

RESEARCH

Potential benefits of minimum unit pricing for alcohol versus a ban on below cost selling in England 2014: modelling study



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Abstract

Objective To evaluate the potential impact of two alcohol control policies under consideration in England: banning below cost selling of alcohol and minimum unit pricing.

Design Modelling study using the Sheffield Alcohol Policy Model version 2.5.

Setting England 2014-15.

Population Adults and young people aged 16 or more, including subgroups of moderate, hazardous, and harmful drinkers.

Interventions Policy to ban below cost selling, which means that the selling price to consumers could not be lower than tax payable on the product, compared with policies of minimum unit pricing at £0.40 (€0.57; \$0.75), 45p, and 50p per unit (7.9 g/10 mL) of pure alcohol.

Main outcome measures Changes in mean consumption in terms of units of alcohol, drinkers' expenditure, and reductions in deaths, illnesses, admissions to hospital, and quality adjusted life years.

Results The proportion of the market affected is a key driver of impact, with just 0.7% of all units estimated to be sold below the duty plus value added tax threshold implied by a ban on below cost selling, compared with 23.2% of units for a 45p minimum unit price. Below cost selling is estimated to reduce harmful drinkers' mean annual consumption by just 0.08%, around 3 units per year, compared with 3.7% or 137 units per year for a 45p minimum unit price (an approximately 45 times greater effect). The ban on below cost selling has a small effect on population health—saving an estimated 14 deaths and 500 admissions to hospital per annum. In contrast, a 45p minimum unit price is estimated to save 624 deaths and 23 700 hospital admissions. Most of the harm reductions (for example, 89% of estimated deaths saved per annum) are estimated to occur in the 5.3% of people who are harmful drinkers.

Conclusions The ban on below cost selling, implemented in the England in May 2014, is estimated to have small effects on consumption and

health harm. The previously announced policy of a minimum unit price, if set at expected levels between 40p and 50p per unit, is estimated to have an approximately 40-50 times greater effect.

Introduction

The UK government has been considering different policy options to regulate the price of alcohol in England and Wales. Increasing the price of alcohol has been shown to be effective in reducing both consumption levels¹ and harms.² Recent Canadian research shows that minimum pricing policies reduce total alcohol consumption, shift consumption away from high strength beverages, and reduce alcohol related admissions to hospital.^{3 4} In 2010, the UK government proposed a “ban on below cost selling,” which would target drinks that are currently sold so cheaply that their price is below the cost of production and retail.⁵ In principle this would affect alcohol wherever sold, but in practice such cheap drinks are sold in supermarkets and other shops (the “off-trade”) rather than in pubs, clubs, bars, and restaurants (the “on-trade”). In the absence of detailed, commercially sensitive information on production and retail costs, the government developed a simplified policy, which proposed that the selling price to consumers could not be lower than the tax payable on the product. In the United Kingdom, tax on alcohol has two components: the alcohol beverage specific duty, for example, £28.22 (€35.57; \$46.10) per litre of pure alcohol for spirits as of March 2014, and a sales value added tax (VAT), which is currently an additional 20% on top of the price of the product. Thus the selling price for a product under a ban on below cost selling (BBCS) policy would not be allowed to be lower than $\text{Price}_{\text{BBCS}} = \text{duty} + \text{duty} \times 20\%$. Because the alcohol duty rates vary for different drinks, a ban on below cost selling would target those drinks that currently have higher duty rates (for example, spirits) and have less effect on drinks

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Technical appendix

with lower duty rates (for example, cider). In 2012 the UK government announced an alternative policy for its alcohol strategy—a minimum unit price for alcohol⁶—and levels discussed ranged between 40p and 50p per unit. In 2013 the government then withdrew this commitment and returned to its previous ban on below cost selling policy, which it subsequently introduced in May 2014.⁷ Under a minimum unit price policy, the minimum selling price increases in proportion to the alcohol units contained in the drink (1 unit=7.9 g/10 mL of pure ethanol). Thus a minimum unit price measure would target those drinks that are high in alcohol content and sold relatively cheaply; drinks that are favoured more by those drinking at harmful levels.⁸ For eight example purchases, table 1^{||} shows that a ban on below cost selling thresholds would differ considerably compared with, for example, a 45p minimum unit price level, and that since the duty on cider is low and does not increase in line with alcohol content, the ban on below cost selling threshold falls as low as 6p per unit for high strength cider.

The potential effects of a minimum unit price in England were previously examined in 2009-10.^{8,9} The Sheffield Alcohol Policy Model (version 2.0) used consumption survey data from the general lifestyle survey 2006 as the baseline year. The model also included levels of purchasing and prices paid from the expenditure and food surveys 2001-06 and commercially available population level distributions for prices paid for various alcohol beverage types from the commercial market research companies CGA Strategy and AC Nielsen for 2008. Baseline levels of the harms associated with alcohol were taken from 2005 for admissions to hospital and mortality in 47 diseases.¹⁰ The model estimated changes in consumption and the levels of harms over a 10 year period after the introduction of the policy, examining 54 subgroups of the population based on age, sex, and three levels of consumption (moderate, hazardous, and harmful). The research report and subsequent publications examined the potential impact of a minimum unit price threshold, ranging from 20p to 70p per unit.⁸ The findings contributed substantially to the debate surrounding pricing regulation and future policy options.^{11,12} Several areas were identified for further development of both the version 2.0 model and the evidence used within it. In particular, further evidence and analyses on the price elasticities for alcohol (which are used to quantify the relation between price changes and consumption changes) were a priority. The original work used cross sectional analysis of five years of data from the expenditure and food survey to estimate price elasticities for the main analysis, and also tested how sensitive the results were to alternative estimates taken from the research literature. The previous model combined beers and ciders, which would be better separated given their different duty rates and consumption patterns.

We defined moderate drinking as alcohol intake up to 21 units per week for males and 14 units per week for females, and non-drinkers were included in this group; hazardous drinking as alcohol intake between 21 and 50 units per week for males and between 14 and 35 units for females; and harmful drinking as alcohol intake of more than 50 units per week for males and over 35 units for females.

In this study we have developed a new version of the Sheffield Alcohol Policy Model (version 2.5) in which we have updated data on baseline consumption and prices; developed new estimates on price elasticity accounting for the longitudinal aspects of the expenditure and food survey data (now renamed as the living costs and food survey), separated cider from beers; and incorporated greater subgroup functionality including the ability to define socioeconomic subgroups.¹³ The Sheffield

Alcohol Policy Model (version 2.5) is used to address the current research question: What would be the differential potential impact of a ban on below cost selling versus a minimum unit price policy of 40p, 45p, or 50p if the policies were to be implemented in 2014-15? In particular, what are the estimated potential effects on alcohol consumption, consumer spending, tax and duty revenues, and health harms, including deaths, admissions to hospital, quality of life, and costs to the National Health Service of these outcomes?

Methods

Overview of the model

The aim of Sheffield Alcohol Policy Model (version 2.5) is to appraise a wide variety of policy options, including minimum unit pricing through analysis of selected costs and benefits. This involves modelling a linked series of policy outcomes for 96 population subgroups defined by sex, age, annual income, and consumption level. The outcomes are: the effect of the policy on the distribution of prices for different types of alcohol; the effect of changes in price on alcohol consumption; the effect of changes in alcohol consumption on revenue for retailers, the exchequer, and consumer spending on alcohol; and the effect of changes in alcohol consumption on levels of alcohol related admissions to hospital and deaths and quality adjusted life years lost. The model also appraises effects on crime and workplace outcomes (not reported here). The methods used are set out below (see supplementary technical appendix for full details).

Baseline data

The modelling begins with individual level baseline data from the general lifestyle survey 2009 on mean weekly and peak day consumption (a proxy for individuals' scale of binge drinking) of alcohol for 11 385 people in England. It considers 96 subgroups split by age, sex, mean consumption level (moderate, hazardous, and harmful), and income (low and higher income). (We define low income as those below the relative poverty line, defined as 60% of median equivalised household income and higher income as people above the relative poverty line.) Data on prices paid and quantity purchased by each subgroup for 10 different beverage types (off-trade and on-trade beer, cider, wine, spirits, and ready to drinks "alcopops") are available from the living costs and food survey, an annual two week purchasing diary survey of around 6500 UK households. We utilised data on prices paid for England only, for the years 2001-02 to 2009, a sample of 227 933 purchasing transactions. These self reported prices paid for alcohol are known to over-estimate the mean price paid,⁹ and we adjust them so that the distribution of actual amounts of alcohol bought at different price levels match with actual sales prices in the market using 2011 data from AC Nielsen and CGA Strategy.

Process for estimating effect of price change on consumption for population subgroups

A minimum unit price or a ban on below cost selling policy is assumed to increase all product prices below the policy threshold up to exactly the threshold level, and it is further assumed to affect none of the products currently priced above the threshold. The percentage change in mean price paid in each subgroup for the 10 beverage types is used to estimate the effect of price changes on consumption. This is done in conjunction with own price elasticities (for example, percentage change in consumption of off-trade beer given a 1% increase in off-trade beer price), and cross price elasticities (for example, percentage change in off-trade beer consumption given a 1% increase in

the price of another product, for example, off-trade spirits). When a change in prices is inputted as a model scenario, the percentage change in mean weekly consumption for each population subgroup is estimated for each beverage. This is then applied to the corresponding individual level consumption data in the model. Each individual's percentage change in peak daily consumption is indirectly modelled using a linear regression, with peak daily consumption estimated as a function of mean weekly consumption, age, and sex.

Estimating price elasticities for alcohol

To estimate the effect of changing prices on consumption, a new set of price elasticity models have been developed. Full details on the statistical approach and the model fit can be found elsewhere.¹⁴ Technically, we used individual level data from the living costs and food survey for 2001 to 2009 to construct a time series pseudopanel for 72 defined population groups based on sex, birth year, and socioeconomic status. Within each population group, in each year, and for each of the 10 beverage categories, we calculated the mean number of units purchased and the mean price paid. A set of 10 fixed effects regression models were then fitted to estimate the own and cross price elasticities. Covariates adjusted for in the final models were income, age, and proportions of individuals in each population group having children, and being married, unemployed, and a smoker. Table 2 shows the resulting own price and cross price elasticities. To illustrate the interpretation, the own price elasticity for off-trade beer (top left cell of matrix) was -0.980 , which means that a 1% increase in the price of off-trade beer would be estimated to result in a 0.98% reduction in the amount purchased. Similarly, there can be switching between drinks when prices change, so for example (two cells to the right), a 1% increase in off-trade beer was estimated to produce a slight increase of 0.096% in purchasing of off-trade wine. To examine the effects of uncertainty, we also carried out runs of the Sheffield Alcohol Policy Model (version 2.5) using alternative definitions to generate the pseudopanel purchasing groups, and using probabilistic sensitivity analysis accounting for variable uncertainty reported in the regression coefficients.^{15 16}

Note that different subgroups in Sheffield Alcohol Policy Model (version 2.5) experience different scales of effect due to a price change because for each subgroup we accounted for data on their preferences for the 10 categories of beverage (for example, middle aged women drink more wine at home, younger men drink more beer on nights out) and data on the prices paid for each of the 10 beverages (for example, harmful drinkers spend less per unit on average). Thus, the 10x10 matrix of price elasticities means that each of the 96 modelled population subgroups essentially has a different overall price elasticity and a different scale of response to a given policy (for example, drinkers who favour cheaper cider would be more affected by a minimum unit price because their beverages would experience a relatively large increase in price and also because the own price elasticity for off-trade cider is relatively large at -1.268).

Risk functions and modelling process for health harms

The baseline and estimated post-policy consumption data for each of the population subgroups feed into a second model component relating changes in consumption to changes in harm. We model the effects of consumption changes on mortality and disease prevalence for 47 conditions defined by the international classification of diseases, 10th revision (ICD-10) codes.¹⁰ The modelling uses epidemiological risk functions, which one can visualise as a graph, with the x axis being level of consumption

of alcohol in units and the y axis being the risk of harm, for example, relative risk of mortality from oesophageal cancer (ICD10 code C15). We partitioned the diseases into four categories: chronic or acute conditions, which were attributable partially or wholly to alcohol. For partially attributable chronic conditions, we used functions relating an individual's mean consumption to his or her health risk from the published literature.¹⁵ For partially attributable acute conditions, published literature is more limited, and we quantified functions relating highest daily consumption to risk by calibrating the slope of an assumed linear risk function to published evidence of the alcohol attributable fractions for each condition (see details⁸). For wholly attributable chronic and acute conditions, we similarly calibrated functions relating either mean weekly units or maximum daily consumption to absolute risk to published evidence on the absolute number of cases observed.⁸

This process was undertaken both for annual mortality risk for each condition and for morbidity risk, where morbidity was defined as the annual rate of person specific admissions to hospital. Condition specific mortality rates for each age and sex based subgroup are taken from published analyses of 2005-06 Office for National Statistics, and morbidity rates from 2005-06 hospital episodes statistics.¹⁰

The modelled change in consumption for each subgroup then feeds into a change in relative or absolute risk, and the potential impact fraction method¹⁷ is used to adjust observed mortality and morbidity rates. For chronic conditions, there can be a time lag between population level changes in alcohol consumption and changes in outcome, and we chose a linear time lag function of 10 years to realisation of full effect, which is consistent with average estimates in the literature.¹⁸

Framework for base case and sensitivity analyses

For all ban on below cost selling analyses, we estimated the average duty plus VAT per unit of alcohol for beer, cider, wine, spirits, and ready to drink beverages (or alcopops) in the United Kingdom based on the duty rates set by Her Majesty's Revenue and Customs effective from 25 March 2013. We used several assumptions to estimate these thresholds because different duty rates exist for the same modelled beverage type (for example, there are currently three duty rates for beer which increase with alcohol content) and because duty rates for cider and wine are calculated based on product volume rather than on ethanol content. (For full details see supplementary technical appendix table 13.1 or table 1 in Meng et al¹⁶.)

The set of policies analysed are a ban on below cost selling and minimum unit price policies with thresholds of 40p, 45p, and 50p in 2014-15 prices. We particularly focus on 45p as this was the level proposed by the UK government. The model actually uses 2011 as the baseline year because this is our most recently available price distribution data. We adjusted for future beverage specific retail price indices using estimates provided by the Home Office (for details see supplementary technical Appendix table 5.3).

The analysis reported here applies the elasticity matrix estimated in table 2. See online for the full details on methods and results of sensitivity analyses undertaken to test the robustness of our results under alternative elasticity matrices (for example, assuming no substitution effects, excluding non-significant ($P < 0.05$) elasticities, separate matrices for low income and higher income groups, and separate matrices for moderate versus hazardous or harmful groups).¹⁶

Results

The proportion of the market that would be affected by price regulation is the key driver of the scale of estimated policy impact. Overall, just 0.7% of alcohol units are estimated to be sold below the ban on below cost selling duty plus VAT threshold. In contrast, a 45p minimum unit price would affect 23.2% of all units. For analyses across subgroups, baseline consumption and prices paid are shown in table 3. Harmful drinkers are a policy priority group, as they consume substantially (on average 58 units per week for females, 80 units for males) and spend substantially (£1800 and £3400 per annum, respectively). Of the population aged 16 or more, 2.2 million (5.3%) are harmful drinkers, 7.2 million (17.3%) are hazardous drinkers, and 25.5 million (61.5%) are moderate drinkers. The proportion of alcohol affected by a minimum unit price varied across these subgroups: for example, a 45p minimum unit price would affect 12.5%, 19.5%, and 30.5% of units sold to moderate, hazardous, and harmful drinkers, respectively. In contrast, table 3 and figure 1 show that the impact of a ban on below cost selling on all drinkers would be minimal, and just 1.0% of units currently consumed by harmful drinkers would be affected.

Table 4 shows the estimated impact on consumption and on spending for subgroups. A ban on below cost selling was estimated to reduce harmful drinkers' mean annual consumption by around 3 units (approximately 1.5 fewer pints of beer in a year). In contrast, a 45p minimum unit price was estimated to reduce harmful drinkers' consumption by 137 units per year; an approximately 45 times greater effect than a ban on below cost selling. Changes in spending were relatively small for all subgroups under a 45p minimum unit price. This is because several price elasticity estimates for beverage types particularly affected by these policies (see table 2) are around -1.000, indicating that as people face increased prices for these products they reduce purchasing to an extent that maintains their current level of spending. Thus, for example, although harmful drinkers were estimated to reduce mean annual consumption by 137 units, because the products that they buy would now have higher prices mean spending was estimated to change for this subgroup by just minus £1.70 per year (0.06% of the £2771 total). For a 45p minimum unit price, moderate drinkers on average were barely affected in terms of both mean consumption and mean spending (a reduction of 1.6 units—less than one pint of beer per annum and an increase in spending per annum of 90p). Figure 2 illustrates the 45-fold greater effectiveness of a 45p minimum unit price over a ban on below cost selling in terms of reductions in consumption.

The estimates for reduction in health harm again show that a ban on below cost selling has minimal effect (table 5). For example, 10 years after policy implementation, the ban on below cost selling showed a saving of just 14 deaths and around 500 admissions to hospital per annum, which compared with an estimated 624 deaths and 23 700 admissions prevented by a 45p minimum unit price—around a 40 to 50 times greater effect than a ban on below cost selling. A similar pattern was shown for the cumulative measures of harm reduction over 10 years, which were each almost 50 times higher for a 45p minimum unit price versus a ban on below cost selling—for example, total quality adjusted life year (QALY) gains for England (24 200 v 500), healthcare cost savings (-£9.5m v -£417.2m), and the financial valuation of the QALY gains assuming a £60 000 value for one quality adjusted life year in line with Department for Health guidance (£33m v £1591). Most of the harm reduction occurred in those 5.3% of people who were harmful drinkers (for example, for a 45p minimum unit price, 554 of the 624

deaths equated to 89% of the estimated overall death reduction). Figure 3 illustrates the 40-fold difference between harm reduction estimates for a 45p minimum unit price and those for a ban on below cost selling, and also shows that as the threshold of alternative values for a minimum unit price was increased (for example, 40p, 45p, 50p), thus covering more of the market of products, then the estimated harm reductions increased.

The wider economic effects on retailer revenues and tax revenues have also been examined. In summary, retailer revenues in shops and supermarkets (the off-trade) for a 45p minimum unit price are estimated to increase by 5.6% or £201.1m while for a ban on below cost selling the effects are small: a 0.2% or £5.4m increase. One would expect that this increase in revenues would imply an increase in profits on alcohol sales for off-trade retailers but, without access to the details of retailers' cost base, a quantified calculation of profits cannot be undertaken. In contrast, the effects on government tax revenue are small, primarily because the two separate tax effects counteract each other. Alcohol duty revenue will fall a little because it is related to the volume of alcohol sold, but VAT will rise a little because it is charged as a percentage of product price and products are being sold at higher prices. The net effect was estimated at decreased total alcohol tax revenues of £48.5m or 0.6% for a 45p minimum unit price and £1.5m or 0.02% for a ban on below cost selling.

Several sensitivity analyses have been undertaken on these central estimates to consider uncertainty. Details of all of these are provided in the report sent to the UK Home Office to inform its responses to a consultation on minimum unit pricing, which can be seen online.^{15 16} The results support the above findings on the comparative effectiveness of a ban on below cost selling and a minimum unit price but suggest that the base case minimum unit price model may be conservative in its estimates of policy effectiveness.

Discussion

This study quantifies the potential impact of the UK government's policy of a ban on selling alcohol for less than the cost of the payable duty and VAT using the Sheffield Alcohol Policy Model (version 2.5) to estimate the proportion of products affected, the reduced consumption of alcohol by different population subgroups, and the resulting harm reductions. The findings suggest that the effects of a ban on below cost selling would be small—a -0.04% change in consumption and a central estimate for the reduction in deaths of just 14 per year at full effect. We have compared this with the minimum unit price policy originally proposed by the prime minister in the government's alcohol strategy⁶ and find that such a policy would have an estimated 40-50-fold greater effect than a ban on below cost selling. Sensitivity analyses on these effects suggest that the relative scale of impact between a ban on below cost selling and a minimum unit price are robust to a variety of assumptions and uncertainties.

The study has also examined subgroup impacts, showing that the greatest effects of a 45p minimum unit price policy would be in harmful drinkers. This is because they are the group that buys the greatest share of the cheaply priced alcohol, faces greater price increases than for example moderate drinkers if a 45p minimum unit price were implemented, and buys in larger volumes thus incurring larger absolute reductions in consumption leading to larger harm reductions. For a 45p minimum unit price, they are estimated to reduce consumption by 137 units per year on average and gain in terms of an estimated reduced mortality rate of 550 fewer deaths per year.

In contrast, the 61.5% of the population who are moderate drinkers are on average affected little—a mean reduction in consumption of 1.6 units per year and spending increase of just 90p per year for a 45p minimum unit price.

Strengths and weaknesses of this study

Our study has several limitations in relation to the evidence base available. Self report surveys can be problematic for under-recording alcohol consumption (general lifestyle survey) and purchasing (living costs and food survey), which will affect the results for change in consumption and spending.¹⁹ Potentially, under-recording could also affect the estimation of harm reduction; although this is less clear because there is debate on whether surveys underpinning the risk function literature measure exposure to alcohol in a way that is consistent with our surveys or otherwise.²⁰ In the absence of a single dataset recording both purchase and consumption, the model assumes that a 1% change in purchasing by an individual equates to a 1% change in consumption, although with a ban on below cost selling effect of -0.04% , plausible alternative assumptions would make a negligible difference. The measure of binge drinking available in the general lifestyle survey (consumption on the peak drinking day in the seven days before the survey) also has limitations, and we are beginning to explore the use of more refined measures of binge behaviour, including frequency of drinking occasions and level of consumption on each occasion.²¹ Evidence shows that the relation between consumption and health risk may differ for mortality compared with morbidity for some conditions.²² However, as such evidence is not available for all conditions, we do not model separate mortality and morbidity risk relations, although this would be possible as the evidence base develops. Price elasticities are also an important driver of the results and, although we have further improved our price elasticity estimates in this version of the model, the ideal data, a longitudinal population panel collecting both prices paid and amounts consumed for the various categories of alcohol, is not available in the United Kingdom (see details in Meng et al¹⁴). The model as it stands is valid when comparing the differences between two pricing policies. In quantifying these differences it makes the assumption that, all other things being equal, the patterns of population consumption would remain as they are currently evidenced in the most recent baseline year, rather than having a dynamic long term trend analysis. This means that the model provides an estimate of the incremental difference between “with minimum unit price policy” and “without minimum unit price policy” but does not directly account for concurrent effects of other policies or societal trends on any of the outcome measures used. For example, the model results are not adjusted for trends in macroeconomic factors affecting alcohol affordability, such as changes in incomes or changes in macroeconomic growth, nor are they adjusted for the effects of other alcohol policy interventions operating simultaneously, such as increased use of screening and brief interventions, which we have previously estimated to be cost effective.²³

Strengths and weaknesses in relation to other studies

This study has several strengths in relation to our own previously published work, which addresses minimum unit pricing but not a ban on below cost selling.^{8 9} We have extended the categories of alcoholic beverages to separate out cider, which has a different duty regimen, and this was an important development to allow more robust analysis of a ban on below cost selling. We have updated the data on consumption to 2009. We have

recalibrated the relevant disease risk functions. We have updated prices paid using both new living costs and food survey and data from the commercial market research companies AC Nielsen and CGA Strategy for the years 2009 and 2011, respectively. Most importantly, rather than analysing the data on prices paid in a purely cross sectional manner we have generated new estimates of price elasticity effects, which incorporate a degree of longitudinality into the analysis.

Considering that the pricing policies being discussed here have either never been implemented in the United Kingdom or have only recently been implemented, there is currently a lack of data with which to validate our findings. However, we have also applied these methods to two Canadian provinces,²⁴ the results of which can be compared with external data. Ontario and British Columbia have both government liquor stores and an extensive network of private liquor stores, which are required to comply with minimum price regulations for each beverage type. We applied the Sheffield Alcohol Policy Model (version 2.0) framework to these provinces, using Canadian data on alcohol consumption, alcohol purchasing, and rates of harm. We compared Sheffield Alcohol Policy Model estimates to those obtained from statistical analyses of prices, health outcomes, and hospital admissions in British Columbia between 2002 and 2009.^{3 25} The estimates obtained using the Sheffield Alcohol Policy Model (version 2.0) approach seem to be conservative compared with actual results, with estimates typically less than half those from the statistical modelling. This is consistent with our approach of, where necessary, making conservative assumptions so as not to overstate the potential impact of minimum unit pricing policies. For example, the assumption that higher priced products are not affected by setting a minimum unit price may be conservative, and Canadian evidence from British Columbia has found that when minimum prices were raised, the prices of some more costly beverages also increased.⁴ A second example relates to evidence that is also emerging in Canada whereby the assumption of a lag function of 10 years to realise a full effect on chronic disease outcomes may also be conservative because statistically significant impacts on alcohol related disease have been found between two and four years after prices changed.²⁵

Meaning of the study: possible explanations and implications for clinicians and policymakers

The reasons why the Sheffield Alcohol Policy Model (version 2.5) estimates a 45p minimum unit price has such greater estimated impact than a ban on below cost selling are clear—a greater proportion of the market is affected and to a greater extent and this is especially true for harmful drinkers. It is this more specific targeting of harmful drinkers that sets the minimum unit pricing policies aside from for example general price or tax increases across the board. From a national policy perspective, the UK government has recently implemented the ban on below cost selling but has indicated that it will watch with interest events in Scotland. The Scottish government passed legislation to introduce a 50p minimum unit price after reviewing analyses using the Sheffield Alcohol Policy Model (version 2.0)²⁶, but has not been able to implement the policy owing to a legal challenge from the Scotch Whisky Association. The Republic of Ireland has also committed to introducing a similar policy in conjunction with Northern Ireland. More locally in the United Kingdom, several local authorities are considering or have enacted forms of price agreements or voluntary restrictions on sale of high strength low cost alcohol with local retailers,^{27 28} and this study suggests that agreements focusing

on alcohol sold at 40p, 45p, or 50p per unit could have substantive effects in relation to drinker related harms.

Unanswered questions and future research

A key unanswered question is the relative effectiveness of minimum unit pricing when compared with general increases in tax. It would be of great interest and value to decision makers to analyse the comparative effects of further pricing policy options by, for example, quantifying the scale of increase in excise duty necessary to have equivalent consumption or harm reductions as those modelled here for a 45p minimum unit price, and to investigate what the impact of such duty increases would be on moderate drinkers. To do so requires analysis of duty rates and also the extent to which tax rises are passed on to consumers by retailers after they are implemented by government.²⁹ This tax pass-through and comparative analysis is a topic of our ongoing research.

In addition to our analysis of health harms as described in this paper, a wider public health perspective can be used, and estimates are also available on the effects of these policies in terms of reductions in crime and absence from work. Beyond these policy research questions at national and local level, methodological issues remain around estimating the joint impact of price policies implemented alongside other interventions and services such as screening and brief interventions or specialist treatment services for dependent drinkers; the financial valuation of harms; and quantifying the harms done to others (for example, in families) rather than to drinkers themselves.

Conclusion

The UK government's recently implemented ban on below cost selling affects just 0.7% of alcohol units currently sold and is estimated to have small effects on consumption and health harm. The previously considered policy of a minimum unit price, if set at expected levels between 40p and 50p per unit, is estimated to have an approximately 40-50 times greater effect.

Contributors: AB supervised the design and conduct of the modelling and drafted and finalised the manuscript. He is the guarantor. YM undertook the modelling work and led the development of version 2.5. JH contributed to the design of the modelling and drafting and revising the manuscript. DH contributed to the development of the modelling and drafting and revising the manuscript. PM is the principal investigator of the study and contributed to the design of the modelling and revision of the manuscript. All authors, external and internal, had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. Independence of researchers: Researchers worked independently from the funders. Similarly the writing of the report and the decision to submit the article for publication was entirely independent of the funders.

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relationships or activities that could appear to have influenced the submitted work.

Ethical approval: No ethics committee approval was required for this work as it consists of secondary analysis of data collected by third parties. All data on human participants was collected by UK government bodies under their own ethical procedures, and these cover using the data for purposes such as the present study.

Data sharing: The secondary data sources are already publicly available.

Transparency: The lead author (AB) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

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What is already known on this topic

2010 analyses showed the estimated impact of different possible thresholds for a minimum unit price for alcohol in England and found that higher thresholds would lead to greater estimated reductions in harm

Canadian research has shown empirical evidence for direct impacts on health outcomes when minimum unit prices are increased

That research also suggests that the Sheffield Alcohol Model provides conservative estimates of harm reductions

What this study adds

The proportion of the market affected by the two policies differs hugely, with just 0.7% of all alcohol units sold likely to be affected under a ban on below cost selling compared with 23.2% of units for a 45p minimum unit price

Below cost selling would save an estimated 14 deaths and 500 admissions to hospital annually, compared with 624 deaths and 23 700 admissions for a 45p minimum unit price

This study found very small estimated effects for banning below cost selling and showed, in comparison, that a minimum unit price of 45p would be expected to have 40-50 times larger reductions in consumption and health harms

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Tables

Table 1 | Example prices for different product categories under a ban on below cost selling compared with minimum unit pricing

	Product (duty category)							
	4x440 mL cans of beer (normal strength beer)	4x440 mL cans of strong beer (high strength beer)	4x440 mL cans of cider (normal strength cider)	2 L bottle of strong cider (threshold strength for normal strength cider)	750 mL bottle of white wine (wine)	750 mL bottle of red wine (wine)	700 mL bottle of vodka (spirits)	4x175 mL bottles of ready to drink "alcopops" (spirits)
% alcohol by volume	4.00	9.00	5.00	7.50	11.00	14.00	40.00	17.50
No of units	7.0	15.8	8.8	15	8.3	10.5	28	12.3
Implied minimum price								
Under minimum unit pricing policy proposed in 2012:								
40 pence per unit (£)	2.82	6.34	3.52	6.00	3.30	4.20	11.20	4.90
45 pence per unit (£)	3.17	7.13	3.96	6.75	3.71	4.73	12.60	5.51
50 pence per unit (£)	3.52	7.92	4.40	7.50	4.13	5.25	14.00	6.13
Under ban on below cost selling:								
Duty+VAT threshold (£)	1.58	4.57	0.84	0.95	2.46	2.40	9.48	4.15
Implied threshold price per unit (pence)	0.22	0.29	0.10	0.06	0.30	0.23	0.34	0.34
VAT=value added tax. £1.00 (€1.26; \$1.63); 2014 rates.								

Table 2| Base case estimated own price and cross price elasticities for off-trade and on-trade beer, cider, wine, spirits, and ready to drinks (RTDs, or “alcopops”) in the United Kingdom

		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‡

Each cell gives the estimated percentage reduction in consumption that would occur for the column beverage after a 1% increase in price for the row beverage.

*Significant coefficients at P<0.05.

†Off-beverages are those purchased in off-trade outlets (for example, supermarkets and other shops).

‡Own-price elasticities, with remaining cells showing cross price elasticities.

¶On-beverages are those purchased in on-trade outlets (for example, pubs, clubs, bars, and restaurants).

Table 3| Baseline patterns of consumption and spending on alcohol in England for drinkers aged 16 or more

Variables	Drinker subgroups			
	Moderate, excluding abstainers*	Hazardous†	Harmful‡	All drinkers average
Population in England§ (millions)	25.5	7.2	2.2	34.9
Self reported alcohol consumption¶				
Mean weekly consumption (total No of units)**	5.5	27.2	71.4	14.1
Category of alcohol (%):				
Beer	39	38	44	40
Cider	3	3	6	4
Wine	42	46	34	41
Spirit	15	11	12	12
Ready to drink	2	2	4	3
Self reported alcohol expenditure††				
Mean spend per annum (£):				
Total	275	1143	2771	612
Off-trade‡‡	85	469	1189	234
On-trade§§	191	673	1582	378
Mean price paid (pence/unit):				
Off-trade	54.4	51.3	48.1	51.0
On-trade	148.1	133.6	126.6	136.5
% of units purchased below various threshold prices/unit:				
Duty+VAT¶¶	0.3	0.5	1.0	0.7
40p per unit***	6.8	10.3	15.3	11.9
45p per unit***	12.5	19.5	30.5	23.2
50p per unit***	19.5	30.5	43.6	34.4

£1.00 (€1.26; \$1.63); 2014 rates.

VAT=value added tax.

*Adult drinkers (≥16) with a mean weekly consumption ≤21 units for males and ≤14 units for females.

†Mean weekly consumption >21 units for males and >14 units for females but ≤50 units for males and ≤35 units for females.

‡Mean weekly consumption >50 units for males and >35 units for females.

§From Office for National Statistics mid-2010 population estimates for England (ages 16-89 inclusive), combined with proportions from general lifestyle survey 2009.

¶From general lifestyle survey 2009.

**1 unit=10 mL by volume of ethanol.

††From living cost and food survey 2001-02 to 2009, inflated to 2013 prices with off-trade interpolated over AC Nielsen price distribution.

‡‡Off-beverages are those purchased in off-trade outlets (for example, supermarkets and other shops).

§§On-beverages are those purchased in on-trade outlets (for example, pubs, clubs, bars, and restaurants).

¶¶Estimated in pence per unit of alcohol: 22.9, 9.4, 24.5, 33.9, and 33.9 for beer, cider, wine, spirits, and ready to drinks, respectively in 2013 prices. Details of assumptions are in table 1 of the addendum of the published report.¹⁶

***Minimum unit price thresholds in 2014-15 prices. Details of assumptions can be found in table 2.1 of the published report.¹³

Table 4| Central estimates for consumption and spending for ban on below cost selling and minimum unit price policies of 40p, 45p, and 50p per unit

Consumption and spending levels	Moderate drinkers	Hazardous drinkers	Harmful drinkers	All England population (≥16)
% change in consumption per drinker				
Below cost selling	-0.03	-0.01	-0.08	-0.04
Minimum unit price:				
40p	-0.34	-0.34	-2.33	-0.97
45p	-0.57	-0.67	-3.67	-1.59
50p	-0.97	-1.22	-5.37	-2.47
Change in consumption per drinker per year (units)				
Below cost selling	-0.1	-0.1	-3.0	-0.3
Minimum unit price:				
40p	-1.0	-4.8	-86.7	-7.2
45p	-1.6	-9.5	-136.6	-11.7
50p	-2.7	-17.3	-200.0	-18.2
% change in spending per drinker				
Below cost selling	0.00	0.03	0.01	0.02
Minimum unit price:				
40p	0.02	0.29	-0.36	0.02
45p	0.34	0.85	-0.06	0.42
50p	0.93	1.85	0.57	1.18
Change in spending per drinker per year (£)				
Below cost selling	0.01	0.33	0.27	0.09
Minimum unit price:				
40p	0.05	3.35	-9.92	0.10
45p	0.93	9.75	-1.70	2.59
50p	2.55	21.13	15.69	7.23

£1.00 (€1.26; \$1.63); 2014 rates.

Table 5| Central estimates of harm reduction for ban on below cost selling and minimum unit price policies of 40p, 45p, and 50p per unit

Policies	Year 1 health harm reductions				Year 10 health harm			Cumulative health harm		
	Deaths	Illness (000s)	Hospital admissions (000s)	QALYs saved (000s)	Deaths annually	Illness annually (000s)	Hospital admissions annually (000s)	10 year cumulative discounted QALYs (000s)	10 year cumulative healthcare costs (£m)	10 year financial valuation of QALYs (£m)
England population (age ≥16)										
Below cost selling	-3	-0.1	-0.1	0.0	-14	-0.3	-0.5	0.5	-9.5	33.0
Minimum unit price:										
40p	-74	-2.4	-3.5	0.8	-379	-7.8	-15.0	14.8	-257.5	981.4
45p	-123	-4.0	-5.7	1.2	-624	-12.5	-23.7	24.2	-417.2	1591.1
50p	-192	-6.2	-8.7	1.9	-960	-18.7	-35.1	37.1	-634.2	2413.1
Moderate drinkers										
Below cost selling	-1	0.0	0.0	0.0	-1	-0.1	-0.1	0.1	-2.4	8.2
Minimum unit price:										
40p	-10	-0.4	-0.5	0.2	-7	-0.6	-0.8	2.5	-30.3	148.2
45p	-17	-0.7	-0.9	0.2	-11	-1.0	-1.4	4.1	-49.5	241.5
50p	-27	-1.2	-1.4	0.4	-19	-1.7	-2.4	6.6	-82.0	388.3
Hazardous drinkers										
Below cost selling	-1	0.0	0.0	0.0	-3	0.0	-0.1	0.1	-1.5	5.7
Minimum unit price:										
40p	-10	-0.4	-0.5	0.2	-23	-0.5	-0.8	2.0	-28.2	113.8
45p	-21	-0.8	-1.0	0.3	-60	-1.2	-1.8	3.9	-58.4	227.1
50p	-39	-1.5	-1.8	0.5	-129	-2.5	-3.8	7.1	-110.4	417.7
Harmful drinkers										
Below cost selling	-2	-0.1	-0.1	0.0	-11	-0.2	-0.4	0.3	-5.6	19.1
Minimum unit price:										
40p	-53	-1.6	-2.4	0.4	-349	-6.7	-13.4	10.3	-199.0	719.4
45p	-85	-2.5	-3.8	0.7	-554	-10.3	-20.5	16.2	-309.4	1122.4
50p	-125	-3.6	-5.4	1.0	-812	-14.5	-29.0	23.4	-441.8	1607.2

QALYs=quality adjusted life years.

Figures

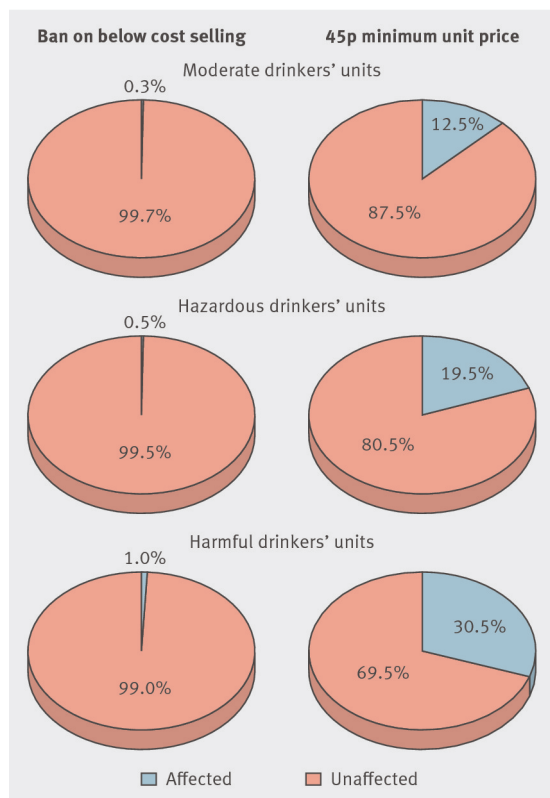


Fig 1 Estimated proportion of current alcohol units consumed that would be affected by price rises from proposed policies of ban on below cost selling versus 45p minimum unit price central estimate



Fig 2 Modelled impact of a ban on below cost selling compared with impact of a 45p minimum unit price

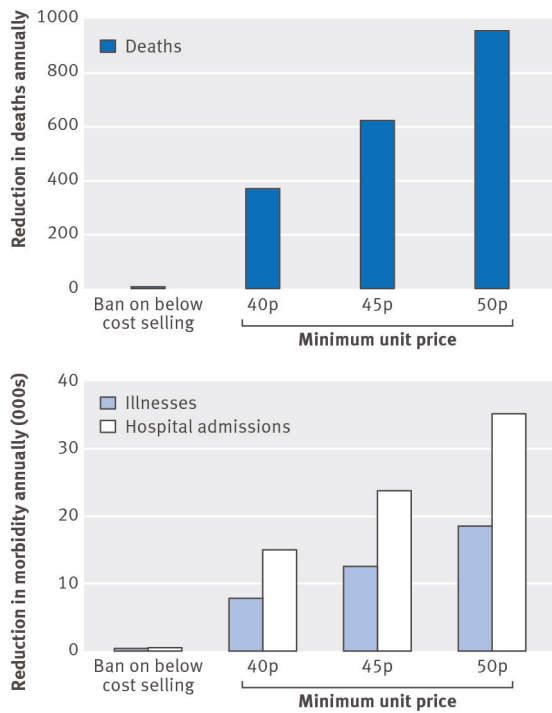


Fig 3 Estimated impact of a ban on below cost selling versus minimum unit price in England in terms of annual savings in deaths, illnesses, and admissions to hospital (at full effect)