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Policy Options for Alcohol Price Regulation: The Importance of Modelling Population Heterogeneity

Short title: Impact of alcohol pricing policies

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ABSTRACT

Context and aims: Internationally, the repertoire of alcohol pricing policies has expanded to include targeted taxation, inflation-linked taxation, taxation based on alcohol-by-volume (ABV), minimum pricing policies (general or targeted), bans of below-cost selling and restricting price-based promotions. Policy makers clearly need to consider how options compare in reducing harms at the population level, but are also required to demonstrate proportionality of their actions, which necessitates a detailed understanding of policy effects on different population subgroups. This paper presents selected findings from a policy appraisal for the UK government and discusses the importance of accounting for population heterogeneity in such analyses.

Method: We have built a causal, deterministic, epidemiological model which takes account of differential preferences by population subgroups defined by age, gender and level of drinking (moderate, hazardous, harmful). We consider purchasing preferences in terms of the types and volumes of alcoholic beverages, prices paid, and the balance between bars, clubs and restaurants as opposed to supermarkets and off-licenses.

Results: Age, sex and level of drinking fundamentally affect beverage preferences, drinking location, prices paid, price sensitivity and tendency to substitute for other beverage types. Pricing policies vary in their impact on different product types, price points and venues, thus having distinctly different effects on subgroups. Because population subgroups also have substantially different risk profiles for harms, policies are differentially effective in reducing health, crime, workplace absence and unemployment harms.

Conclusion: Policy appraisals must account for population heterogeneity and complexity if resulting interventions are to be well-considered, proportionate, effective and cost-effective.

INTRODUCTION

The effectiveness of increasing alcohol prices in reducing population level alcohol consumption and related harm is well supported by empirical evidence (1, 2). However, our 2008 systematic review on pricing policies found that, beyond this broad finding, there has been less effort aimed at understanding the detailed underlying effects of price changes on different purchasing and drinking patterns or different subgroups of the population (3). Previous policy modelling in the alcohol field (e.g. 4, 5, 6) has used relatively simple model structures and usually examined the population in terms of age, gender and some definition of consumption status (eg. harmful drinker or not).

In recent years, the international pricing policy repertoire has expanded beyond general duty rate increases to include more complex and targeted taxation policies (eg. aimed at advantaging or disadvantaging certain beverage types), inflation-linked taxation, taxation by ABV, general or targeted minimum pricing policies, bans of loss-leading as well as policies restricting price promotions (7-9). When comparing such policy options, we clearly need to compare how the policy measures perform in reducing harmful outcomes at the population level. However, policy makers in the UK and elsewhere are increasingly under pressure to demonstrate proportionality of their actions through a more detailed understanding of effects on different population subgroups. If we are to understand whether policy options (1) target the drinking patterns causing the most concern, (2) affect subgroups in unintended ways or (3) affect some groups disproportionately, we may need more fine-grained analyses and model structures accounting for population heterogeneity.

During 2008, we undertook a major modelling exercise examining alcohol pricing and promotion policies for the UK government (10). Population heterogeneity is examined in relation to consumption and purchasing behaviours, accounting for differences by age, sex and drinker type (moderate, hazardous, harmful). We consider the types of alcoholic products purchased, their price, and their source (on- or off-trade; ie. bar, club and restaurant versus supermarket and off-licence purchases). Heterogeneity is further investigated in terms of the effect on different subgroups (e.g. would a minimum price have greater impact on consumption by young harmful drinkers than a general price rise?), and in terms of differential effect on outcomes for health, crime and employment. Finally we discuss the implications and limitations of these findings for policy analysis in the field, and argue that accounting for heterogeneity is necessary in providing the analytic capability required by government and regulators.

METHODS

A detailed description of the modelling methodology is beyond the current paper, and the reader is referred to the project report (10) and forthcoming publications. Here we provide a brief overview of the two most important data sources for the analysis and the model structure.

In the UK, the annual General Household Survey (GHS) can be used to derive data on alcohol consumption for adults aged 16+ (11). We used the 2006 GHS, which provides, for each of over 14,000 individual respondents, details on mean weekly alcohol consumption in UK units (equivalent to 10ml of ethanol) as well as maximum per day alcohol intake in the survey week. It allows consumption data to be split by beverage type, ie. beers, wines, spirits and 'ready to drinks' or alcopops (RTDs). Sampling weights provided by the ONS were used to adjust for sampling bias and scale the data to the England population. We follow Office for National Statistics (ONS) conventions for beverage classification (ciders are included in the beer category, fortified wines in the wine category) and drinking level cut-off points (moderate, hazardous and harmful drinkers: ≤21/14 units, >21/14 but <50/35 units and ≥50/35 units per week for males and females, respectively, corresponding to ≤24/16; >24/16 but <57/40 and 57/40+ g/ethanol per day). Crucially, the GHS contains no information on prices paid or place of purchase (on-trade or off-trade) of the alcohol consumed.

The annual Expenditure and Food Survey (EFS), a large general household survey which uses 14-day diaries to record purchasing of products by each person in a household provides detailed information on alcohol purchasing transactions (12). The EFS contains detailed information on purchasing location (on- vs off-trade), beverage type, price paid and volume purchased in ml, allowing conversion into price per unit of alcohol. We adjust to 2007 prices using alcohol-specific retail price indices. Low-level diary data, which also contains purchaser demographics, has been obtained for 2001/2 to 2005/6, resulting in data relating to 61,618 individuals. Again, sampling weights provided by the data depositors were used to correct for sampling bias. AC Nielsen data served as a gold standard calibration for off-trade prices derived from the EFS.

We define 54 population subgroups: moderate / hazardous / harmful, split by gender, and split into 9 age bands (11-15, 16-17, 18-24, 25-34, …, 65-74, 75+). We link the GHS and EFS data at subgroup level by using the preferences for off-trade versus on-trade

purchasing of the four beverage types and price distributions (from the EFS) to apportion GHS consumption data into 16 product categories (beers, wines, spirits, RTDs, split by on/off-trade, and split by low/high price using cut-offs of <30p per unit off-trade and <80p per unit on-trade). The distribution of price paid, by each subgroup, for each of the 16 alcohol categories, can then be estimated, resulting in 864 separate price distributions. The underlying assumption is that the EFS proportions of on/off trade and low/high price purchasing for that subgroup can be applied to apportion GHS consumption, and we report a sensitivity analysis around this assumption in the results section.

Econometric analysis of the EFS data has been undertaken to quantify the elasticity of demand for alcohol – the change to purchasing levels that is expected after a price change. Price elasticities were estimated using iterative three-stage least-squares regression (for details, see 10). We undertook elasticity analyses for the 16 different categories of alcohol, estimating a separate 16x16 matrix for moderate drinkers vs. hazardous/harmful drinkers, and by gender. The sample was of sufficient size to estimate a matrix containing both own-price elasticities (ie. the impact of a price rise affecting a product type on the consumption of that product type) and cross-price elasticities (eg. the impact of "switching behaviour" between beverage types, price points or between on- and off-trade).

For the estimation of the effect of discounting restrictions, the distribution of price-based promotions in the off-trade was obtained from AC Nielsen for the year ending May 2008.

Essentially, we build a causal, deterministic, epidemiological model which takes the 2006 GHS population sample as its baseline and for a chosen pricing policy produces a simulated future GHS sample, in particular estimating a revised average and peak daily consumption for each individual. We then model the impact of the consumption changes on the disease prevalence of 47 chronic and acute conditions either wholly or partially attributable to alcohol (13). Mortality rates are taken from the ONS figures for England and Wales for 2006. Morbidity rates are estimated from published 2006 person-specific hospital admission volumes for England (13). We use 2008 Department of Health estimates (14) to derive the average health and social care cost for each illness. For chronic conditions, we use functions relating average consumption to health risk from the published literature, whereas for acute conditions, functions relating maximum daily consumption to risk were fitted using ordinary least-squares regression to observations of the attributable fraction of cases (for details, see 10). Adjusted mortality and morbidity rates are then applied to male and female life tables of the English population, enabling changes in deaths, illnesses, hospital admissions, health

and social care costs to be estimated. The total valuation of each policy is calculated as the cumulative net saving over the ten years to full effectiveness, with costs discounted at 3.5%.

RESULTS

Heterogeneity in UK alcohol consumption patterns

Distribution of consumption in the population: A well-quoted statistic in the field is that 80% of all alcohol is consumed by the heaviest 20% of drinkers (e.g. 15). Results from England show a similar but slightly broader distribution, with 45% of alcohol consumed by the heaviest 10% of drinkers, 66% consumed by the heaviest 20% and 79% consumed by the heaviest 30% (Table 1). At the other end of the spectrum, the lightest 40% of drinkers account for just 2% of all consumption. These total population summary statistics hide significant variation: The heaviest 10% of female drinkers consume 32% of all alcohol drunk by women, whilst the heaviest 10% of male drinkers consume 52% of all alcohol drunk by men. The skew in the distribution is even more extreme in younger people (18-24), with 59% and 37% of alcohol being consumed by the heaviest drinking 10% of young males and females, respectively.

Insert Table 1

Variability in drinking preferences by age, gender and drinker type: Of all alcohol units consumed in England during 2006, beer accounted for 44%, wine for 36%, spirits for 14% and RTDs for 5%. Figure 1 shows preferences for the different beverage types by age and gender. Men drink predominantly beer, which accounts for 57% of their total alcohol consumption. Wine accounts for 27%, spirits for 13% and RTDs for 3%. For young men, beer is by far the most popular drink, accounting for 68% of their consumption, with wine and spirits much lower (accounting for just 7% of alcohol consumption each) and RTDs higher for this group (9%). In comparison, for older men higher proportions of the total alcohol consumed are made up of spirits and wine.

Insert Figure 1

Women's beverage preferences are more diverse and vary even more strongly by age. The most prominent category for women is wine (57% of all consumption), followed by spirits (18%), beer (17%), and RTDs (9%). However, in the under-25s age group, spirits and RTDs together make up half of all consumption (27% and 23%, respectively), with wine only accounting for 29%. In the older age groups, women show a strong preference for wine, with spirits popular in the oldest age group.

There is far less variability between moderate, hazardous and harmful drinkers of both genders (Figure 2). Male harmful drinkers show a somewhat more pronounced preference for beer, especially extra strength beers (which account for 10% of harmful drinkers' consumption but only 2% of moderate drinkers' consumption). Compared with moderate drinkers, female harmful drinkers show less of a preference for spirits.

Insert Figure 2

Preference of drinking locations: Overall, 61% of all alcohol is consumed in the off-trade and 39% in the on-trade sector. Female drinkers show a much stronger preference for off-trade drinking than male drinkers, 79% of all consumption compared to 52% (Table 2). Heavier drinkers also show a stronger preference for off-trade alcohol than moderate drinkers, indeed harmful drinkers of both genders obtain the majority of the alcohol they consume from the off-trade sector (men: 57%; women: 88%). There are also pronounced age effects: On-trade drinking is much more common in young people, and is the dominant drinking pattern hazardous drinkers under the age of 25 (for men: 76% of their consumption, women: 60%).

Insert Table 2

Heterogeneity in UK alcohol purchasing patterns

Variation in prices paid. Currently, the average price paid for an alcohol unit in England is 65p. Drinking preferences, especially in terms of alcohol outlet and beverage type, have a major impact on the average unit prices paid by individuals. Table 3 shows average unit prices paid in the on/off trade, by gender and level of drinking. For both genders and in on-trade and off-trade sectors, average unit price declines the heavier someone drinks. In the

on-trade sector, women pay considerably more per unit than men, which is partly explained by the higher price of wine, RTDs and spirits compared to beer (average on-trade unit prices: beer £0.94, wine £2.40, spirits £1.15, RTDs £1.50). This may also be influenced by the type of drinking venues preferred by women. In the off-trade sector, there are only small gender differences, probably because average unit prices for different beverages are more similar (beer: £0.34, wine £0.47, spirits £0.36, RTDs £0.77).

Insert Table 3

Heterogeneity in price sensitivity

Our results show that moderate drinkers are, overall, somewhat more price sensitive compared to heavy drinkers (elasticities: -0.47 vs. -0.21), in line with recent international meta-analyses (1, 2). However, these overall estimates obscure some interesting nuances. Heavy drinkers actually had *higher* own-price elasticities than moderate drinkers for most product categories in the 16x16 matrices. But, further investigation shows that this is counterbalanced by heavy drinkers also tending to have higher cross-price elasticities, which indicates more switching behaviour, i.e. some of their purchases are replaced by purchases of a different alcohol category. This switching includes switches in where alcohol is purchased (off-trade/on-trade), switches in type of product (e.g. wine to spirits), and switches between higher-priced and lower-priced products. Women, especially those drinking moderately, are somewhat more sensitive to price compared to men (elasticities of -.50 and -.22 for female moderate and heavy drinkers and -.43 and -.20 for male moderate and heavy drinkers, respectively).

Effects of different pricing policies on consumption and consumer spending

Having shown that there are important differences in how much and which beverage types the population subgroups prefer to consume, where and for what price they purchase their alcohol, and how they respond to price changes, we now seek to show that such differences determine the effectiveness of policies in each subgroups. To illustrate, we have selected 10 of 41 analysed policy options, and show their estimated effects on two of the outcomes considered in the model: changes in overall consumption levels and overall financial valuation of the policy option (Table 4). We present results for the total population and then 6 subgroups of drinkers: (a) moderate, (b) hazardous and (c) harmful drinkers of all ages; (d) young hazardous drinkers (age <25) as well as (e) male and (f) female drinkers of all ages. It

is important to note that we have not attempted to account for possible industry responses to the policies.

The following policy options were selected: 1. A general pricing option (assuming a policy that leads to a 10% price increase across all beverage categories). 2. A policy targeting low-priced off-trade products (retailing at <30p per unit) and cause price rises of 25% for these products. 3. As 2, but for on-trade products, 4. A policy setting a minimum unit price of 30p (ie. a pint of beer containing 3 alcohol units could not be sold below 90p). 5. A 40p minimum unit price. 6. A 50p minimum unit price. 7. A 30p minimum unit price for beer only. 8. A differential minimum unit price for on-trade and off-trade of 60p and 20p, respectively. 9. A differential minimum unit price for on-trade and off-trade of 80p and 30p, respectively. 10. A policy banning all off-trade discounting.

Insert Table 4

To facilitate the comparison of proportionate policy effects, we have calculated consumption change ratios reflecting the differential effects on harmful vs. moderate drinkers, young hazardous vs. moderate drinkers, moderate drinkers vs. total drinking population, and male vs. female drinkers. A ratio of 1 means that, the policy has the same effect (in terms of % consumption change) on both groups. A ratio of more than 1 means that the policy affects for example harmful drinkers more than moderate drinkers, and vice versa for a ratio of less than 1. Note that these ratios do not allow comparison of absolute effect size.

Harmful vs moderate drinkers: Whilst policy options 1 (general price increase) and 3 (price increase for cheap products in off-and on-trade) have similar effects on the consumption of moderate and harmful drinkers, options 7 (minimum price for beer only), 4, 5 (minimum prices of 30p and 40p) and 2 (price increase for cheap off-trade products) clearly affect harmful drinkers far more, proportionately, than moderate drinkers.

Young hazardous vs moderate drinkers: Because of their stronger link to crime and disorder, young hazardous drinkers are one of the priority groups in the government's alcohol strategy (16), and we were asked to consider how policy options would impact on this group. Several policy options appear to be far less effective for this group compared to other groups, and some policy options are in fact counter-productive. Young male hazardous drinkers are over-represented in this group and these are known to have a strong preference for beer and for

on-trade sector drinking. For example, increasing the price of cheap off-trade alcohol (option 2) does not produce consumption decreases. In contrast, several policy options affecting on-trade prices appear to target this group very effectively whilst having smaller effects on moderate and harmful drinkers. Policy measures that effectively reduce consumption in this group include options 3 & 4 (increasing the price of cheap on-trade or on-trade and off-trade alcohol by 25%) and 8 & 9 (setting differential minimum prices for on-trade and off-trade products). Off-trade discount bans (option 10) and minimum pricing options that do not differentiate between on-trade and off-trade tend to affect on-trade prices only marginally, and consequently have limited impact on drinking in this group.

*Moderate vs all drinkers. A*ll policy options affect moderate drinkers less than the total drinking population, there are variations of interest if the desire is to minimise policy effects on moderate drinkers. In comparison to the total drinking population, moderate drinkers' consumption is most affected by general price increases (option 1) and price increases targeted at cheap on-trade alcohol (option 3). Moderate drinkers are least affected by lower minimum pricing options (options 4-6, 9) and policies targeting cheap off-trade alcohol (option 2). Minimum pricing options higher than those shown here (eg. 60p, 70p) start affecting the higher-priced beverages preferred by moderate drinkers and thus lead to more pronounced consumption changes in moderate drinkers.

Gender: As expected given the differential preferences for off- vs. on-trade drinking and wine vs. beer as the dominant beverage type, male drinkers are more affected by policies targeting beer prices or prices in the on-trade sector (options 7 and 2), whereas female drinkers are affected more by those policies targeting wine or the off-trade sector (option 3). Minimum pricing options which operate predominantly in the off-trade sector (options 4-6) tend to impact on women more than men, whereas options setting differential on-trade and off-trade minimum prices (options 8-9) have greater effects on men than women.

Impact on consumer spending. Table 4 also shows the impact of policies on annual consumer expenditure. All pricing policies are estimated to increase overall spending. This is because estimated reductions in alcohol consumption are smaller than the increases in prices (i.e. elasticities are between 0 and -1). As might be expected, changes in spending affect harmful drinkers most, with hazardous drinkers somewhat affected and moderate drinkers affected very little. Different policies strike a different balance between impacts on spending by moderate, hazardous and harmful drinkers, with general price rises having proportionately higher impacts on moderate drinkers than other policy options.

Variations in harm reductions and estimated financial savings of different pricing policy options

Our systematic review of the evidence clearly shows that different drinking patterns are associated with different types of harm (3). For example, crime and disorder as well as workplace absences (sick days) are associated predominantly with levels of peak alcohol intake during a single drinking occasion, and crime rates are most influenced by changes in drinking in young males rather than drinking by females or older people. In contrast, a large proportion of the direct health costs are associated with long-term chronic drinking in older drinkers. Therefore, policy options that differentially impact on consumption patterns (not just overall volume, but what is consumed where by whom and over what time period) also lead to differential effects on health, crime and other societal outcomes, and may thus be more or less attractive to the various sectors in governments (as well as lobby groups).

Accounting for heterogeneity in the model structure gives us the ability to assess variation in the effects of policies arising from different behavioural patterns in the subgroups. One indicator that enables comparisons of effects on different types of harms is the financial valuation of the harm reductions associated with each policy. The estimated financial valuations of the policy options (estimated savings in direct costs to healthcare, crime, and workplace harms) range from £633m for Option 8: minimum price 20p/60p for off/on-trade; to £7.1bn for Option 6: minimum price of 50p, over a 10-year period (Table 4).

In Figure 3, we use this indicator to illustrate some important variations in the proportions of the total estimated saving that are accounted for by health, crime, workplace absence and unemployment-related savings, respectively, as well as the giving the estimated monetary value of the savings under each heading. Policies are ordered from left to right according to their total valuation.

Insert Figure 3 here.

It is evident that policies that target the on-trade sector (Options 1, 3, 8-9: general price increases, policies targeting cheap on-trade alcohol and differential minimum prices) lead to proportionately greater crime cost savings than those that only affect the off-trade sector (Options 2, 4-5, 10: single minimum prices unless set at relatively high levels, policies targeting cheap off-trade products, off-trade discounting ban). Again, this can be explained by the strong relationship between alcohol-related crime and drinking preferences (predominantly on-trade drinking) in young men.

However, it is important to balance this against actual estimated savings. For example, whilst less than 6% of the total savings associated with a 50p minimum price (Option 6) are associated with reductions in crime, the estimated monetary value of these crime savings is £413m. In contrast, 34% of savings associated with the policy targeting cheap on-trade alcohol (Option 3) are from crime reductions, but the monetary value is lower at £400m.

Policy options targeting cheap off-trade products and minimum prices set at low levels lead to savings which are associated more with workplace related savings than with savings in health and crime. Health savings are proportionately smallest in options setting minimum prices at a very low level and highest for a ban on off-trade discounting, higher minimum pricing options (50p and higher) and general price increases.

Sensitivity analysis

An underlying assumption of our work is that the EFS proportions of on/off trade and low/high price purchasing for that subgroup can be applied to apportion GHS consumption. We tested this assumption by comparing the beverage preferences between subgroups in GHS and subgroups in EFS and whilst overall there is a good match, older female subgroups purchase a greater proportion of beer and spirits in the EFS than they consume in the GHS. A likely explanation for this that they may be doing more of the household's shopping, and thus some alcohol purchased by this group will likely be drunk by other household members. Therefore we have run a sensitivity analysis in which some of the off-trade purchases for females over the age of 25 are reallocated to other sub-groups in the model (males and younger females). The sensitivity analysis was run for three scenarios: a 10% general price increase, a 40p per unit minimum price and a total ban on off-trade price-based promotions. The general price increase shows almost no change in effect from the baseline results because the price distributions for all subgroups increase in the same way, regardless of the nature of the purchases. The 40p minimum price and off-trade promotion ban both show increased effectiveness from baseline (consumption changes for moderate, hazardous and harmful drinkers are -1.5%, -2.4% and -6.3% instead of -1.2%, -1.8% and -4.5% for a 40p Minimum Price; and -1.9%, -3.2% and -3.5% instead of -1.8%, -3.1% and -3.2% for an off-trade promotion ban). This is because the transfer of off-trade purchasing from females to males increases the proportion of off-trade beverages consumed by males. It is this type of consumption that is affected the most by minimum pricing and off-trade promotion bans, and because males drink more alcohol than females, the overall effect of

these policies increases. No difference is seen in the ranking by effectiveness of the priority groups.

Discussion

Alcohol pricing policy options that are more complex than simple duty increases are becoming available to policy makers. The UK Government has started engaging in a debate about possible price promotion bans, whilst the Scottish Government is considering minimum unit pricing options after already announcing discount bans.

In the context of these debates, we were commissioned by the UK Department of Health to systematically review existing evidence on the effects of pricing and promotion on alcohol consumption and related harm. We were asked to analyse the different policy options and consider their effects not only on the total population, but also on three priority groups considered in the government's alcohol strategy, namely underage drinkers, 18-24 year old binge drinkers, and harmful drinkers (16). Our study used individual level data-sets on alcohol consumption and purchasing to enable substantial heterogeneity to be accounted for in policy analysis.

This work pushes further than existing studies by examining subgroups by age, gender and three consumption levels, and considering their drinking preferences in terms of beverage types, price points and purchasing locations, enabling a fine-grained analysis. We have shown that, even though alcohol policies may look similar at a total population level, different groups are affected by alternative policies in differential ways. For example, we showed that compared to general price increases, minimum pricing policies tend to affect harmful drinkers proportionately more but young hazardous drinkers less than drinkers in general. There are also significant differences in how the policy options perform in terms the balance between health, crime and workplace harm reductions.

Whilst going further than previous modelling efforts in the field, we wish to point to several limitations and highlight areas for further research. No adequate evidence existed that would have allowed us to account for likely industry response to the policy options and possible effects on market structure and supply. Equally, we were unable to extend to wider costs or benefits, "drinkers' pleasure" or "social lubricant" effects, or include lower-level social disorder and the effect on families and friends of harmful drinkers. Our analysis has only partially taken income levels into account and we have not yet explored the differential effects of policies on income or socio-economic groups. Detailed UK data on the extent of

sales promotion in the on-trade are lacking and research or infrastructure investment to ascertain patterns here would likely be beneficial for policy and evaluation of change.

There is currently no longitudinal UK survey dataset that includes both price and consumption data, and matching the GHS and EFS data at a subgroup level was necessary. This introduces the risk of aggregation bias if purchasing preferences and consumption preferences do not match. Whilst we have been able to do some validation around this issue, a single data source containing both consumption and purchasing data would have been invaluable. General population surveys are also known to underestimate alcohol consumption (and expenditure) levels due to under-reporting and also under-represent some population groups at high risk of alcohol-related harm (17). Therefore, what data we have used is limited in that it stems from cross-sectional general population surveys, where we observe associations of patterns of price changes and consumption changes, rather than individual responses to price cues. Only short-run elasticities could be estimated, which tend to be substantially lower than long-run elasticities(1), thus the scenarios may underestimate the long-run effects of policy options. However, whilst acknowledging the limitations of the correlational design and the available data, our findings should be seen in the context of a very comprehensive literature on the link between pricing and consumption. Nevertheless, our elasticity estimates are in the same order of magnitude as those reported in the two recent international meta-analyses (1, 2).

Value judgements are being made at the level of individual societal subgroups and at the level of type of alcohol-related harms, especially by lobbyists and the media. Which particular groups the public and media are concerned with is largely dependent on the current societal discourse around proposed policy measures and may well vary from country to country. In the UK, much of the media debate about pricing policies is concerned with whether policies are fair on the “majority who enjoy responsibly” and whether any infringement of individual rights is proportional to the harms that are avoided. Accounting for heterogeneity shows more clearly the trade-offs between groups and stakeholder interests that are being made when a decision is taken.

It would be interesting to carry out further research on how this added transparency affects the policy making process. Does it help policy makers avoid unintended hardships and side-effects? When an effective policy has clear losers which have a strong lobby does this help policy makers or lobbyists? Does it make it easier or more difficult to negotiate policies between different stakeholders?

Obviously, choosing an appropriate level of heterogeneity is important, and will be influenced by researchers' and policy makers' knowledge of the subject, prior evidence, current policy priorities, time scales as well as limitations of available data. How to determine whether adding a further level of heterogeneity will have a major impact on the modelling results requires further methodological research.

There also remains a trade-off to be made on international generalisability. On the one hand, developing our model for England has set out a structure and some detailed thinking on accounting for heterogeneity that can be adapted to countries across the world. As we have shown, unless heterogeneity is incorporated, it is difficult to undertake analysis on more complex, targeted policy options. However, many countries will not have surveys similar to EFS and GHS, nor other UK data sources we have used to estimate health, crime and employment costs. Whilst much simpler model structures would be more easily generalised across countries, researchers have to consider carefully whether ignoring heterogeneity is reasonable. We anticipate that several adaptation case studies will emerge over the coming years.

In summary, this is the first integrated modelling study to answer specific questions around relatively complex pricing and promotion policies, and their related effects on harms in terms of health, crime and employment in England. The suite of models, links drinking and purchasing preferences to wholly and partially attributable, chronic and acute alcohol-related illnesses and mortality, to crimes, and to work absence and unemployment. Results show that accounting for heterogeneity and complexity in such a way is both informative and essential if the resulting policy decisions are to be well-considered, proportionate, effective and cost-effective. Whether our modelling has gone far enough in considering heterogeneity, or whether some more detail or other factors are also crucial is for debate.

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Table 1. Proportion of alcohol consumed by percentiles of the population and its variation across age/sex groups

Consumption decile	Total population	Men	Women	Young men	Young women
10th decile (10% heaviest drinkers)	44.9%	52.0%	32.4%	59.0%	37.3%
9th decile	20.7%	20.7%	20.7%	17.5%	20.3%
8th decile	13.3%	12.2%	15.2%	10.3%	15.4%
7th decile	9.8%	7.8%	13.3%	6.2%	10.2%
6th decile	5.9%	3.8%	9.4%	3.7%	8.5%
5th decile	3.4%	2.2%	5.4%	2.1%	5.4%
4th decile	1.6%	1.0%	2.7%	0.9%	2.2%
3rd decile	0.4%	0.2%	0.8%	0.2%	0.7%
2nd decile	0.0%	0.0%	0.1%	0.0%	0.1%
1st decile (10% lightest drinkers)	0.0%	0.0%	0.0%	0.0%	0.0%

Note. Reanalysis of data from the General Household Survey 2006, Office for National Statistics. Social and Vital Statistics Division, data supplied by the UK Data Archive. Data are Crown copyright (11).

Table 2. Average weekly units consumed in the on-trade versus off-trade sector: by gender and drinking level

	Male				Female			
	On-trade		Off-trade		On-trade		Off-trade	
	Units	Row %	Units	Row %	Units	Row %	Units	Row %
Moderate	4.4	57%	3.4	43%	1.2	31%	2.7	69%
Hazardous (all ages)	15.1	47%	16.8	53%	4.1	20%	17.1	80%
Hazardous (age < 25)	24.1	76%	7.8	24%	13.0	60%	8.7	40%
Harmful	34.9	43%	46.4	57%	6.6	12%	48.3	88%
All drinkers	10.1	48%	10.7	52%	2.4	21%	8.7	79%

Note. Analysis of data from the General Household Survey 2006 and Expenditure and Food Survey 2005/6 (11, 12)

Table 3. Average price (in £) per unit of alcohol by drinker group and drinking location

	Men off-trade	Women off-trade	Men on-trade	Women on-trade	Total on- and off-trade
Moderate	0.45	0.45	1.16	1.40	0.87
Hazardous	0.41	0.42	1.02	1.21	0.68
Hazardous (aged <25)	0.40	0.41	1.05	1.13	0.89
Harmful	0.41	0.39	0.98	1.14	0.55
All drinkers	0.42	0.40	1.04	1.25	0.65

Table 4. % change in consumption for selected policy options: by drinker subgroup, ranked by total 10-year valuation of cost savings

Option #	Policy Description	10 year financial valuation (£m)[a]	Consumption changes in %							Consumption change ratios				Increases in consumer spending (£ per drinker per annum)		
				Drinking level				Gender								
		Total population	Total population	moderate	hazardous	harmful	hazardous aged <25	male	female	Ratio harm/ mod	Ratio haz <25/ mod	Ratio mod/ all	Ratio male/ female	moderate	hazardous	harmful
6	Minimum price 50p	7,128	-6.9	-3.5	-5.9	-10.3	-3.0	-5.6	-9.3	2.92	0.85	0.51	0.60	11.8	68.2	163.4
1	General price increase +10%	3,951	-4.4	-3.5	-4.7	-4.5	-6.0	-4.4	-4.4	1.30	1.72	0.80	1.00	17.1	50.2	115.9
5	Minimum price 40p	3,140	-2.6	-1.2	-1.8	-4.5	-0.7	-2.2	-3.5	3.80	0.59	0.45	0.63	6.0	39.1	105.5
10	Total ban of off-trade discounting	2,358	-2.8	-1.8	-3.1	-3.2	-0.9	-2.1	-4.1	1.78	0.50	0.64	0.51	4.2	19.5	49.1
9	Minimum price 30p/80p off/on-trade	2,348	-2.1	-1.3	-1.9	-2.5	-7.2	-2.5	-1.4	1.92	5.60	0.61	1.79	4.9	20.8	70.4
3	Low-price on-trade products +25%	1,170	-1.3	-1.0	-1.6	-0.9	-6.1	-1.7	-0.7	0.92	5.92	0.78	2.43	3.1	5.1	24.0
4	Minimum price 30p	927	-0.6	-0.2	-0.3	-1.3	0.0	-0.6	-0.7	6.98	0.00	0.29	0.86	1.9	13.7	43.0
7	30p Minimum price beers only	786	-0.5	-0.1	-0.1	-1.2	-0.1	-0.7	-0.1	15.43	1.31	0.15	7.00	0.9	7.9	22.5
2	Low-price off-trade products +25%	716	-0.6	-0.3	-0.2	-1.1	0.1	-0.4	-0.9	3.58	-0.33	0.53	0.44	2.1	14.1	37.8
8	Minimum price 20p/60p off/on-trade	633	-0.6	-0.3	-0.6	-0.6	-2.8	-0.7	-0.3	2.06	9.81	0.50	2.33	1.2	5.5	21.0

[a] Estimate of direct cost savings in health, crime and workplace, for the 10 years following the policy change

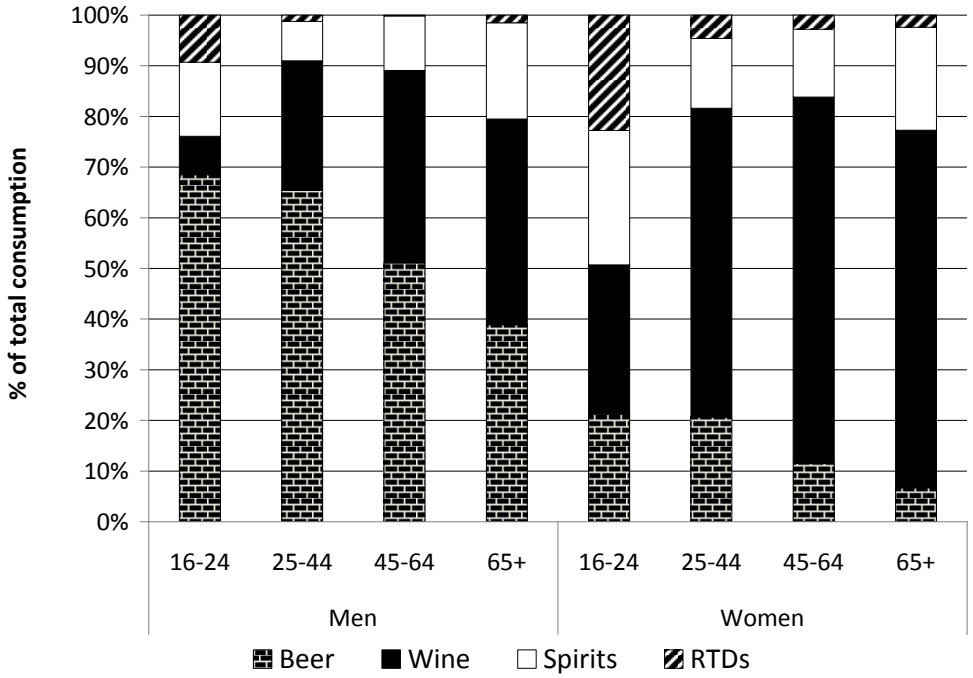

Figure 1. Consumption of each beverage type as a proportion of total weekly average consumption: by age and gender.

Note. Analysis of General Household Survey 2006 data (11)

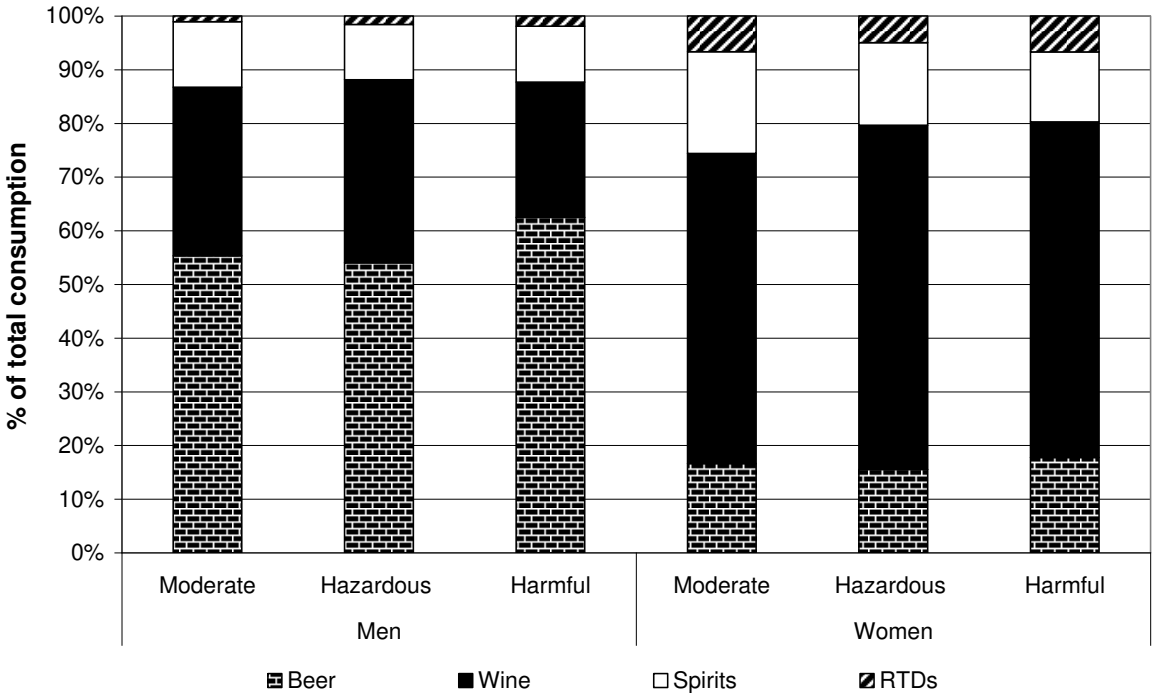

Figure 2. Consumption of each beverage type as a proportion of total average weekly consumption: by gender and drinking level.

Note. Analysis of General Household Survey 2006 data (11).

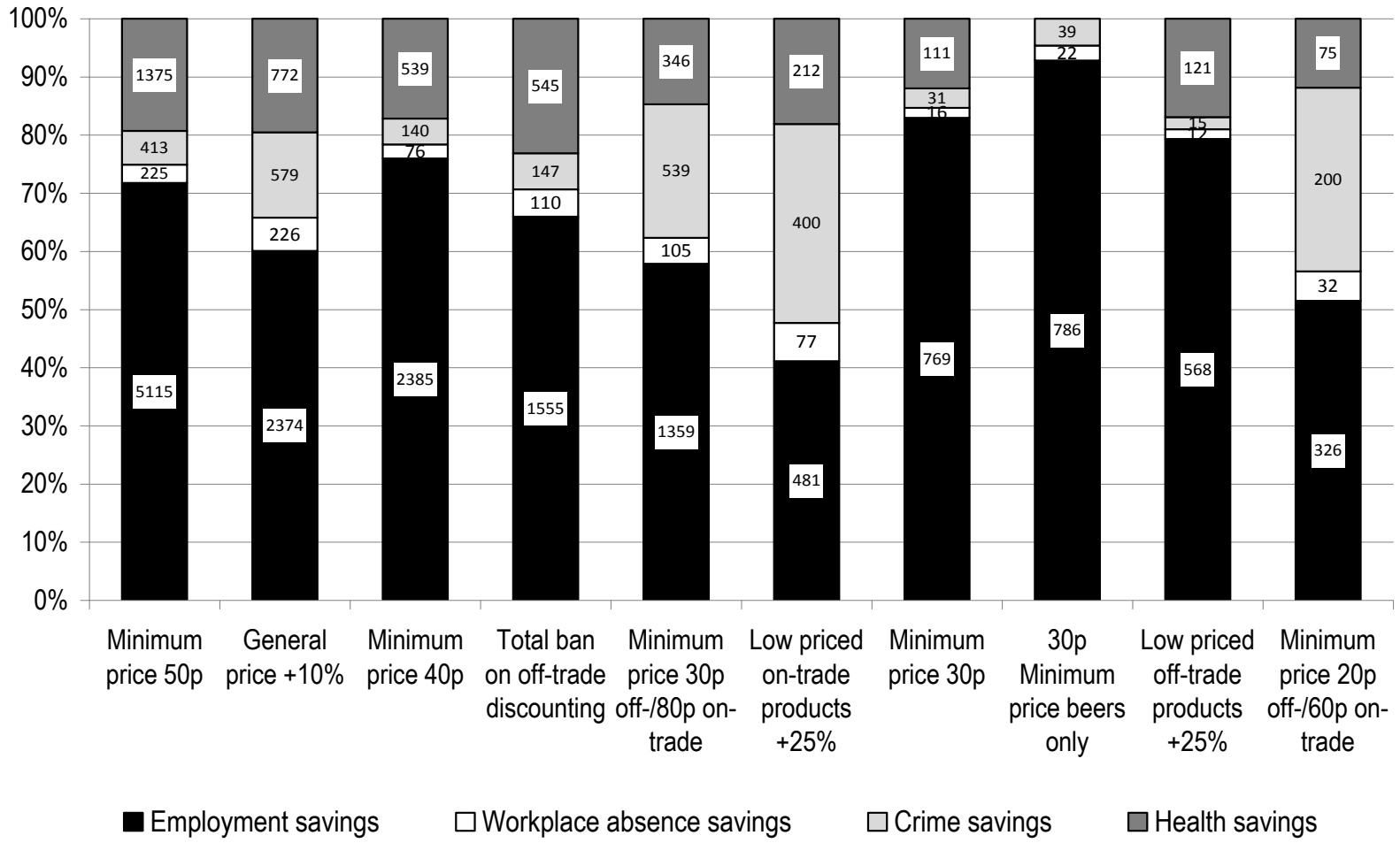

Figure 3. £m saved and relative proportion of total saving associated with reductions in health, crime, workplace absence and unemployment harm. Note. Policies are ordered by total valuation, with the highest valued policy option on the left-hand side, the lowest-valued option on the right-hand side.