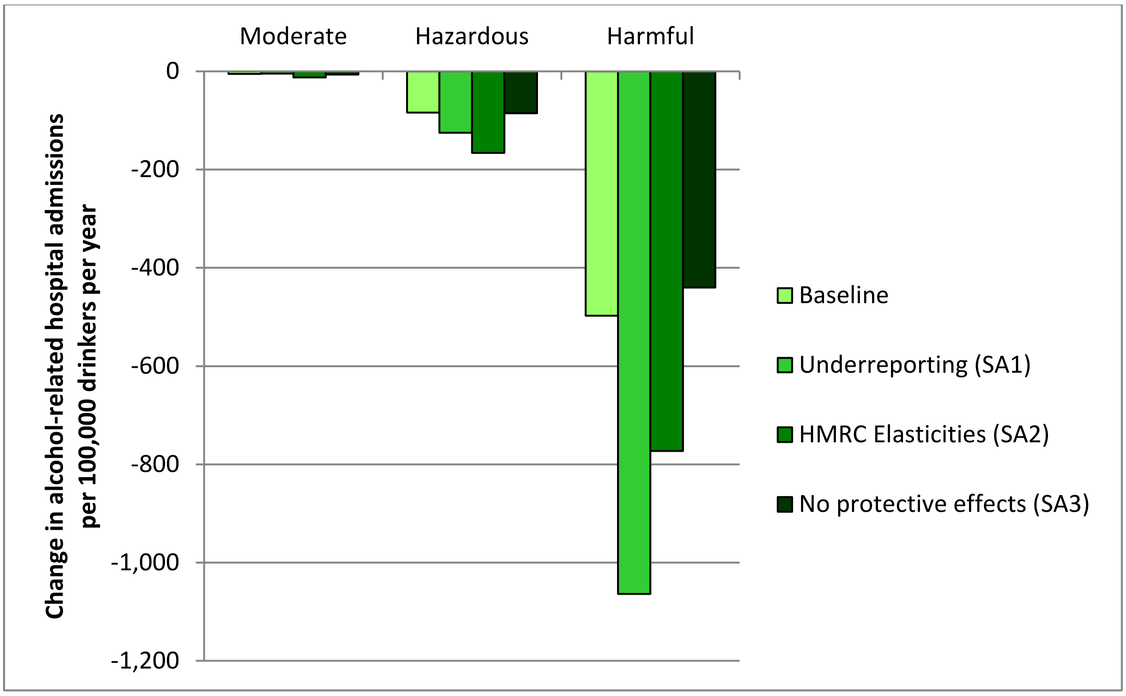

Figure 4.35: Sensitivity analysis effects on hospital admission impacts of 50p MUP by drinker group

5 SUMMARY OF RESULTS AND DISCUSSION

5.1 SUMMARY OF KEY FINDINGS

The analyses presented in this report suggest that a 50p MUP is an effective approach to reducing alcohol consumption and alcohol-related harm. Alcohol consumption in Scotland is estimated to fall by 3.5% following introduction of the policy. This would lead to an estimated 2,040 fewer alcohol-related deaths and 38,900 fewer hospital admissions in the first 20 years of the policy.

MUP is also a well-targeted policy with the largest consumption reductions seen among hazardous and, particularly, harmful drinkers. These targeted reductions occur because a 50p MUP imposes large price increases on the low cost alcohol which is disproportionately purchased by the heaviest consumers. Moderate drinkers would experience only small impacts on their alcohol consumption as a result of introducing a 50p MUP. This is because they tend to buy alcohol which would be subject to little or no increase in price following the introduction of the policy.

To achieve the same reduction in alcohol-related deaths among hazardous and harmful drinkers as a 50p MUP, a 28% increase in alcohol taxation would be required. Although still effective in reducing alcohol-related mortality, a 28% tax increase is less well-targeted when compared to a 50p MUP. It is estimated to lead to smaller consumption reductions among harmful drinkers, who are at greatest health risk, and larger consumption reductions among hazardous and moderate drinkers (who are at proportionately less health risk).

Impacts on consumer spending also differ between a 50p MUP and a 28% tax increase. While spending changes under a 50p MUP would be modest and would include a mixture of both spending increases and decreases within different population groups, changes would be larger under a 28% tax increase and spending would increase in all population groups.

5.2 NEW ANALYSES RELATED TO INCOME GROUPS

This report presents the first income-specific results from the Scottish adaptation of SAPM and provides further evidence of the targeted nature of MUP. Three key points emerge from these results.

First, alcohol-related mortality and morbidity are particularly concentrated within hazardous and harmful drinkers with low incomes, making them a key target for policies aiming to reduce population levels of alcohol-related harm. A 50p MUP is estimated to impact on both drinkers in poverty and those not in poverty; however, the largest consumption reductions are estimated to occur among harmful drinkers in poverty – the group at greatest risk from their drinking. Substantial consumption reductions are estimated to also occur in other key groups including hazardous drinkers in poverty and harmful drinkers not in poverty. As above, this pattern of targeted effects arises from a 50p MUP imposing large price increases on the alcohol disproportionately purchased by hazardous and harmful drinkers, particularly those on lower incomes.

Second, concerns have previously been expressed that MUP is a regressive policy which disproportionately affects low income drinkers (10). These new analyses suggest this claim requires substantial qualification as, among those in poverty, it is only the drinking of hazardous and harmful drinkers which is affected to a large degree by the policy. These drinkers are at substantial risk from their alcohol consumption and the health benefits received from reduced alcohol consumption should be taken into account in any equity considerations. In contrast, moderate drinkers in poverty would be little affected by a 50p MUP as only small amounts of the alcohol they purchase is sold for less than 50p per unit.

Third, reducing health inequalities is a major public health concern. By targeting alcohol consumption reductions, and thus reductions in alcohol-related mortality and morbidity, on heavier drinkers with lower incomes, reductions in health inequalities are likely to arise from a 50p MUP.

5.3 NEW ANALYSES COMPARING A 50P MUP TO ALCOHOL TAXATION INCREASES

This report illustrates the level of alcohol tax increases required to achieve the same impacts on alcohol-related mortality within specific population groups as a 50p MUP. Broadly, the results show that targeting groups at progressively higher risk from their drinking requires progressively larger tax increases to achieve the same reduction in alcohol-related mortality as a 50p MUP. For example, a 28% tax increase would be required to achieve the same reduction in deaths among hazardous and harmful drinkers as a 50p MUP, a 36% tax increase would be required to achieve the same reductions in deaths among harmful drinkers and a 70% tax increase would be required to achieve the same reduction in deaths among harmful drinkers in poverty.

These results are seen because, unlike the targeted price increases seen under MUP, raising alcohol taxes affects the price of alcohol consumed by all drinkers. If one wishes to reduce alcohol-related harm in a specific group within the population (e.g. harmful drinkers) then large tax increases are needed to produce large consumption (and thus harm) reductions within this smaller population. Such large tax increases will also affect those not within the target population.

Tax increases also allow for more flexible responses by consumers and retailers to the policy. Whereas MUP requires alcohol to be sold above a particular price point, tax increases permit cheap alcohol to continue to be sold. This gives rise to two phenomena which impact the effectiveness of tax policies. First, tax increases may not directly translate into price increases. Previous analyses have shown that, when alcohol tax is increased in the UK, retailers increase the price of cheap products by less than would be expected given the tax increase and increase the price of expensive products by more than would be expected (18). These patterns of tax pass-through redirect price increases away from the cheap alcohol disproportionately purchased by those at greatest risk from their drinking and towards the more expensive alcohol which is purchased by those at least risk from their drinking. In so doing, this necessitates larger tax increases to achieve a given reduction in alcohol consumption. Second, heavier drinkers may trade-down to cheaper alcohol if products increase in price. This may occur to some extent under a 50p MUP with products currently sold above the 50p threshold, although the removal of very cheap alcohol from the market significantly limits the potential for this price substitution (as there is no cheaper alcohol to trade-down to). In contrast, taxation does not remove the cheapest alcohol from the market and as such hazardous and harmful drinkers who currently buy large amounts of cheap alcohol may be able to maintain their pre-tax increase consumption levels by trading down to still cheaper alcohol when prices go up (59).

This trading down effect is not directly accounted for within SAPM due to a lack of suitable data, however it should be noted that this may mean our results overstate, to some extent, the relative consumption reductions arising from taxation increases.

Overall, although alcohol tax increases are an effective approach to reducing alcohol consumption and alcohol-related mortality and morbidity, the analyses above suggest they are a less well-targeted and robust approach than MUP and, in particular, impose greater costs on drinkers whose alcohol consumption is low risk.

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7 APPENDIX

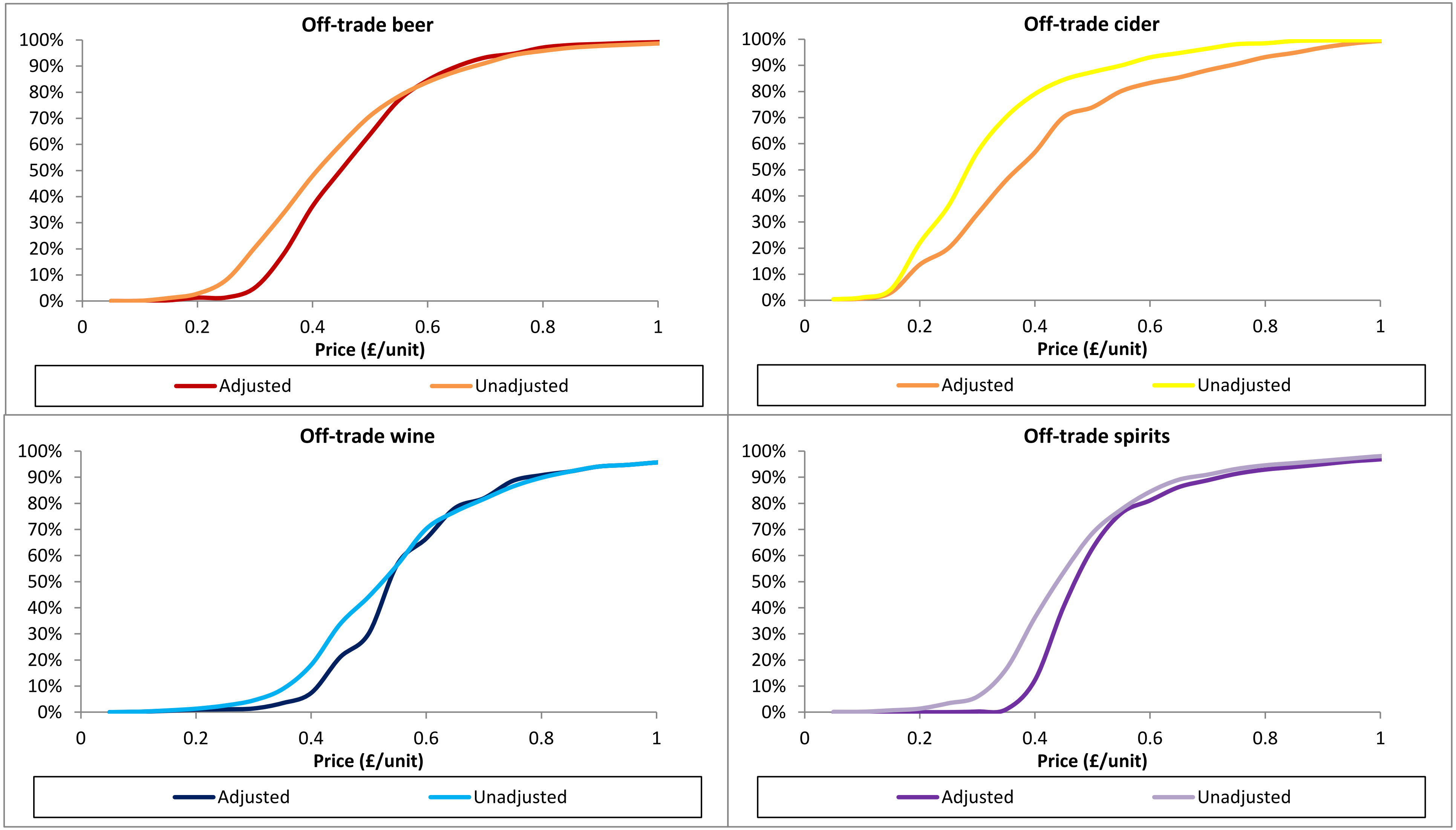

Figure 7.1: Raw and adjusted off-trade price distributions by beverage type

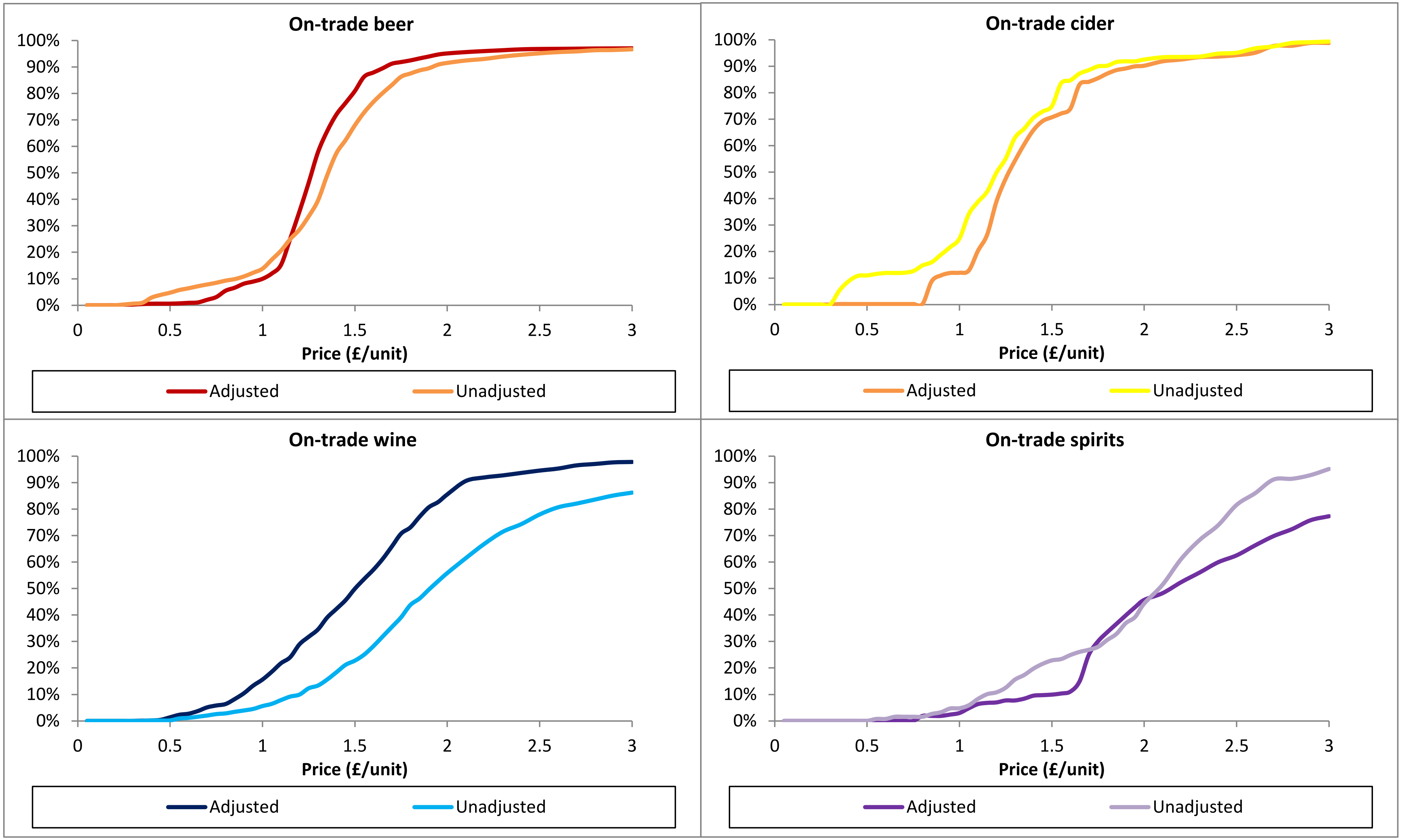

Figure 7.2: Raw and adjusted on-trade price distributions by beverage type

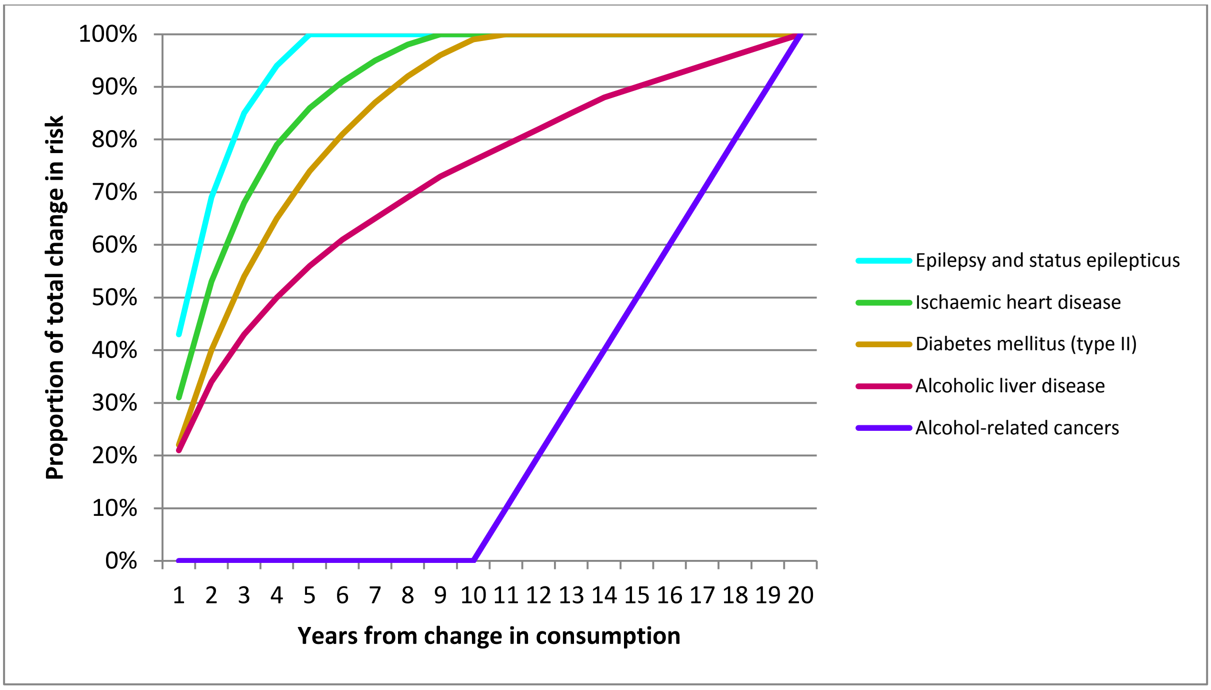

Figure 7.3: Modelled time lag structures for selected health conditions from Holmes et al. 2012

Table 7.1: Annual mortality rates for all modelled health conditions

Condition	Deaths per 100,000 adults (aged 16-89) per year		
	Population	In poverty	Not in poverty
Alcohol-induced pseudo-Cushing's syndrome	N/A[6]		
Degeneration			
Alcoholic polyneuropathy			
Alcoholic myopathy			
Alcoholic cardiomyopathy	0.21	0.52	0.16
Alcoholic gastritis	0.02	0.00	0.03
Alcoholic liver disease	15.03	30.19	12.75
Actue pancreatitis (alcohol induced)	0.48	1.57	0.32
Chronic pancreatitis (alcohol induced)	0.09	0.17	0.08
Maternal care for (suspected) damage to fetus from alcohol	N/A		
Mental and behavioural disorders due to use of alcohol	6.35	14.31	5.15
Excessive blood level of alcohol	N/A		
Toxic effect of alcohol			
Accidental poisoning by exposure to alcohol	1.39	3.32	1.10
Intentional self-poisoning by and and exposure to alcohol	0.05	0.00	0.05
Poisoning by and exposure to alcohol, undetermined intent	N/A		
Evidence of alcohol involvement determined by blood alcohol level			
Tuberculosis	0.57	1.05	0.50
Malignant neoplasm of lip, oral cavity and pharynx	6.74	11.34	6.04
Malignant neoplasm of oesophagus	18.45	21.81	17.95
Malignant neoplasm of colon and rectum	32.27	36.29	31.67
Malignant neoplasm of liver and intrahepatic bile ducts	11.63	13.61	11.33
Malignant neoplasm of larynx	2.35	4.71	2.00
Malignant neoplasm of breast	20.56	19.19	20.76
Diabetes mellitus (typeII)	16.26	19.89	15.72
Epilepsy and status epilepticus	2.38	3.84	2.15
Hypertensive diseases	8.93	9.95	8.78
Ischaemic heart disease	133.29	174.32	127.11
Cardiac arrhythmias	7.90	8.72	7.78
Haemorrhagic and other non-ischaemic stroke	17.54	24.08	16.56
Ischaemic stroke	38.35	40.31	38.05
Lower respiratory infections: pneumonia	29.55	41.53	27.75
Cirrhosis of the liver	3.68	6.63	3.23
Acute and chronic pancreatitis	2.42	3.49	2.26
Transport injuries (including road traffic accidents)	4.93	5.58	4.84
Fall injuries	11.97	11.52	12.04
Exposure to mechanical forces (including machinery accidents)	0.14	0.00	0.16
Drowning	0.50	0.17	0.55
Other Unintentional Injuries	1.12	1.74	1.02
Accidental poisoning by exposure to noxious substances	11.56	34.37	8.12
Intentional self-harm	12.33	20.07	11.17
Assault	1.10	1.92	0.97
Other intentional injuries	N/A		
Overall mortality from alcohol-related conditions[7]	420.14	566.23	398.13
Mortality from all other-causes	616.95	797.25	589.79
Overall mortality	1037.08	1363.48	987.93

[6] For some conditions, marked N/A, no deaths were recorded in Scotland in 2014

[7] Note that this represents all deaths from the conditions included in the model, not just those which are attributable to alcohol (e.g. it includes all deaths from transport injuries, although many will not be attributable to alcohol)

Table 7.2: Annual hospital admissions for all modelled health conditions

Condition	Multiplier	Hospital admissions per 100,000 adults (aged 16-89) per year		
		Population	In poverty	Not in poverty
Alcohol-induced pseudo-Cushing's syndrome	1.00	N/A[8]		
Degeneration	1.10	0.89	1.57	0.79
Alcoholic polyneuropathy	1.07	0.34	0.35	0.34
Alcoholic myopathy	1.50	0.09	0.17	0.08
Alcoholic cardiomyopathy	1.36	0.57	0.87	0.53
Alcoholic gastritis	1.12	7.15	19.57	5.28
Alcoholic liver disease	2.00	49.81	103.09	41.80
Actue pancreatitis (alcohol induced)	1.00	5.82	14.33	4.55
Chronic pancreatitis (alcohol induced)	1.42	2.01	4.72	1.60
Maternal care for (suspected) damage to fetus from alcohol	1.00	N/A		
Mental and behavioural disorders due to use of alcohol	1.54	195.17	462.87	154.91
Excessive blood level of alcohol	1.00	0.14	0.70	0.05
Toxic effect of alcohol	1.12	47.69	91.56	41.09
Accidental poisoning by exposure to alcohol	1.00	0.11	0.17	0.11
Intentional self-poisoning by and and exposure to alcohol	1.00	0.27	0.52	0.24
Poisoning by and exposure to alcohol, undetermined intent	1.00	N/A		
Evidence of alcohol involvement determined by blood alcohol level	1.25	0.09	0.00	0.11
Tuberculosis	1.31	4.16	8.04	3.57
Malignant neoplasm of lip, oral cavity and pharynx	2.65	26.75	40.01	24.75
Malignant neoplasm of oesophagus	3.55	32.00	37.39	31.19
Malignant neoplasm of colon and rectum	3.37	109.79	108.68	109.96
Malignant neoplasm of liver and intrahepatic bile ducts	2.47	16.65	18.70	16.34
Malignant neoplasm of larynx	2.29	8.79	17.65	7.46
Malignant neoplasm of breast	3.85	141.15	121.09	144.17
Diabetes mellitus (typeII)	1.61	539.11	733.88	509.82
Epilepsy and status epilepticus	1.44	96.52	159.53	87.05
Hypertensive diseases	1.29	607.38	568.93	613.16
Ischaemic heart disease	1.52	877.23	1,105.71	842.87
Cardiac arrhythmias	1.45	447.64	450.46	447.21
Haemorrhagic and other non-ischaemic stroke	1.07	45.31	51.37	44.40
Ischaemic stroke	1.17	224.22	300.89	212.69
Lower respiratory infections: pneumonia	1.16	621.58	956.66	571.20
Cirrhosis of the liver	1.62	24.35	36.69	22.49
Acute and chronic pancreatitis	1.37	68.13	93.13	64.37
Transport injuries (including road traffic accidents)	1.05	89.19	84.22	89.94
Fall injuries	1.07	559.05	726.36	533.89
Exposure to mechanical forces (including machinery accidents)	1.04	135.69	195.18	126.75
Drowning	1.00	0.37	0.87	0.29
Other Unintentional Injuries	1.02	29.46	26.04	29.98
Accidental poisoning by exposure to noxious substances	1.04	41.91	92.96	34.24
Intentional self-harm	1.26	132.65	266.47	112.53
Assault	1.06	58.58	144.50	45.66
Other intentional injuries	1.00	N/A		
All alcohol-related conditions		5,247.82	7,045.93	4,977.44

[8] For some health conditions, marked N/A, no hospital admissions were recorded in Scotland in 2014

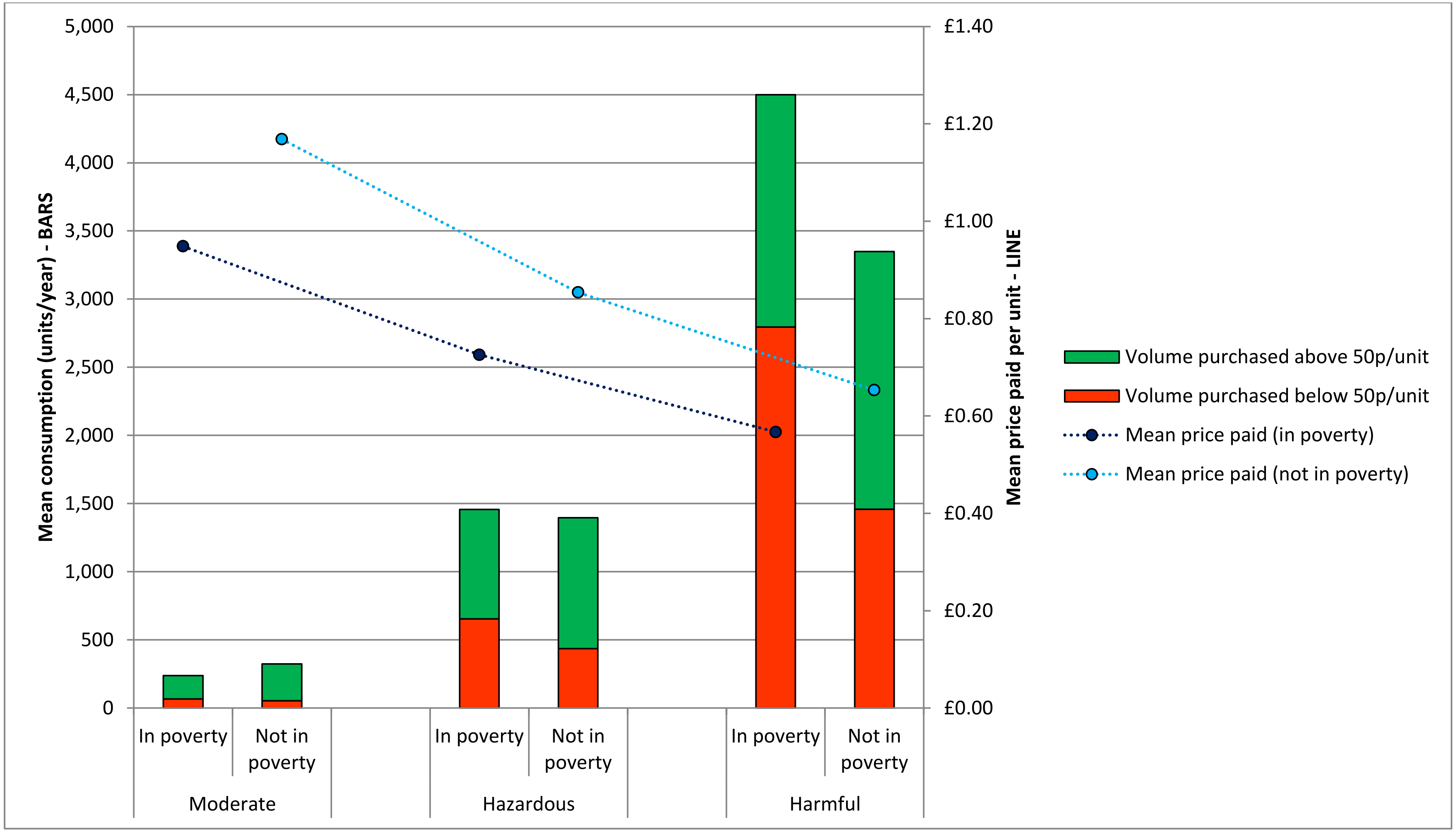

Figure 7.4: Mean consumption, units purchased below 50p per unit and mean prices paid by consumption and poverty group

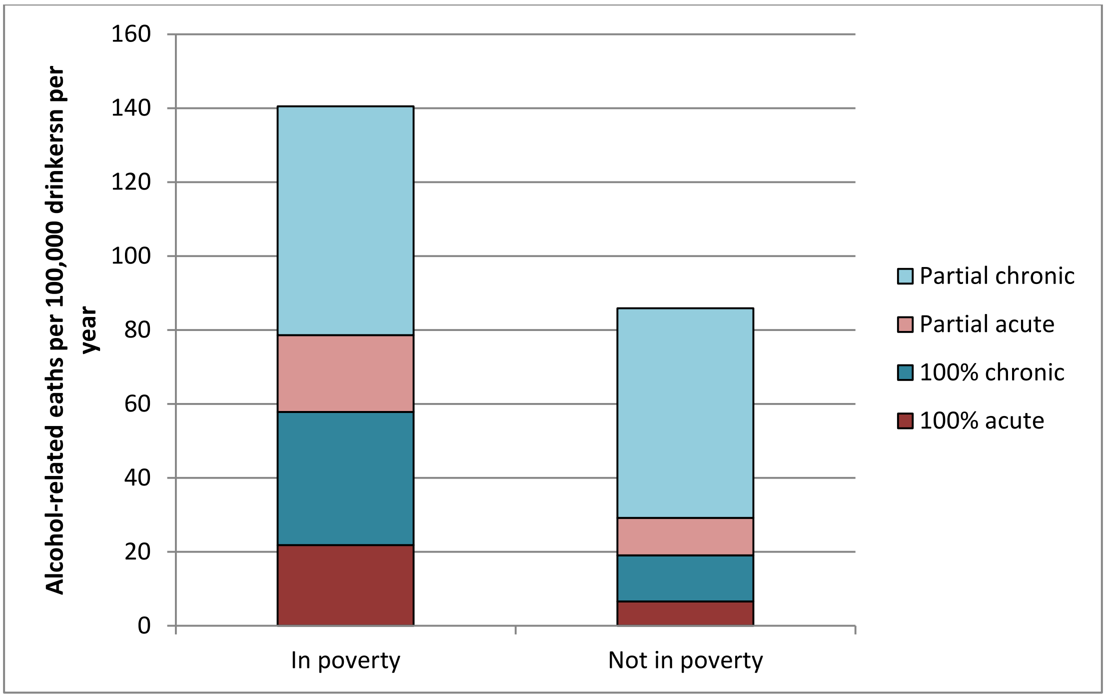

Figure 7.5: Baseline alcohol-related mortality rates by condition type and poverty group

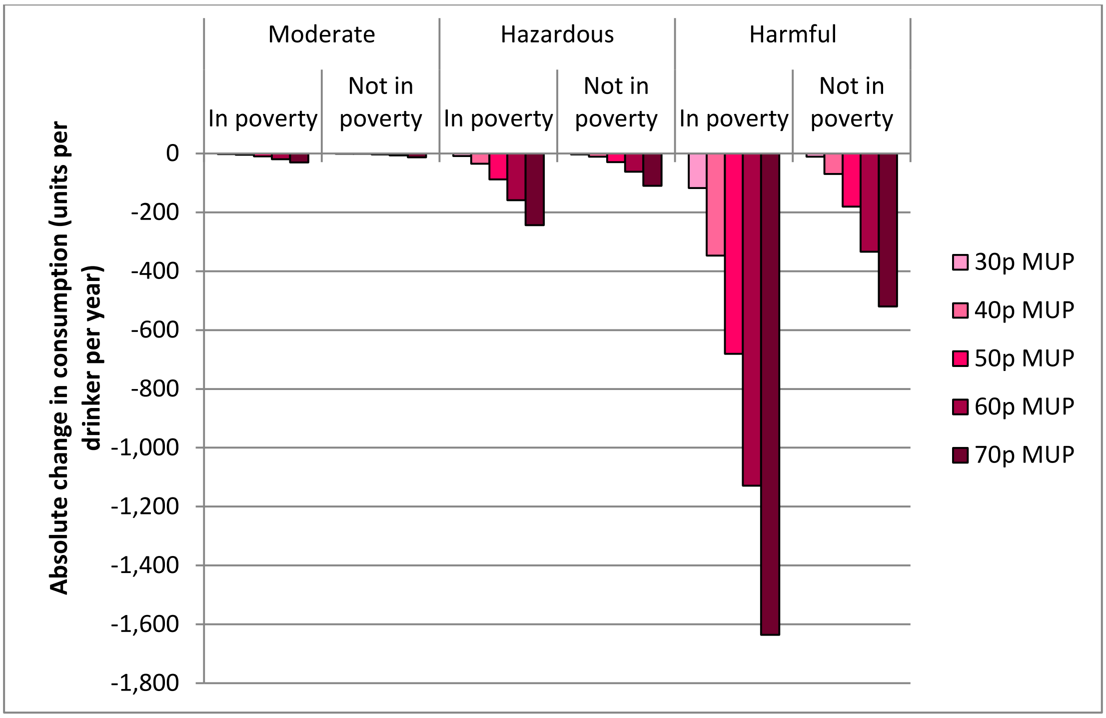

Figure 7.6: Absolute changes in consumption under MUP policies by drinker and poverty group

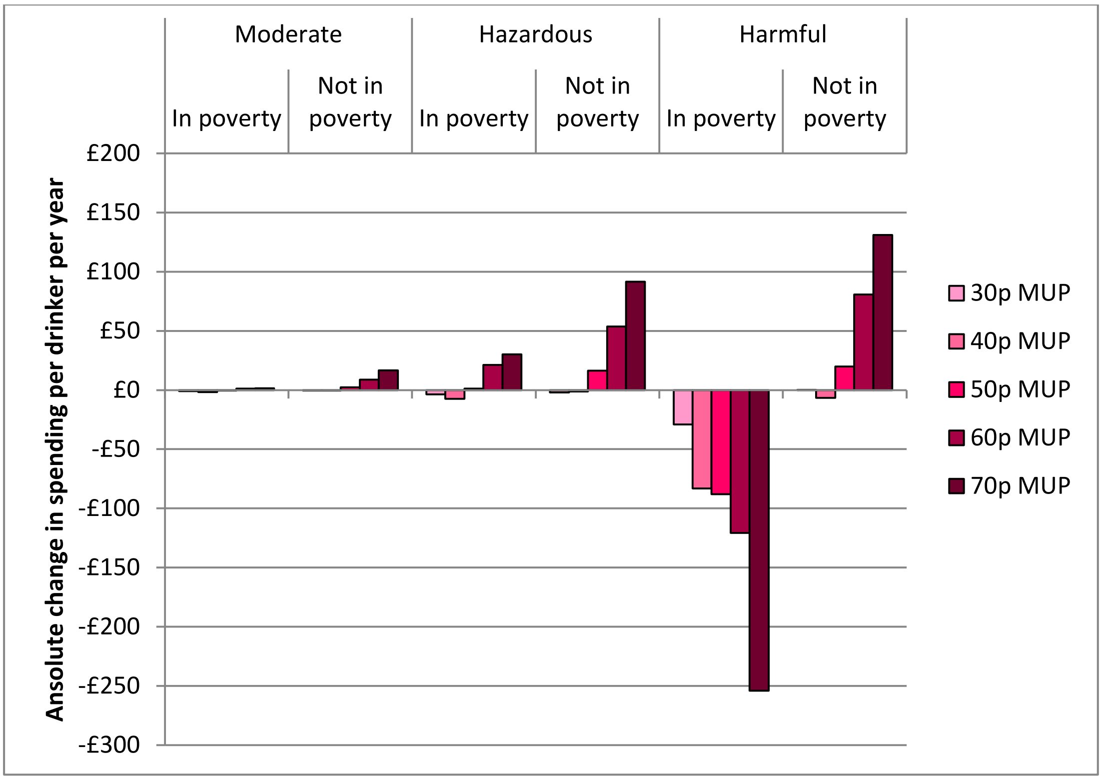

Figure 7.7: Absolute changes in spending under MUP policies by drinker and poverty group

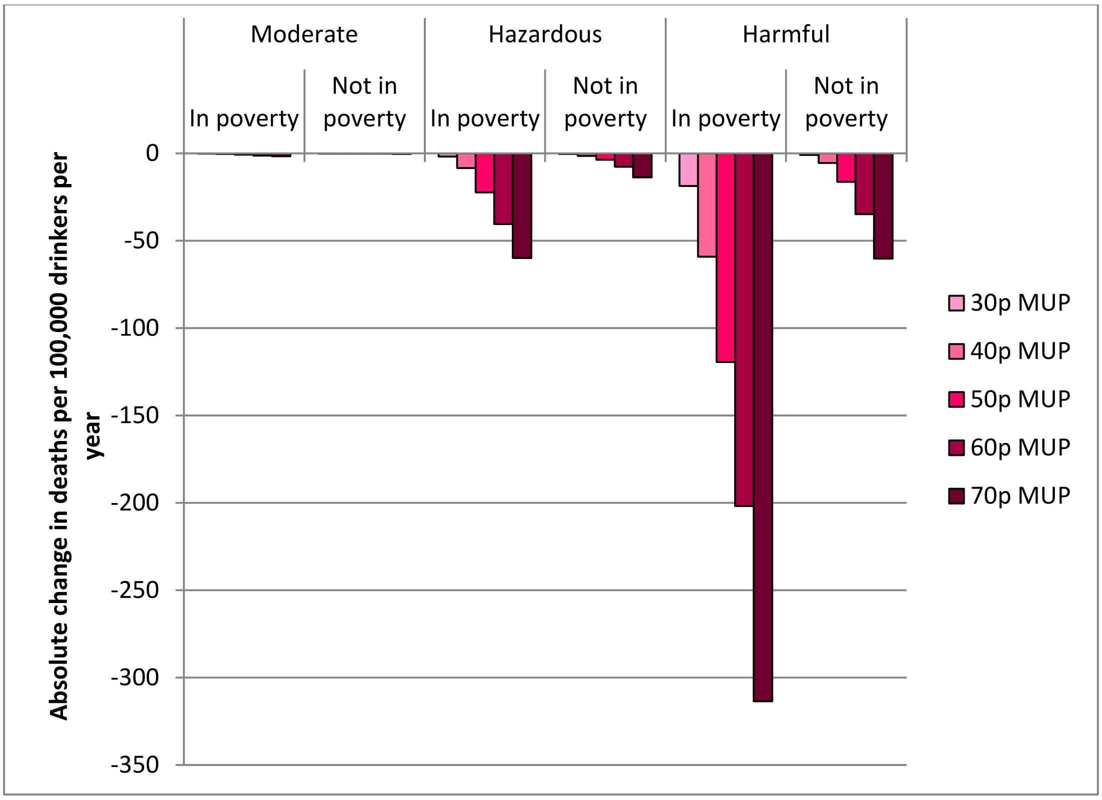

Figure 7.8: Absolute changes in alcohol-related deaths under MUP policies by drinker and poverty group

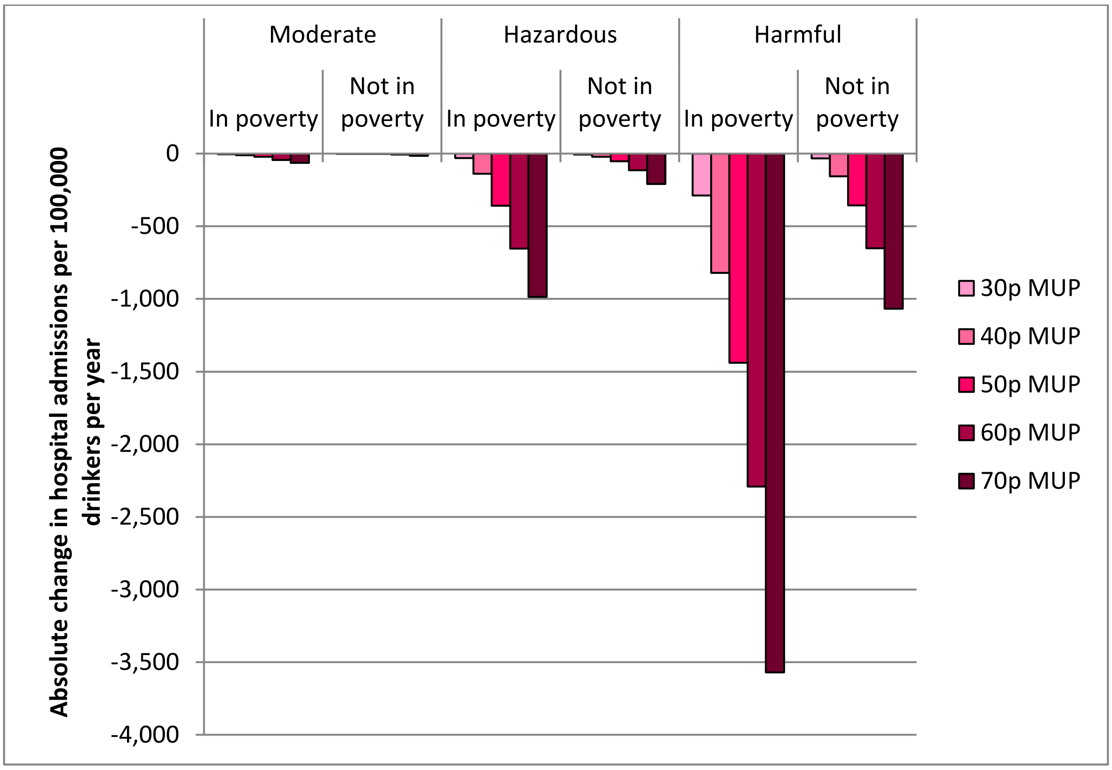

Figure 7.9: Absolute changes in alcohol-related hospital admission rates under MUP policies by drinker and poverty group

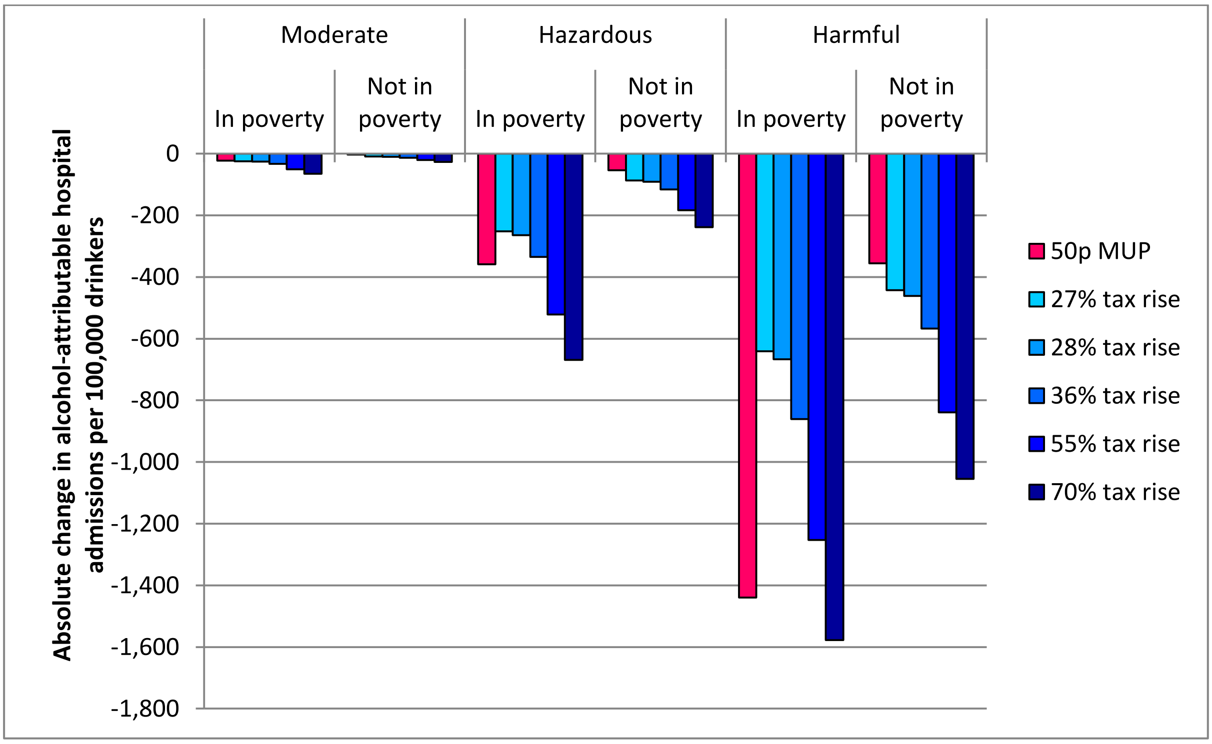

Figure 7.10: Changes in alcohol-related hospital admissions under taxation and MUP policies by drinker and poverty group

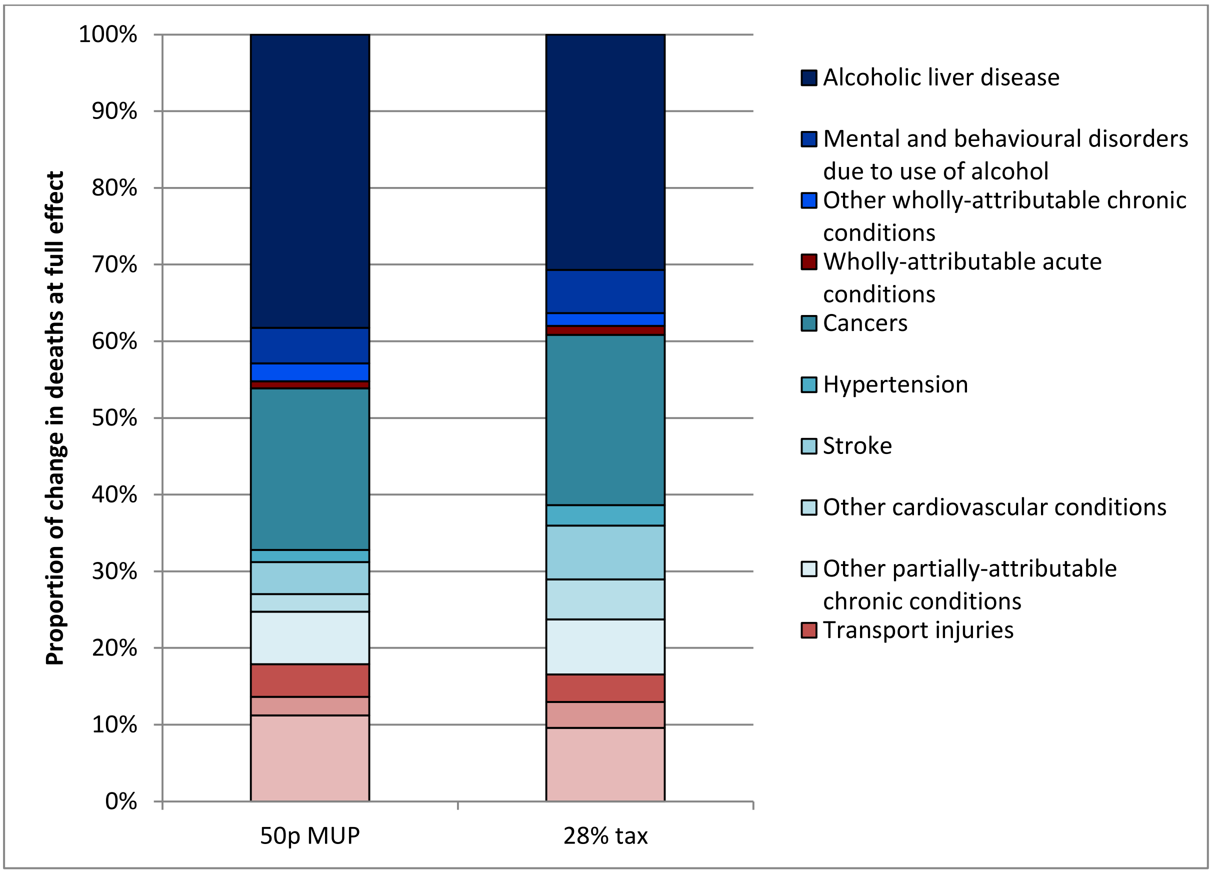

Figure 7.11: Breakdown of deaths averted under 50p MUP and 28% tax by health condition