
Article:
Jiang, H., Livingston, M., Room, R. et al. (4 more authors) (2020) Modelling the effects of alcohol pricing policies on alcohol consumption in subpopulations in Australia. Addiction. ISSN 0965-2140

https://doi.org/10.1111/add.14898

Modelling the effects of alcohol pricing policies on alcohol consumption in subpopulations in Australia

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Running head: The effects of alcohol pricing policies

Total page count: 19

Word count for abstract:300

Word count for body text: 4150

References: 40

Figures: 2

Tables: 4

Supplement: 1

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Aims: To model effects of a range of alcohol pricing policies on alcohol consumption in subpopulation groups (e.g., alcohol consumption pattern, and age and income groups) in Australia.

Design: We used estimated price elasticities to model the effects of proposed pricing policies on consumption for 11 beverage categories among subpopulation groups.

Setting:

Australia.

Participants:

A total of 1789 adults (16+ years) who reported they purchased and consumed alcohol in the 2013 Australian International Alcohol Control Study, an adult population survey.

Measurements: Mean and percentage changes in alcohol consumption were estimated for each scenario across sub-groups. The policy scenarios evaluated included: 1) increasing the excise rate 10% for all off-premise beverages; 2) replacing the wine equalisation tax with a volumetric excise rate equal to the current spirits tax rate; 3) applying a uniform excise tax rate to all beverages equal to the current sprits tax rate and a 10% or 20% increase in it; and 4) introducing a minimum unit price (MUP) on all beverages categories at $1.00, $1.30 or $1.50.

Findings: The effects of different tax and MUP policies varied greatly across different subgroups. The effect of the MUP policy on alcohol consumption increased rapidly in the range from $1 to $1.50. Applying a uniform tax rate across all beverages equal to current spirits

tax rate, or a 10% or 20% increase beyond that, could generate large reductions in overall alcohol consumption in Australia. Compared with the uniform tax rate with or without further tax increase, introducing an MUP at $1.30 or $1.50 could reduce consumption particularly among harmful drinkers and lower income drinkers, with comparatively smaller impacts on moderate drinkers and higher income drinkers.

Conclusions: Both uniform excise tax and minimum unit price policies are predicted to reduce alcohol consumption in Australia. Minimum unit price policies are predicted to have a greater impact on drinking among harmful drinkers than moderate drinkers.

Key words: Alcohol, tax policy, minimum unit pricing, consumption reduction, subpopulation

Introduction

Alcohol use is a leading risk factor for non-communicable diseases and injuries, annually causing approximately 3.3 million deaths, accounting for 5.9% of all deaths worldwide [1]. Price-based interventions have been shown to be one of the most effective means to reduce the level of alcohol consumption and of related health and social problems [2]. Research evidence suggests that increasing alcohol tax or price can lead to reductions in consumption, fatal traffic accidents, deaths from liver cirrhosis, workplace injuries, violence and other crime [3].

In order to tackle alcohol-related health and social harm, a minimum unit price (MUP) has been implemented in several Canadian provinces since the 1990s and in a number of Eastern European countries (including Russia, Ukraine, Uzbekistan and the Republic of Moldova) since 2008 [4]. An increase in MUP on alcohol in Canadian provinces was found to be associated with a reduction in alcohol consumption and related mortalities and morbidities [5-7]. The recently implemented alcohol floor price regulation in Scotland (1 May 2018) and the alcohol minimum unit pricing policy ($1.30 AUD per standard drink) effective in the Northern Territory, Australia in October 2018 have attracted further attention to this public health strategy [8, 9]. A common argument against price interventions in public debates has been that any increase in the alcohol price or tax would disproportionately affect moderate drinkers [10] or socio-economically disadvantaged groups [11]. A recent Australian parliamentary inquiry into alcohol-related harms has recommended reforms to increase the effectiveness of taxation policies in reducing health and social costs of alcohol [12]. Thus, health policy makers in Australia, the U.K. and many other countries with similar circumstances need more evidence on the impacts of different pricing initiatives on alcohol consumption among different subpopulations.

The Australian alcohol taxation system is complex, with a combination of both volumetric and *ad valorem* taxes, varying in their application by the type of alcohol product and by the range of alcohol content [13]. For example, excise taxes on beer and spirits are levied based on the volume of alcohol contained in the product, while taxes on wine are applied based on the sales value of the product. Alcoholic beverages sold at off-premises are generally cheaper than when sold for on-premises consumption, and presently make up about 80% of the alcohol market in Australia [14]. Recent Australian studies have shown that the heaviest 20% of Australian drinkers drank over 80% of all alcohol consumed in the last year [15], and a high proportion of the consumption of these heavy drinkers was of low price alcohol [16].

Alcohol consumption per capita in Australia has declined in the last decade. Reasons for this change are not clear. The only major change to prices has been an increase in taxation on pre-mixed spirits in 2008 (approximately 0.8% of the market). Otherwise, alcohol affordability has generally remained the same in the last 30 years [17]. In contrast, alcohol-related hospitalisations, emergency department and ambulance presentations, assaults and community-based specialist drug and alcohol treatment episodes have steadily increased in Australian states [18-20]. This may reflect heterogeneity in consumption trends, with reductions in the general population not necessarily reflected among heavy drinkers. Previous research has argued that understanding how policies affect different classes of drinkers is key to understanding the likely effects of policy on harm reduction [21].

A few modelling studies in the U.K. have estimated the effects of different alcohol price initiatives on consumption and health outcomes [22, 23] and found that lower income and more hazardous drinkers there are more price responsive than higher income and moderate drinkers. The existing studies of effects of alcohol pricing policy on consumption and health outcomes

in Australia used scanned samples of off-premise purchases in Victoria, or national aggregate data [13, 24-26], and neither of them provided any estimates for consumption of population subgroups. Using Australian International Alcohol Control survey data [27], we have estimated price elasticity of demand for 11 beverage categories among various subpopulation groups in Australia, providing new estimates of how policies affect drinking across sub-populations -- an issue which was identified as critically important for policy makers [23].

Our previous analyses found that over 40% of older Australian heavy drinkers (55 years old or over) drank low price alcohol (<$1AUD per standard drink) in the last 12 months [28]. The evidence suggests that pricing policy impacts on heavy drinkers may vary in different age groups [4]. Furthermore, the effects of pricing policies on consumption differed between socioeconomic groups in the UK and Finland [21, 29] -- though the effects of pricing policies may vary across different countries or regions and time periods [30]. But disregarding the differential effectiveness of pricing policies in reducing alcohol consumption across different demographic groups (e.g. age and income groups) remains a weakness of the existing literature. Thus, this study aims to explore the variations of alcohol consumption and purchasing across different subpopulation groups, and further model and estimate the effects of different pricing policy initiatives on alcohol consumption in the overall population and in different drinking, income and age groups.

Study design, data and method:

Study design

The baseline information was first calculated using the IAC survey data, including mean prices and consumption of different alcoholic beverages among different subpopulation groups. Then, a wide variety of policy options were appraised, including tax raises and minimum unit price

introduction at different levels. We modelled policy outcomes for 18 subpopulation groups defined by dinking level, age and income using the national survey data and our estimated price elasticities across different beverages. The outcome is an estimate of the effects of pricing policy on alcohol consumption in subpopulation groups and in the overall population.

After reviewing existing Australian studies and policy documents [4, 13, 16, 31, 32], eight realistic pricing policy scenarios were proposed and modelled in this study:

1. Increasing the excise rate 10% for all off-premise sale beverages;
2. Replacing the wine equalisation tax with a volumetric excise rate equal to the current spirits tax rate;
3. Applying a uniform excise tax rate (UR) per unit of alcohol to all beverages equal to the current spirits tax rate;
4. Applying a UR to all beverages equal to a 10% increase in the current spirits tax rate;
5. Applying a UR to all beverages equal to a 20% increase in the current spirits tax rate;
6. Introducing a floor price (or minimum unit price - MUP) on all beverage categories at $1 per Australia standard drink;
7. Introducing a floor price on all beverage categories at $1.30 per Australia standard drink.
8. Introducing a floor price on all beverage categories at $1.50 per Australia standard drink.

Data:

Alcohol consumption and purchasing data were collected from the Australian International Alcohol Control (IAC) Survey - a national landline (60%) and mobile phone (40%) computer assisted telephone interview collecting data on the experience of alcohol consumption and purchasing from 2020 Australians (aged 16 and above). The sample was generally representative of the Australian adult population, with a response rate of 37.2%. Details of the

survey method, questionnaire and technical report can be found in Jiang et al. [33] and Livingston and Callinan [34]. The 231 respondents who didn't drink alcohol in the last 12 months were excluded from the analysis, leaving 1789 respondents. This procedure reflects the assumption that the changes in alcohol pricing policy will not affect abstainers.

In the IAC survey, respondents were asked how often they consume and purchase alcohol from a range of on- and off-premise beverage types, what they usually purchase at each venue type, and how much they consumed in a range of on- and off-premise settings in the last 6 months. In our analysis, the alcohol consumption and purchasing spending and volumes were doubled to give an annual amount, to be consistent with and comparable to other Australian survey analyses. The changes in mean consumption on 11 beverage categories [e.g. on- and off-premises full-strength beer, low-middle strength beer, bottle wine, spirits, Ready-To-Drinks (RTDs) and off-premise cask wine] after a change in price can be estimated based on the price elasticities derived from our econometric modelling [27]. Elasticities are estimated for subpopulation groups based on drinking level (moderate, hazardous, harmful), age and income (three levels). The different drinking, age and income groups were defined as follows:

- Moderate drinkers (≤14 ASDs per week for men and women),
- Hazardous drinkers (15-42 ASDs per week for men and 15-35 ASDs for women),
- Harmful drinkers (>42 ASDs per week for men and >35 ASDs for women)
- Younger age group (16-34 years)
- Middle age group (35-54 years)
- Older age group (55 years and over)
- Lower income drinker (annual household income <$61k)
- Middle income drinker (annual household income was $61-114k)

- Higher income drinker (annual household income >$114k)

Respondents were categorised based on their alcohol consumption, in terms of three drinking levels defined in the *Australian Guidelines to Reduce Health Risk from Drinking Alcohol* [16, 35]. Those who drank up to 14 ASD per week were designated 'moderate drinkers', those who drank >14 ASD but <42 ASD for males or <35 ASD for females were designated 'hazardous' drinkers and those drinking more than these levels were designated as 'harmful' drinkers. (Drinking up to 2 drinks per day (i.e. up to 14 per week) is recommended as 'low-risk' in the 2009 NHMRC guidelines for low-risk drinking, with a lifetime risk of death from alcohol-related disease of less than 1 in 100. In the risk tables for each gender in the NHMRC report, men drinking 6 drinks or more per day (42+ per week) and women drinking 5 or more (35+ per week) are both at a lifetime risk of above 3 in 100 (3.80 for men, 3.68 for women) of death from alcohol-related disease, *Australian Guidelines to Reduce Health Risk from Drinking Alcohol* [35]). We further split the subpopulations into 18 groups with 3 drinking levels * 3 income levels and 3 drinking levels * 3 age groups in our analysis, using age and income groupings with roughly equal numbers in each category. The smallest sample size in these subpopulation groups is larger than 90, sufficient for estimation within each sub-sample.

Statistical method:

In our previous study [27] we analysed the eleven beverage types to derive a population-level 11×11 matrix containing both significant and non-significant own-price and cross-price elasticities (see Tables A4-A13 in the Appendix for more detail), We use these elasticities to model the impact of the change in taxes or prices caused by the policy on different on- and off-

sale alcoholic beverage consumption for each modelled subpopulation group. The formula is shown below [36]:

$$\%\Delta D_i = (1 + E_{i,i}\%\Delta P_i)(1 + \sum_{j \neq i}^{\forall j} E_{i,j}\%\Delta P_j) - 1$$

where $\%\Delta D_i$ is the estimated percentage change in alcohol demand or consumption for beverage i, $E_{i,i}$ is the own-price elasticity for beverage i, $\%\Delta P_i$ is the percentage change in price for beverage i, $E_{i,j}$ 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*. Own-price elasticities show associations between the price of a single alcoholic beverage and its consumption, while cross-elasticities show associations between price of one alcohol beverage and consumption of another. A full description of price elasticities and discussion of how alcohol elasticities relate to other correlates is provided in the appendix.

To model the effect of a minimum unit price, we assume that alcohol retailers will only increase the alcohol price to match the MUP threshold**,** and the prices of beverage above the MUP will be unchanged; the effects of price increases to the minimum unit price can be estimated using the formula above. Sensitivity analyses were conducted using alternative elasticities, including significant price elasticities and own-price elasticities only. The research protocol of this study was published in *BMJ Open* [37] and ethics approval of the study was obtained from the College Human Ethics Sub-Committee of La Trobe University (No: S17-206).

Results

Tax rates of different types of beverages in Australia, their mean price per unit of alcohol, mean alcohol consumption and total consumption volume of each modelled beverage in the last 12 months are presented in Table 1. Significant variations were found in mean prices and

consumption across different on- and off-premise alcoholic beverages. Off-premise cask wine was the cheapest beverage consumed by all Australian drinkers in 2013, followed by off-premise regular beer, off-premise spirits and off-premise bottle wine. Australian drinkers consumed over 62% of their total alcohol consumption on off-premise regular beer and off-premise bottle wine.

<Table 1 about here>

Mean weekly alcohol consumption and purchasing among different age, income and drinking groups are summarized in Table 2. On average, Australian drinkers consumed 14 ASDs per week. Compared with moderate drinkers, harmful drinkers consumed a 17 times greater amount of alcohol per week (4.6 *vs* 80.7 ASDs). Average weekly alcohol spending by harmful drinkers was 11 times higher than spending by moderate drinkers ($178.40 *vs* $20.90). Harmful drinkers purchased a higher proportion (48%) of their total alcohol for under $1.30 per ASD than moderate (35%) drinkers. Older drinkers purchased a greater percentage of alcohol for below $1.30 per ASD than younger age groups (56% *vs* 41% *vs* 34%). Higher income drinkers spent more weekly on alcohol than lower income drinkers, while the lower income group consumed a higher proportion of alcohol for under $1.30 per ASD than higher income groups -- though the result is statistically insignificant.

< Table 2 about here>

Figure 1 shows that the price distribution for alcohol consumption of on- and off-premise beverages in Australia varies across different beverage types. Over 95% of on-premises beverages were sold at over $1.30 per standard drink. In contrast, about 95% of off-sale cask

wine was sold at under $1.30 per standard drink, and about 40% of off-sale regular beer, off-sale bottle wine and off-sale spirits were sold at under $1.30 per ASD. The beverage-specific consumption distribution across 18 subgroups is summarized in Figure 2. Lower-income harmful drinkers consumed more off-premise cask wine than other income subgroups and middle-income harmful drinkers consumed more off-premise spirits than other income subgroups. Younger harmful drinkers drank more on- and off-premise regular beer, while older- and high-income harmful drinkers consumed more off-premise bottle wine compared with other subgroups in the last 12 months.

<Figure 1 about here>

<Figure 2 about here>

The estimated effects of our 8 pricing policy initiatives on alcohol consumption, overall and in different sub-types of drinkers, are summarized in Table 3. The effects of different tax and MUP policies vary greatly across different subgroups. Implementing a 10% tax increase on off-sale beverages and replacing the current wine tax with a system and rate equal to the spirits tax rate tend to be the two least effective policies in their estimated effects on overall alcohol consumption. The effect of an MUP policy on alcohol consumption increases noticeably as the minimum price increases from $1.00 to $1.50. Applying a uniform tax rate across all beverages equal to the current spirits tax, or with a 10% or 20% increase on top of that, can generate large reductions in overall alcohol consumption in Australia. It is worth noting that introducing a $1.30 or $1.50 MUP (Options 7 and 8) could achieve similar impacts on overall alcohol consumption to applying a uniform tax rate on all beverages equal to the current spirits rate or with a 10% increase (Options 3 and 4). However, the MUP policies (Options 7 and 8) lead to a higher reduction of alcohol consumption in harmful drinkers than applying a uniform tax rate

(Options 3 and 4), while MUP policies generate lower impacts on moderate drinkers than the tax increase policy.

<Table 3 about here>

As the $1.30 MUP (Option 7) has been applied in the Northern Territory in Australia, and a uniform tax rate policy (Option 3) was estimated to have similar reduction effects to it, these two policies were selected for further comparisons in more specific subpopulation groups. The effects of these two policies on sub-groups defined by drinking level, income and age are presented in Table 4. Among harmful and hazardous drinkers, the $1.30 MUP leads to a greater reduction of consumption than the uniform tax rate pricing policy. The $1.30 MUP is particularly effective in reducing consumption in older harmful drinkers. However, the $1.30 MUP policy is less effective for higher income drinkers and younger age groups across all drinker types, compared with the uniform tax rate policy.

<Table 4 about here>

Discussion

Using survey data of the International Alcohol Consumption Study, this study has presented the first estimates of the effects of different alcohol pricing policy initiatives on alcohol consumption in different drinking, income and age subpopulation groups. Variations were observed in alcohol prices and consumption volumes across different alcoholic beverages and subpopulation groups, with younger harmful drinkers consumed more on- and off-premise regular beer, while off-premise bottle wine was more favored by high-income harmful drinkers and middle- and older-age harmful drinkers. The eight pricing policy initiatives modelled were

estimated to reduce overall alcohol consumption among the population in the range of 1% to 22%. An increase of 10% in the tax on all off-sale beverages, and replacing the current wine tax with a tax equal to the current spirits tax were both estimated to have little effect on overall alcohol consumption. However, introducing an MUP of $1.30 or $1.50 (Options 7 and 8) or applying a uniform excise tax rate to all beverages equal to the tax on spirits (Option 3) or with a 10% or 20% tax increase (Options 4 and 5) produced over a 10% reduction in drinking, which is in line with the WHO's Global Strategy to reduce 10% of alcohol use within the national context [38]. Our modelling results also show that MUP policies primarily affect prices of low-cost beverages, nearly always sold off-premise [28], while a uniform excise tax raising taxes on some or all beverages will increase prices of almost all on- and off-sale beverages substantially, though with a smaller impact on spirits.

The recent introduction of MUPs in the NT and in Scotland has caused a huge public debate, with arguments that the MUP may unfairly penalise moderate drinkers and that lower income drinkers will spend a higher proportion of their disposable income on alcohol, leading to adverse financial and health impacts. Our study results suggest that compared with applying a uniform tax rate with a higher tax on some or all beverages, introducing an MUP at $1.30 or $1.50 per ASD can achieve a greater reduction in drinking among harmful drinkers and low income drinkers, with comparatively smaller impacts on moderate drinkers and higher income drinkers. This suggests that introducing a MUP at $1.30 or $1.50 per ASD (Options 7 and 8) is more effective on controlling harmful or heavy drinkers' drinking (particularly among lower income harmful drinkers and older harmful drinkers) than applying the uniform tax rate policy in one or another form (Options 3 and 4).

Because of the novel study design and data collection procedure, our modelling results are not directly comparable with existing studies in Australia and other countries [13, 23, 26]. Using Victorian state level scanner data, Sharma, et al. [13] and Vandenberg et al., [26] both concluded that applying a $1.00 MUP or an uniform volumetric tax across all beverages will have little impact on moderate drinkers' purchasing and a greater effect on reducing the alcohol purchasing by the heaviest consumers. The UK modelling study [23] suggests that the MUP policies are more effective on controlling harmful drinkers' drinking, with smaller impact on moderate drinkers than tax rate policies. Our study results are broadly in line with these findings. Additionally, all of our modelled policies had bigger impacts on low income drinkers than other drinkers, lending some support to concerns about the potential regressive effects of price interventions. But, in an alternative perspective, these effects also suggest that pricing interventions (especially the MUP policies) can help to reduce health inequalities in Australia.

It was estimated that introducing a MUP at $1.30 per ASD can reduce alcohol consumption among harmful drinkers by 14.2% (14.2%*81=12 ASDs per week), with only a 3% reduction among moderate drinkers (3%*5=0.15 ASD per week). From a public health perspective, a drinking reduction of 12 ASDs per week may mean significant health benefits in the medium- and long-term from reduced alcohol-related chronic diseases and injuries among the heavier drinkers, with only minor effects on moderate drinkers. On the other hand, applying a uniform excise tax rate raising the tax on some or all beverages could achieve a greater consumption reduction among younger age drinkers and higher income drinkers compared with the MUP policies. Such measures are estimated to have broader and more consistent impact on drinkers at all three drinking levels. If the government aims to reduce harmful drinking among younger age groups, applying a uniform excise tax rate equal to the current spirits tax or along with a further tax increase has some advantages, but may also impact the consumption of moderate drinkers.

Both pricing policies – a tax rate increase and the MUP -- will raise revenues, but with different beneficiaries, under current Australian law. The former will increase tax revenue for the federal government, while the latter will only increase sales revenue, benefitting alcohol retailers, wholesalers and/or producers. It can be assumed that most of the alcohol industry will be against increased taxes, though the spirits industry would welcome the equalisation of taxes. But on-premise venues may support the $1.30 or $1.50 MUP policy, as there will be nearly no impact on them, and it will tend to reduce the gap between on-premise and off-premise prices. Thus the MUP policy will tend to curb the off-premise sector's promotion and sales of low-cost alcohol.

In another frame of reference, raising the price or tax for alcohol may result in a loss of consumer surplus and welfare. It may impose a welfare loss on alcohol consumers, particularly among light drinkers. If consumers who drink moderately change their behaviour to avoid the tax increase, this creates a loss of social benefits for them, and potentially lost tax revenue for the government. This welfare loss is not measured in our model, as we focus on health outcomes only. As with the view of effects of tax and price increases as regressive, the obverse of this "welfare loss" is a gain from the perspective of public health.

There are some limitations in this study. Recall bias may affect our estimation of both consumption and prices paid. Our sample size was not big enough for us to split the whole sample by age*drinker*income -- instead we had to analyse by income*drinker and age*drinker separately. We wanted to specifically analyse the effects on adolescents/ young adults. However, our sample size for young adults (16-24 years) is not big enough for us to run analyses on young adults*drinker types and this is a limitation in this study. We calculated

alcohol price by dividing reported purchasing values by consumption volumes. There might be some cases where drinkers may not immediately consume all alcohol that they have purchased. Nevertheless, we used group means in our analysis, and this impact on the modelling results is likely to be small. It worth noting that the response rate in the IAC survey is lower than in surveys in previous decades, although it is consistent with other recent Australian population surveys, such as the 2013 National Drug Strategy Household Survey (32.7%) [39] and the Alcohol's Harm to Others Survey 2008 (35.2%) [40]. In the IAC survey, respondents were asked to report their usual alcohol consumption and purchasing in the last 6 months, and the reported costs and volumes of consumption and purchasing may not be completely accurate. However, this survey method of questioning yields results closer to the official sales data than other methods [34]. Although our analyses were based on 2013 alcohol purchasing and consumption data in our models, they still apply, as pricing policies in Australia have remained unchanged in the last 20 years, except for the recent $1.30 MUP policy in NT (the population of which is about 1% of the total Australian population). Additionally, we have done a sensitivity analysis using only the elasticity and own-elasticity values which were statistically significant (see Tables A15-18 in Appendix), and we found similar results with the model in this paper, which used all elasticities estimated in our econometric models. Elasticity values from other studies were not applicable to our model, because of information on the beverage types and subpopulation groups were captured differently in different countries and surveys, such as elasticities published in the recent UK minimum unit price policy study [23].

This study appraised the effects of a range of specific and relatively complex alcohol pricing policy options on alcohol consumption that are under consideration by policy makers in Australia and internationally. The research evidence provided in this study may help to inform future alcohol policy formulation in Australia and internationally.

Acknowledgements

The Centre for Alcohol Policy receives core funding from the Foundation for Alcohol Research and Education, an independent, charitable organisation working to prevent the harmful use of alcohol in Australia (www.fare.org.au).

Funding

This study was funded by a National Health and Medical Research Council Project Grant (#1141325). The datasets used in this study were from the International Alcohol Control Study, which was funded by the Australian National Preventive Health Agency (ANPHA; grant #157ROO2011). ML is supported by a National Health and Medical Research Council Career Development Fellowship. SC is supported by an Australian Research Council Discovery Early Career Researcher Award (DE180100016).

All researchers were independent of the funding bodies and the funders had no role in data collection, analysis and interpretation of data; in the writing of the report; or in the decision to submit the article for publication.

Competing interests

The authors declare that they have no competing interests.

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Figures

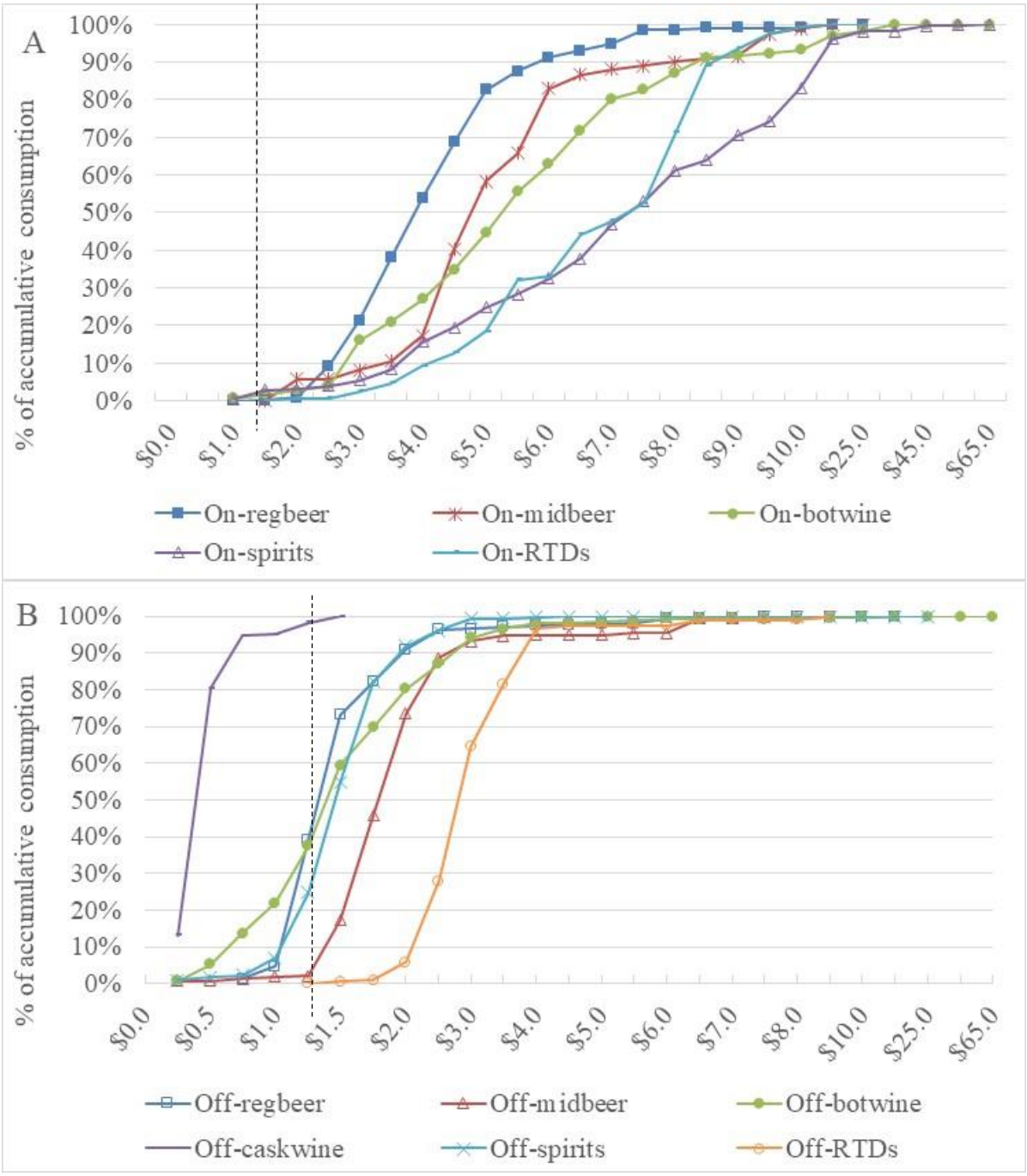

Figure 1. Price distribution for retail sale of on-premise beverages (A) and off-premise beverages (B) (Vertical dot line is $1.30 AUD). Please note that “regbeer” is regular beer; “midbeer” is low- and middle-strength beer; “botwine” is bottle wine and “RTDs” is Ready to Drinks.

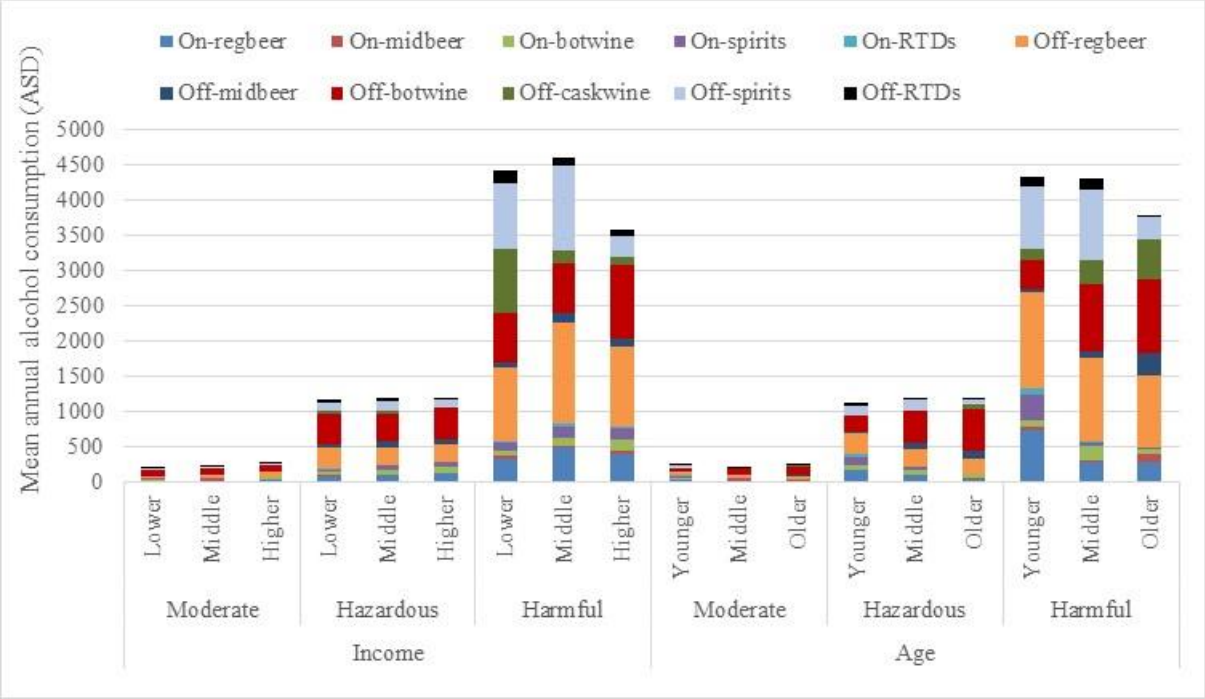

Figure 2. Mean beverage-specific consumption in different subpopulation groups in 2013; Please note that "regbeer" is regular beer; "midbeer" is low- and middle-strength beer; "botwine" is bottle wine and "RTDs" is Ready to Drinks.

Tables

Table 1. Alcohol tax rate, mean and total annual alcohol consumption, and mean price per standard drink among 11 alcoholic beverages in 2013

(N=1789) [a]	Alcohol by volume (%)	Excise duty rate or WET rate in 2013[b]	Tax rate per ASD in 2013 ($)	Mean price per standard drink (95% CIs)	Mean alcohol consumption (ASD) in the last 12 months (95% CIs)	Annual total alcohol consumption (ASD) and share of alcohol market (%)
On-premise						
Regular beer	5.0%	$31.74 per LAL on alcohol content >1.15% ABV	$0.31	$4.41 ($4.24, 4.58)	85.8 (70.2, 101.5)	1553567.8 (6.7%)
Low-middle strength beer	3.0%	$24.25 per LAL on alcohol content >1.15% ABV	$0.19	$5.99 ($5.62, 6.37)	13.6 (9.7, 17.5)	24348.3 (1.1%)
Bottle wine	14.0%	29% of wholesale value	$0.21	$6.25 ($5.80, 6.71)	47.5 (34.2, 60.8)	84959.6 (3.7%)
Spirits	22.0–43.0%	$76.37 per LAL	$0.97	$5.34 ($4.76, 5.91)	37.3 (29.0, 45.5)	66676.0 (2.9%)
Ready to Drinks	3.0–9.0%	$76.37 per LAL	$0.97	$6.35 ($5.90, 6.79)	10.3 (6.1, 14.2)	18426.7 (0.8%)
Off-premise						
Regular beer	5.0%	A$45.08 per LAL on alcohol content >1.15% ABV	$0.44	$1.57 ($1.51, 1.63)	454.1 (248.0, 660.2)	812349.1 (35.4%)
Low-middle strength beer	3.0 %	$38.70 per LAL on alcohol content >1.15% ABV	$0.30	$2.31 ($2.01, 2.62)	62.3 (41.8, 82.7)	111418.9 (4.9%)
Bottle wine	14.0%	29% of wholesale value	$0.21	$1.96 ($1.78, 2.13)	342.6 (296.3, 388.8)	612822.0 (26.7%)
Cask wine	12.5%	29% of wholesale value	$0.04	$0.65 ($0.47, 0.83)	51.1 (30.3, 71.9)	91400.0 (4.0%)
Spirits	22.0–43.0%	$76.37 per LAL	$0.97	$1.67 ($1.52, 1.83)	155.0 (111.8, 198.3)	277348.7 (12.1%)
Ready to Drinks	3.0–9.0%	$76.37 per LAL	$0.97	$2.79 ($2.46, 3.12)	22.9 (15.6, 30.3)	41021.8 (1.8%)

Note: [a] the total sample size in our survey is 2020, in which 231 respondents were excluded in the modelling analysis due to no alcohol consumption in the last 12 months. The mean alcohol price and consumption in the last 12 months were weighted.

LAL, litre of alcohol; ABV, alcohol by volume; WET, wine equalization tax; ASD, Australian standard drink; One Australian standard drink equals to 10 grams or 12.7 ml of pure alcohol (ethanol). Excise duty rate and WET rate in 2013 were abstracted from Australian Taxation Office [41].

Table 2. Weekly alcohol consumption and purchasing among different age, income and consumption groups

Overall sample (N=2020) Abstainer (N=231)		Age			Income		
		Young (16-34yrs)	Middle (35-54 yrs)	Old (55+ yrs)	Lower	Middle	Higher
All drinkers, N (%)	1789 (100%)	605 (100%)	659 (100%)	525 (100%)	459 (100%)	586 (100%)	577 (100%)
Weekly consumption (ASDs)	13.8 (12.4, 15.2)	19.4 (16.6, 22.2)	18.9 (15.2, 22.7)	16.2 (14.4, 18.2)	17.9 (14.6, 21.3)	19.4 (15.4, 23.4)	19.1 (16.8, 21.6)
Weekly spending ($)	$49.9 ($42.5, 57.2)	$67.4 ($57.3, 77.4)	$49.4 ($32.1, 66.6)	$30.8 ($26.8, 34.8)	$37.9 ($31.2, 44.5)	$54.8 ($45.1, 64.5)	$59.8 ($51.8, 67.8)
Percentage of total units purchased below $1.30	42.7% (28.9, 46.5%)	33.7% (26.9, 40.5%)	41.1% (36.5, 45.8%)	56.2% (49.0, 63.4%)	48.0% (41.0, 54.9%)	42.1% (35.6, 48.6%)	39.0% (33.1, 44.9%)
Moderate drinkers, N(%)	840 (64%)	299 (63%)	301 (65%)	240 (64%)	238 (65%)	282 (64%)	218 (56%)
Weekly consumption (ASDs)	4.6 (4.2, 4.9)	5.1 (4.5, 5.7)	3.9 (3.4, 4.5)	4.9 (4.2 5.5)	4.0 (3.4, 4.6)	4.5 (3.9, 5.1)	4.9 (4.2, 5.6)
Weekly spending ($)	$20.9 ($18.2, 23.8)	$27.4 ($20.9, 33.8)	$20.1 ($16.2, 23.9)	$15.2 ($11.7, 18.6)	$15.8 ($10.7, 20.9)	$19.8 ($16.6, 23.0)	$27.6 ($22.7, 32.5)
Percentage of total units purchased below $1.30	34.5% (30.0, 39.0%)	24.9% (19.1, 30.8%)	37.2% (29.7, 44.7%)	42.2% (32.4, 51.9%)	35.6% (25.4, 45.7%)	35.1% (28.7, 41.6%)	32.5% (25.8, 39.3%)
Hazardous drinkers, N(%)	576 (24%)	185 (25%)	219 (22%)	172 (27%)	128 (23%)	179 (23%)	229 (30%)
Weekly consumption (ASDs)	23.2 (22.5, 24.0)	22.7 (21.3, 24.0)	23.4 (22.4, 24.6)	23.5 (22.2, 24.9)	23.3 (21.7, 24.9)	23.4 (22.3, 24.5)	23.3 (22.0, 24.6)
Weekly spending ($)	$61.4 ($56.0, 66.9)	$81.8 ($69.8, 93.7)	$59.0 ($50.6, 67.4)	$42.8 ($36.5, 49.2)	$52.0 ($40.3, 63.8)	$57.5 ($49.5, 65.5)	$73.7 ($64.3, 83.2)
Percentage of total units purchased below $1.30	39.0% (35.6, 42.4%)	26.7% (22.1, 31.2%)	36.5% (32.2, 40.7%)	52.6% (43.9, 61.3%)	46.1% (36.2, 55.9%)	43.9% (37.5, 50.5%)	31.3% (27.6, 35.0%)
Harmful drinkers, N(%)	373 (12%)	121 (13%)	139 (14%)	113 (10%)	93 (12%)	125 (13%)	130 (14%)
Weekly consumption (ASDs)	80.7 (73.9, 87.5)	83.8 (73.2, 94.4)	82.8 (70.1, 95.5)	72.3 (64.5, 80.0)	85.3 (70.4, 100.1)	87.6 (74.3, 100.8)	68.3 (62.2, 74.3)
Weekly spending ($)	$178.4 ($129.5, 227.2)	$236.4 ($185.5, 287.3)	$173.1 ($76.1, 270.0)	$101.1 ($79.0, 123.1)	$132.9 ($104.2, 161.7)	$227.6 ($103.7, 351.4)	$159.3 ($117.1, 201.5)
Percentage of total units purchased below $1.30	48.4% (41.4, 55.4%)	40.2% (27.2, 53.3%)	45.9% (38.1, 53.7%)	64.3% (53.0, 75.7%)	57.4% (46.8, 67.9%)	48.4% (37.0, 59.7%)	43.3% (31.6, 55.1%)

Note: The 95% Confidence Interval was presented in the brackets. N is the sample size of each subgroup and percentages refer to the sample size after survey weights have been applied. ASDs means Australian standard drinks; [a] the total sample size in our survey is 2020, in which 231 respondents were excluded in the age * consumption analysis due to no alcohol consumption in the last 12 months, and a further 167 respondents were excluded in the income * consumption analysis due to missing income data.

Table 3. Estimated effects (%) of 8 proposed pricing policies on alcohol consumption in all and sub-types of drinkers [#]

		Type of drinker			Household income			Age		
	All drinkers	Harmful	Hazardous	Moderate	Lower	Mid	Higher	Younger	Middle	Older
Opt 1 - 10% tax increase on off-beverages	-1.0 (-1.1, -0.9)	-2.0 (-2.2, -1.8)	-1.0 (-1.0, -1.0)	-0.8 (-0.9, -0.7)	-1.4 (-1.7, -1.1)	-1.1 (-1.3, -0.9)	-0.5 (-0.6, -0.4)	-0.6 (-0.7, -0.5)	-1.2 (-1.4, -1.0)	-1.4 (-1.6, -1.2)
Opt 2 - Replace wine tax to equal spirits tax	-3.1 (-3.4, -3.1)	-3.4 (-3.7, -3.1)	-3.0 (-3.1, -2.9)	-1.6 (-1.7, -1.5)	-3.8 (-4.5, -3.1)	-2.9 (-3.5, -2.3)	-1.6 (-1.8, -1.4)	-1.7 (-1.9, -1.5)	-2.9 (-3.5, -2.3)	-3.9 (-4.3, -3.5)
Opt 3 - Uniform volumetric excise rate (UR)	-10.4 (-11.5, -9.3)	-13.6 (-14.7, -12.5)	-9.6 (-9.9, -9.3)	-8.8 (-9.6, -8.0)	-13.2 (-15.6, -10.8)	-10.0 (-12.1, -7.9)	-8.4 (-9.4, -7.4)	-7.4 (-8.5, -6.3)	-10.2 (-12.2, -8.2)	-12.5 (-13.9, -11.1)
Opt 4 - UR + 10% tax increase on all	-16.5 (-18.2, -14.8)	-19.2 (-20.8, -17.6)	-15.8 (-16.3, -15.3)	-13.4 (-14.6, -12.2)	-18.2 (-21.6, -14.8)	-15.2 (-18.3, -12.1)	-11.2 (-12.5, -9.9)	-13.1 (-15.0, -11.2)	-17.0 (-20.3, -13.7)	-19.2 (-21.3, -17.1)
Opt 5 - UR + 20% tax increase on all	-21.7 (-23.9, 19.5)	-23.7 (-25.7, -21.7)	-21.0 (-20.4, -21.6)	-16.9 (-18.4, 15.4)	-23.7 (-28.1, -19.3)	-21.5 (-25.9, -17.1%)	-16.2 (-18.2, -14.2)	-15.7 (-18.0, -13.4)	-21.6 (-25.8, -17.4)	-24.1 (-26.8, -21.4)
Opt 6 - $1.00 MUP	-5.8 (-6.4, -5.2)	-7.2 (-7.8, -6.6)	-5.2 (-5.4, -5.0)	-1.1 (-1.2, -1.0)	-7.0 (-8.3, -5.7)	-6.5 (-7.8, -5.2)	-2.8 (-3.1, -2.5)	-3.9 (-4.5, -3.3)	-5.5 (-6.6, -4.4)	-7.3 (-8.1, -6.5)
Opt 7 - $1.30 MUP	-10.7 (-11.8, -9.6)	-14.2 (-15.4, -13.0)	-9.9 (-10.2, -9.6)	-3.0 (-3.3, -2.7)	-12.7 (-15.0, -10.4)	-11.1 (-13.4, -8.8)	-4.1 (-4.6, -3.6)	-6.2 (-7.1, -5.3)	-10.8 (-12.9, -8.7)	-13.7 (-15.2, -12.2)
Opt 8 - $1.50 MUP	-14.9 (-16.4, -13.4)	-22.1 (-24.0, -20.2)	-13.2 (-13.6, -12.8)	-5.2 (-5.7, -4.7)	-19.0 (-22.5, -15.5)	-15.7 (-18.9, -12.5)	-6.2 (-6.9, -5.5)	-11.3 (-12.9, -9.7)	-14.3 (-17.1, -11.5)	-18.2 (-20.2, -16.2)

Note: [#] Price elasticities and consumption effects were estimated based on 2013 data, and the household income, drinking and age groups were defined in the method section.

Table 4. Estimated effects (%) of eight alcohol pricing initiatives on alcohol consumption among different drinking, income and age subpopulation groups [#]

	Increasing alcohol tax					Introducing a MUP		
	Opt 1 - 10% tax increase on off-beverages	Opt 2 - Replace wine tax equal to spirits	Opt 3 - Uniform tax rate for all beverages equal to spirits	Opt 4 - Uniform rate + 10% tax increase on all	Opt 5 - Uniform rate + 20% tax increase on all	Opt 6 - $1.00 MUP	Opt 7 - $1.30 MUP	Opt 8 - $1.50 MUP
Household income * drinking level								
Moderate-low income	-1.2 (-1.4, -1.0)	-2.2 (-2.5, -1.9)	-11.1 (-12.8, -9.4)	-16.4 (-18.9, -13.9)	-19.6 (-22.5, -16.7)	-1.4 (-1.6, -1.2)	-4.1 (-4.7, -3.5)	-7.3 (-8.4, -6.2)
Moderate- middle income	-0.9 (-1.0, -0.8)	-1.7 (-1.9, -1.5)	-8.4 (-9.5, -7.3)	-13.7 (-15.5, -11.9)	-17.8 (-20.2, -15.4)	-1.3 (-1.5, -1.1)	-3.7 (-4.2, -3.2)	-6.0 (-6.8, -5.2)
Moderate-high income	-0.4 (-0.5, -0.3)	-1.0 (-1.1, -0.9)	-7.1 (-8.1, -6.1)	-10.1 (-11.5, -8.7)	-13.4 (-15.3, -11.5)	-0.6 (-0.7, -0.5)	-1.3 (-1.5, -1.1)	-2.4 (-2.7, -2.1)
Hazardous-low income	-1.5 (-1.6, -1.4)	-4.1 (-4.4, -3.8)	-12.0 (-12.8, -11.2)	-19.4 (-20.7, -18.1)	-24.3 (-26.0, -22.6)	-6.7 (-7.2, -6.2)	-13.3 (-14.2, -12.4)	-18.4 (-19.7, -17.1)
Hazardous- middle income	-1.1 (-1.2, -1.0)	-3.2 (-3.4, -3.0)	-9.2 (-9.6, -8.8)	-16.8 (-17.6, -16.0)	-22.1 (-23.1, -21.1)	-6.2 (-6.5, -5.9)	-9.2 (-9.6, -8.8)	-14.3 (-15.0, -13.6)
Hazardous-high income	-0.5 (-0.5, -0.5)	-1.8 (-1.9, -1.7)	-7.7 (-8.1, -7.3)	-11.9 (-12.6, -11.2)	-16.6 (-17.5, -15.7)	-2.7 (-2.9, -2.5)	-3.9 (-4.1, -3.7)	-6.0 (-6.3, -5.7)
Harmful-low income	-2.8 (-3.3, -2.3)	-4.6 (-5.4, -3.3)	-17.0 (-20.0, -14.0)	-23.6 (-27.7, -19.5)	-27.4 (-32.2, -22.6)	-9.3 (-10.9, -7.7)	-18.9 (-22.2, -15.6)	-30.7 (-36.1, -25.3)
Harmful-middle income	-2.1 (-2.4, -1.8)	-3.6 (-4.1, -3.1)	-12.9 (-14.9, -10.9)	-19.6 (-22.6, -16.6)	-24.9 (-28.7, -27.1)	-8.7 (-10.0, -7.4)	-14.6 (-16.8, -12.4)	-25.5 (-29.4, -21.6)
Harmful-high income	-0.9 (-1.0, -0.8)	-2.0 (-2.2, -1.8)	-10.9 (-11.9, -9.9)	-14.5 (-15.8, -13.2)	-18.7 (-20.4, -17.0)	-3.7 (-4.0, -3.4)	-7.4 (-8.1, -6.7)	-10.0 (-10.9, -9.1)
Age group * drinking level								
Moderate-younger	-0.5 (-0.6, -0.4)	-1.0 (-1.1, -0.9)	-6.5 (-7.3, -5.7)	-10.7 (-12.0, -9.4)	-13.0 (-14.5, -11.5)	-0.8 (-0.9, -0.7)	-1.9 (-2.1, -1.7)	-4.0 (-4.5, -3.5)
Moderate-middle age	-1.0 (-1.1, -0.9)	-1.6 (-1.8, -1.4)	-9.0 (-10.2, -7.8)	-13.9 (-15.7, -12.1)	-17.9 (-20.2, -15.6)	-1.1 (-1.2, -1.0)	-3.2 (-3.6, -2.8)	-5.1 (-5.8, -4.4)
Moderate-older	-1.1 (-1.3, -0.9)	-2.2 (-2.5, -1.9)	-11.0 (-12.6, -9.4)	-15.6 (-17.8, -13.4)	-19.9 (-22.7, -17.1)	-1.4 (-1.6, -1.2)	-4.1 (-4.7, -3.5)	-6.5 (-7.4, -5.6)
Hazardous-younger	-0.6 (-0.6, -0.6)	-1.9 (-2.0, -1.8)	-7.1 (-7.5, -6.7)	-12.6 (-13.4, -11.8)	-16.1 (-17.1, -15.1)	-3.7 (-3.9, -3.5)	-5.6 (-5.9, -5.3)	-10.2 (-10.8, -9.6)
Hazardous-middle age	-1.2 (-1.3, -1.1)	-3.1 (-3.2, -3.0)	-9.8 (-10.2, -9.4)	-16.4 (-17.1, -15.7)	-22.2 (-23.1, -21.3)	-5.1 (-5.3, -4.9)	-9.6 (-10.0, -9.2)	-13.0 (-13.6, -12.4)
Hazardous-older	-1.3 (-1.4, -1.2)	-4.2 (-4.4, -4.0)	-12.0 (-12.7, -11.3)	-18.5 (-19.5, -17.5)	-24.7 (-26.1, -23.3)	-6.8 (-7.2, -6.4)	-12.2 (-12.9, -11.5)	-16.5 (-17.4, -15.6)
Harmful-younger	-1.1 (-1.2, -1.0)	-2.1 (-2.4, -1.8)	-10.0 (-11.3, -8.7)	-15.3 (-17.2, -13.4)	-18.2 (-20.5, -15.9)	-5.1 (-5.7, -4.5)	-9.0 (-10.1, -7.9)	-17.1 (-19.3, -14.9)
Harmful-middle age	-2.3 (-2.7, -1.9)	-3.5 (-4.0, -3.0)	-13.9 (-16.0, -11.8)	-19.9 (-23.0, -16.8)	-25.1 (-28.9, -21.3)	-7.2 (-8.3, -6.1)	-15.6 (-18.0, -13.2)	-21.7 (-15.0, -18.4)

Harmful-older	-2.5 (-2.8, -2.2)	-4.7 (-5.2, -4.2)	-16.9 (-18.7, -15.1)	-22.4 (-24.8, -20.0)	-27.9 (-30.9, -20.0)	-9.4 (-10.4, -8.4)	-19.8 (-21.9, -17.7)	-27.6 (-30.6, -24.6)

Note: # Price elasticities and consumption effects were estimated based on 2013 data, and the household income, drinking and age groups were defined in the method section.