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Are Alcohol Taxation and Pricing Policies Regressive? Product-Level Effects of a Specific Tax and a Minimum Unit Price for Alcohol

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Abstract

Aims: To compare estimated effects of two policy alternatives, (i) a minimum unit price (MUP) for alcohol and (ii) specific (per-unit) taxation, upon current product prices, per capita spending (A$), and per capita consumption by income quintile, consumption quintile and product type.
Methods: Estimation of baseline spending and consumption, and modelling policy-to-price and price-to-consumption effects of policy changes using scanner data from a panel of demographically representative Australian households that includes product-level details of their off-trade alcohol spending ($n = 885$; total observations = 12,505). Robustness checks include alternative price elasticities, tax rates, minimum price thresholds and tax pass-through rates.
Results: Current alcohol taxes and alternative taxation and pricing policies are not highly regressive. Any regressive effects are small and concentrated among heavy consumers. The lowest-income consumers currently spend a larger proportion of income (2.3%) on alcohol taxes than the highest-income consumers (0.3%), but the mean amount is small in magnitude [A$5.50 per week (95%CI: 5.18–5.88)]. Both a MUP and specific taxation will have some regressive effects, but the effects are limited, as they are greatest for the heaviest consumers, irrespective of income. Among the policy alternatives, a MUP is more effective in reducing consumption than specific taxation, especially for consumers in the lowest-income quintile: an estimated mean per capita reduction of 11.9 standard drinks per week (95%CI: 11.3–12.6).
Conclusion: Policies that increase the cost of the cheapest alcohol can be effective in reducing alcohol consumption, without having highly regressive effects.

INTRODUCTION

Harm from alcohol is a major public health concern in Australia, where annually an estimated 5,500 deaths and >157,000 hospitalizations are attributable to alcohol (2010 figures) (Gao *et al.*, 2014). The total social cost of harm from alcohol in Australia is estimated to be A$36 billion annually (FARE, 2010). Reducing this harm, a large proportion of which is preventable through both targeted and population-wide interventions, will require the implementation of policies that are effective in deterring heavy consumption. Empirical research and modelling studies show that taxation and pricing policies, which increase the relative cost of alcohol, are among the most effective strategies for reducing heavy consumption and harm in the population (Purshouse *et al.*, 2010; Wagenaar *et al.*, 2010; Stockwell *et al.*, 2011; Doran *et al.*, 2013; Zhao *et al.*, 2013). These policies are particularly effective if they increase the cost of the cheapest products, as these are commonly favoured by the heaviest consumers (Black *et al.*, 2011; Crawford *et al.*, 2012; Sharma *et al.*, 2014; Sheron *et al.*, 2014).

Alcohol taxation and pricing policy in Australia

In Australia, taxation of alcohol is the responsibility of the federal government which has two regimens: (i) a value-based '*ad valorem*' tax for wine and traditional cider, and (ii) 16 different specific tax rates (excise duties on domestic products and equivalent customs duties on imported products) for beer, spirits and other excisable alcohol. The dissimilar rate of government taxation across alcohol products

Box 1. Amount of alcohol tax payable [excise duties, equivalent customs duties and the wine equalization tax (WET)] per standard drink for various alcohol product types, sizes and alcohol content (alcohol by volume %) sold in Australia, as at 1 August 2015[a]

Description of product	Alcohol by volume (%)	Excise duty rate or WET rate[b]	Tax per standard drink (A$)
Basic wine (<$5 per litre) (e.g. 5 l cask wine)	12.5*	29% of half the retail price	0.04
Low-strength beer on tap	2.0	A$8.08 per LAL on alcohol content >1.15% ABV	0.04
Popular premium wine ($3.75–$6.00 per 750-ml bottle)	14.0	29% of half the retail price	0.07
Premium wine ($6.00–$11.25 per 750-ml bottle)	14.0	29% of half the retail price	0.10
Fortified wine ($10–$20 per 750-ml bottle)	18.0	29% of half the retail price	0.14
Cider—traditional (apple, pear)	5.0	29% of half the retail price	0.18
Mid-strength beer on tap	3.0	A$25.33 per LAL on alcohol content >1.15% ABV	0.20
Super premium wine ($11.25–$18.75 per 750-ml bottle)	14.0	29% of half the retail price	0.20
Packaged low-strength beer	2.0	A$40.43 per LAL on alcohol content >1.15% ABV	0.22
Regular-strength beer on tap	5.0	A$33.16 per LAL on alcohol content >1.15% ABV	0.32
Specialty wine (>$18.75 per 750-ml bottle)	14.0	29% of half the retail price	0.33
Packaged mid-strength beer	3.0	A$47.09 per LAL on alcohol content >1.15% ABV	0.37
Packaged regular-strength beer	5.0	A$47.09 per LAL on alcohol content >1.15% ABV	0.46
Brandy	37.0	A$74.50 per LAL	0.95
Cider—flavoured	4.0	A$79.77 per LAL	1.02
Ready to drink products (RTDs)	3.0–9.0	A$79.77 per LAL	1.02
Whisky, rum, vodka, liqueurs	22.0–43.0	A$79.77 per LAL	1.02

A$, Australian Dollar; One standard drink contains 12.67 ml (10 g) of pure alcohol; WET, wine equalization tax; LAL, litre of alcohol (ethanol); ABV, alcohol by volume.

[a]Indexation of excise duty rates occurs on 1 February and 1 August each year. WET rate is not subject to indexation.

[b]Source of excise duty rate and WET: Australian Tax Office (2015).

in Australia translates into large disparities between product types in the amount of tax paid per standard drink, which unevenly affects the retail price of products, and can influence consumption decisions in ways that may be deleterious to health (see Box 1).

Recent government-commissioned and independent reviews of the Australian alcohol taxation system, along with parliamentary inquiries into alcohol-related harm, have consistently recommended reforms to increase the effectiveness of taxation policies in reducing the external social costs of alcohol (Preventative Health Taskforce, 2009; AFTS, 2010; House of Representatives, 2015). The most common recommendation is the adoption of a per-unit tax, or specific tax across all alcohol products [a per-unit tax or specific tax on alcohol is one where the rate of tax is expressed as a dollar value per unit, where a unit may be the litres of beverage or litres of alcohol (ethanol); the latter unit is the convention used in Australia; a per-unit tax on alcohol is also referred to as a volumetric tax] (AFTS 2010). It is argued that this could closely reflect the social costs of alcohol (Cnossen, 2010), target and reduce heavy consumption (Sharma *et al.*, 2014), and produce benefits to population health and government revenue (Collins and Lapsley, 2008; Doran *et al.*, 2013). However, replacing Australia's current regime of tiered specific taxes on beer and spirits, and the *ad valorem* wine tax, with a common specific tax on all products would have wide-ranging effects across alcohol product prices, and may affect consumption behaviours in ways that could impact negatively upon public health. For instance, low-strength beer is currently taxed at a lower tax rate than regular-strength beer, and the introduction of a single specific tax across all product types set at the tax rate currently applicable to regular-strength beer would increase the tax (and price) of low-strength beer. Conversely, it would reduce the tax (and price) of high-strength alcohol products, such as spirits, which are currently taxed at a higher rate than regular-strength beer. Furthermore, a single common specific tax is unlikely to prevent some alcohol from being sold very cheaply, nor prevent drinkers from downshifting to cheaper products.

To prevent reductions in the tax (and price) of high alcohol products (e.g. spirits), modelling studies and independent inquiries suggest retaining the higher specific tax rate currently applicable to spirits, while replacing the *ad valorem* tax currently on wine with a new specific tax, set at a rate similar to that currently applied to beer (Doran *et al.*, 2013; Preventative Health Taskforce, 2009). To prevent downshifting, and enhance the effect of specific taxation in limiting the availability of very cheap alcohol, it is also recommended that the Australian government explore the feasibility of introducing a minimum unit price (MUP) for alcohol (a MUP for alcohol establishes a government-regulated price for a specified volume of pure alcohol or alcoholic beverage below which products may not be sold) (Preventative Health Taskforce, 2009). Evidence of the effects of a MUP on consumption and harms is largely limited to provinces in Canada where versions of a MUP have been implemented and evaluated (Stockwell *et al.*, 2011; Stockwell *et al.*, 2012; Zhao *et al.*, 2013), along with modelling studies that estimate the effects of a MUP if it were introduced in the UK (Purshouse *et al.*, 2010; Holmes *et al.*, 2014). While a MUP has not been implemented in an Australian context, starting in 2002 the Northern Territory government sanctioned indirect alcohol price controls in the town of Alice Springs by banning the cheapest alcohol available for purchase: cask wine and fortified wine (in containers >2 and 1 l, respectively) (cask wine in Australia is wine that is packaged for sale in a wine cask, also known as a bag-in-box,

which consists of a plastic bladder containing wine, fitted with a plastic tap opening, and packed within a cardboard box; wine casks are a cheaper alternative to glass bottling and range in volume from 2 to 5 l). An evaluation of these indirect price controls reported a 37% increase in the mean price of alcohol, from A$0.80 to A$1.10 per standard drink, a 20% reduction in mean weekly consumption in the population, and an interruption to the increasing rate of alcohol-related hospital admissions (Symons *et al.*, 2012).

Despite the benefits to population health, concerns are raised that alcohol taxation and pricing policies can have regressive impacts on consumers (ANPHA, 2013; Ludbrook, 2009). Regressive impacts mean an increase in spending that is higher as a proportion of income for the poorest households compared with the wealthiest. While there are a number of overseas studies that examine the effect of alcohol tax and price policies by income group (for example, Ashton *et al.*, 1989; Lyon and Schwab, 1995; Ataguba, 2012; Daley *et al.*, 2012; Holmes *et al.*, 2014), to our knowledge, there are no Australian studies of the regressivity of such policies. The aim of our study is to investigate whether alcohol taxation and pricing policies are regressive, by comparing household income quintiles' current per capita spending on alcohol taxation with the estimated changes in spending under two policy alternatives: (i) a MUP on all alcohol products (A$1.00 per standard drink, i.e. per 10 g ethanol) and (ii) specific taxation [A$41.68 per litre of alcohol (LAL) for wine and beer; A$70.61 per LAL for spirits]. Using differential alcohol price elasticities of demand for consumption levels and beverage type, we estimate the predicted changes in annual per capita apparent consumption of alcohol, and hence the potential for health improvements. This study builds on a previous investigation, using the same dataset, into whether these policies will reduce heavy consumption without adversely affecting light and moderate consumers (Sharma *et al.*, 2014), but differs significantly by focussing on the variation in policy effects according to income. For our investigation, we are able to accurately estimate policy effects using individual households' alcohol expenditure records and specific product-level details covering a full year.

METHODS

Data

Several reviews highlight limitations of data commonly used in this field of research, and recommend that models be built using datasets that include individual alcohol spending and consumption, product details, location of purchase and the price paid per product (WHO, 2000; Ruhm *et al.*, 2012). With regard to alcohol price data, a review by Ruhm *et al.* (2012) found that 'scanner data' (i.e. prices recorded by retailers or consumers directly scanning the barcode of a product) are the most accurate and reliable data for analysing the effects of alcohol price changes. For this study, we use a sample of consumer scanner data for Australian households' annual alcohol purchases, obtained from the Nielsen Company's continuous HomeScan panel survey ($n = 885$; total observations = 12,505). The data include a high level of specificity on individual household alcohol purchases not provided in publicly available population survey datasets, such as alcohol type, brand, flavour variant, size (litres of beverage and litres of alcohol), quantity, packaging (e.g. multi-pack), price paid per item (A$), total spend per shopping trip, and the date and location (i.e. store name) of the shopping trip, along with demographic and economic information about the individual household and the shopper. Refer to Supplementary Information (S1) for details.

Analysis

Our analysis has two main steps:

(a) Calculating baseline information, including: current mean prices paid (A$) by the household's shopper for various alcoholic beverages under existing tax policies; the base price (i.e. the price exclusive of all taxes) for various alcoholic beverages; the mean annual per capita spending on alcohol (A$); and the estimated mean annual apparent consumption of alcohol per capita (number of standard drinks).
(b) Estimating changes to these baseline values under alternative taxation and pricing policies.

See Supplementary Information (S2) for the detailed method.

Where appropriate, we adapt aspects of the mathematical framework in the Sheffield Alcohol Policy Model (SAPM) version 2.0 (see Brennan *et al.*, 2014) to guide our own modelling, including the SAPM method of modelling baseline consumption and purchasing, policy-to-price and price-to-consumption.

The effect of applying a MUP policy is estimated by inflating the price of individual products up to A$1.00 per standard drink where the original purchase price is <A$1.00 per standard drink. To estimate the effect of a uniform specific tax on wine and beer, we apply a tax rate of A$41.68 per LAL with an exemption from taxation for the first 1.15% of alcohol in all beverages, as per recent recommendations to government (AFTS 2010), and we retain the current specific tax rate on spirits of A$70.61 per LAL.

To estimate the change in mean annual volume of alcohol consumption per capita resulting from the estimated changes in spending, we assign recent Australian estimates of the own-price elasticity of alcohol (Fogarty, 2012) to each consumer aged >11 years (within households), differentiated by assumed drinking pattern (according to mean annual alcohol consumption per capita) and product type, given that price elasticity of demand for alcohol is known to vary by different categories of drinkers (Wagenaar *et al.*, 2009) (see Supplementary Information S3 for our review of published elasticities). In our robustness checks, we include alternative elasticity estimates by beverage type, consumption level, income level and place of purchase (see Supplementary Information S4). Estimating substitution between off-trade and on-trade consumptions is not possible as we do not have consumers' on-trade expenditure information. Estimating substitution between and within beverage types is not attempted, given that our review of the published estimates of cross-price elasticities found very few studies that have addressed this complex and difficult question, and most estimates are of a very small magnitude and/or not statistically significant. While there is variation in alcohol tax pass-through rates reported in the international literature (see Supplementary Information S5), we assume full (1.0) tax pass-through in the estimations. We include alternative pass-through rates in our robustness checks (see Supplementary Information S6).

RESULTS

Spending, consumption and prices paid for alcohol

Baseline estimates show a large variation in mean annual per capita spending on alcohol across income quintiles in our sample (which excludes consumers in households with zero purchases) (see Table 1). Along with disparities in spending, the distribution of mean annual consumption of alcohol across income quintiles is very unequal, with a clear negative income gradient. These gradients are steeper and more linear than the small negative income gradient among consumers in households with zero purchases that are excluded from our sample for analysis (data not shown). The prevalence of zero purchases is only somewhat greater in the lowest-income quintile (38.9%) compared with the highest-income quintile (31.8%).

Table 1. Summary of baseline information including alcohol spending (A$), alcohol prices (A$) and volume (standard drinks) of alcohol purchased by each income quintile

Equivalized annual household income quintiles[a]	Number of households [proportion of total (%)]	Mean number of persons per household (95% CI)	Mean annual spending (A$) on alcohol per capita[b] (95% CI)	Mean annual spending (A$) on alcohol per capita[b] as a proportion of equivalized annual household income (%) (95% CI)	Mean annual apparent alcohol consumption (standard drinks[c]) per capita (95% CI)	Mean price (A$) paid per standard drink (95% CI)
First quintile (20% lowest income), range: A$0–A$16,000, mean: A$12,490	153 (17.3)	2.3 (2.2, 2.4)	771.41 (737.59, 805.24)	6.1 (5.9, 6.4)	1,210.5 (1147.8, 1273.3)	1.25 (1.19, 1.32)
Second quintile, range: A$16,501–A$25,333, mean: A$21,849	154 (17.4)	2.6 (2.51, 2.8)	1019.56 (935.33, 1103.80)	4.6 (4.2, 5.0)	1,095.9 (1007.2, 1184.6)	1.54 (1.45, 1.63)
Third quintile, range: A$25,334–A$33,000, mean: A$29,881	164 (18.5)	2.8 (2.7, 2.8)	929.50 (871.01, 988.00)	3.0 (2.8, 3.1)	797.3 (756.5, 838.1)	1.63 (1.54, 1.71)
Fourth quintile, range: A$33,001–A$50,000, mean: A$42,138	211 (23.8)	2.8 (2.8, 2.9)	678.49 (649.20, 707.78)	1.6 (1.6, 1.7)	583.6 (558.81, 608.3)	1.86 (1.77, 1.95)
Fifth quintile (20% highest income), range: >A$50,000 mean: A$75,043	203 (22.9)	2.2 (2.1, 2.3)	541.74 (521.33, 562.15)	0.8 (0.7, 0.8)	464.6 (442.2, 487.1)	2.08 (1.95, 2.21)
All households, mean: A$35,721	885 (100.0)	2.6 (2.5, 2.6)	656.8 (274.3, 1039.3)	3.2 (0.5, 5.9)	834.3 (809.5, 859.1)	1.67 (1.63, 1.71)

A$, Australian Dollars; 95%CI, 95% confidence interval.

[a]For all analyses, the sample is divided uniformly into income quintiles in order from the household with the lowest equivalized annual household income to the household with the highest equivalized annual household income.

[b]Per capita estimates are based on all persons aged >11 years in the household.

[c]One standard drink contains 12.67 ml (10 g) of pure alcohol.

Alcohol consumption is also unevenly distributed across the sample when divided into quintiles of per capita consumption. If consumption were evenly distributed across the sample, 20.0% of the total volume of alcohol would be shared equally among consumers in each of 5 consumption quintiles, with each consumption quintile representing 20.0% of households in the sample. In contrast, we find that per capita consumption by households in the two heaviest-consumption quintiles combined (i.e. consumption quintiles 4 and 5) accounts for 40.0% of the total volume of alcohol consumed by the full sample, but these households represent only 9.1% of the sample (see Table 2).

On average, the mean price paid per standard drink increases with consumers' income. However, the price–income relationship differs depending on consumers' consumption level (see Table 3). The heaviest consumers, regardless of their income level, pay relatively lower prices for alcohol on average compared with the lightest consumers who, regardless of their income, pay relatively higher prices.

Regressivity of current and alternative taxes and pricing policies

Current taxes

The current Australian taxation of alcohol has some regressive effects. The mean total amount of alcohol tax paid by the lowest-income consumers of beer, wine and spirits combined is small in magnitude (around A$5.50 per week), but it is greater in value, and as a proportion of income (2.3%) than that paid by the highest-income consumers (0.3%) (see Table 4). Across product categories, consumers of wine incur the least alcohol tax costs, whereas consumers of beer and spirits incur the most. Across income quintiles, differences in mean annual alcohol tax costs per capita depend both on the mean annual volume of alcohol they purchase, as well as the type and quality (i.e. value) of products purchased and how alcohol taxes are currently calculated on these. For example, because beer and spirits taxes are based on alcohol content, the amount of alcohol tax paid per standard drink, generally regardless of the quality of the product, will not differ across income quintiles. However, because wine taxes are currently based on the value of the product, the amount of tax paid per standard drink will vary across income quintiles depending largely on the quality of the wine purchased.

Minimum unit price

For beer, wine and spirits consumption combined, a MUP will have a regressive impact, with spending increases representing 2.7% of income for consumers in the lowest-income quintile, compared with 0.3% of income for those in the highest-income quintile. A MUP will lead to large increases in the mean annual alcohol costs for both wine and beer consumers across all income quintiles, but not for spirits consumers because the current price of most spirits products exceeds the MUP level of A$1.00 per standard drink that we model (see Table 5). Driving the overall cost increases for consumers are some large price rises at the product level. For example, when the MUP policy is applied to 4-l casks of wine containing 36 standard drinks, the estimated mean retail price per product would increase by 190%, from A$12.38 to A$36.00.

Among those who purchase wine, consumers in the lowest-income quintile will incur the greatest increase in mean costs per capita as a result of a MUP. Importantly, however, the predicted change in mean alcohol consumption per capita for low-income wine consumers arising from this cost increase will also be substantial: a mean reduction of around 11.5 standard drinks per week. For the highest-income

Table 2. Mean annual volume (standard drinks[a]) of alcohol purchased per capita[b] by each income quintile and quintile of apparent alcohol consumption per capita[c]

	First consumption quintile (20% lightest consumers)		Second consumption quintile		Third consumption quintile		Fourth consumption quintile		Fifth consumption quintile (20% heaviest consumers)	
Equivalized annual household income quintiles[a]	Standard drinks (95%CI)	Proportion of total households (%)	Standard drinks (95%CI)	Proportion of total households (%)	Standard drinks (95%CI)	Proportion of total households (%)	Standard drinks (95%CI)	Proportion of total households (%)	Standard drinks (95%CI)	Proportion of total households (%)
First income quintile (20% lowest income)	49.6 (46.5, 52.6)	10.3	174.0 (170.4, 177.6)	2.9	353.6 (346.7, 360.5)	2.4	941.0 (927.7, 954.3)	1.0	3469.0 (3344.0, 3594.1)	0.7
Second income quintile	52.7 (50.3, 55.1)	11.3	168.5 (164.2, 172.8)	2.4	365.4 (358.1, 372.7)	1.4	827.5 (809.5, 845.5)	1.5	3135.3 (2855.9, 3414.8)	0.9
Third income quintile	48.1 (45.5, 50.8)	11.5	160.2 (156.8, 163.6)	2.7	356.8 (351.0, 362.6)	2.5	898.0 (871.5, 924.5)	1.1	2569.9 (2480.1, 2659.7)	0.7
Fourth income quintile	37.9 (35.8, 40.0)	16.3	177.7 (174.7, 180.8)	3.8	346.7 (337.9, 355.6)	1.9	784.0 (770.3, 797.7)	1.2	1917.8 (1877.0, 1958.6)	0.6
Fifth income quintile (20% highest income)	50.5 (48.1, 52.9)	14.7	166.0 (163.0, 169.1)	4.7	384.6 (375.4, 393.9)	2.1	834.9 (813.0, 856.8)	1.0	1928.9 (1885.5, 1972.2)	0.3
Total	47.7 (46.6, 48.8)	64.1	169.7 (168.2, 171.3)	16.6	361.8 (358.4, 365.2)	10.3	853.1 (844.8, 861.4)	5.9	2808.6 (2719.1, 2898.1)	3.2

95%CI, 95% Confidence Interval.

[a]One standard drink contains 12.67 ml (10 g) of pure alcohol.

[b]Per capita estimates are based on all persons aged >11 years in the household.

[c]Quintiles are calculated by dividing the sample uniformly in order from the household with the lowest estimated annual per capita alcohol consumption (or annual equivalized household income) to the household with the highest. Note, however, that for this cross-tabulation of income and consumption that each of the consumption quintiles and income quintiles may not necessarily contain an equal number of households.

Table 3. Mean prices paid per standard drink (A$) by quintile[a] of equivalized household income and quintile of apparent alcohol consumption per capita[b]

Equivalized annual household income quintiles[a]	Consumption quintiles				
	First quintile (20% lightest consumers) A$ (95% CI)	Second quintile A$ (95% CI)	Third quintile A$ (95% CI)	Four quintile A$ (95% CI)	Fifth quintile (20% heaviest consumers) A$ (95% CI)
First income quintile (20% lowest income)	1.50 (1.40, 1.59)	1.30 (1.22, 1.37)	1.03 (0.96, 1.10)	0.62 (0.58, 0.65)	0.73 (0.68, 0.79)
Second income quintile	1.44 (1.35, 1.52)	1.25 (1.18, 1.32)	1.07 (0.99, 1.14)	0.67 (0.61, 0.73)	0.98 (0.93, 1.03)
Third income quintile	1.52 (1.44, 1.61)	1.46 (1.38, 1.54)	1.27 (1.22, 1.32)	0.92 (0.85, 1.00)	1.30 (1.23, 1.38)
Fourth income quintile	1.53 (1.44, 1.62)	1.39 (1.33, 1.46)	1.34 (1.25, 1.43)	1.12 (1.06, 1.18)	1.10 (1.01, 1.18)
Fifth income quintile (20% highest income)	1.63 (1.54, 1.71)	1.24 (1.17, 1.32)	1.45 (1.38, 1.52)	1.26 (1.18, 1.33)	0.95 (0.85, 1.04)

A$, Australian Dollars; 95%CI, 95% confidence interval.

[a]For all analyses, the sample is divided uniformly into consumption (or income) quintiles in order from the household with the lowest volume of consumption (or equivalized annual income) to the household with the highest volume of consumption (or equivalized annual income). Note, however, that for this cross-tabulation of income and consumption that each of the consumption quintiles and income quintiles may not necessarily contain an equal number of households.

[b]Per capita estimates are based on all persons aged >11 years in the household.

[c]*Specialty*-grade wine (>$25 per litre) products have been excluded from calculations as they contain a small number of high values that affect the estimates.

Table 4. Current mean annual alcohol tax costs per capita[a] by product category and quintile of equivalized annual household income[b]

Equivalized annual household income quintile	Beer		Wine		Spirits		Total	
	A$ (95% CI)	% of income (95% CI)	A$ (95% CI)	% of income (95% CI)	A$ (95% CI)	% of income (95% CI)	A$ (95% CI)	% of income (95% CI)
First quintile	133.62 (118.91, 148.32)	1.3 (1.1, 1.6)	92.99 (87.74, 98.25)	0.7 (0.7, 0.8)	448.29 (392.00, 504.58)	3.6 (3.2, 4.0)	287.45 (269.37, 305.53)	2.3 (2.2, 2.5)
Second quintile	512.82 (416.50, 609.13)	2.4 (1.9, 2.8)	64.8 (61.1, 68.6)	0.3 (0.3, (0.3)	176.42 (159.80, 193.05)	0.8 (0.7, 0.9)	373.70 (340.33, 407.07)	1.7 (1.5, 1.9)
Third quintile	572.72 (526.83, 618.61)	1.8 (1.6, 1.9)	54.3 (51.3, 57.2)	0.2 (0.2, 0.2)	94.04 (87.27, 100.81)	0.3 (0.3, 0.4)	290.00 (271.84, 308.16)	0.9 (0.9, 1.0)
Fourth quintile	185.73 (167.20, 204.27)	0.5 (0.5, 0.6)	69.4 (64.8, 74.0)	0.2 (0.2, 0.2)	234.28 (210.50, 258.07)	0.5 (0.5, 0.6)	264.45 (251.85, 277.05)	0.6 (0.6, 0.7)
Fifth quintile	217.16 (200.02, 234.31)	0.3 (0.3, 0.4)	59.77 (56.04, 63.50)	0.1 (0.1, 0.1)	128.86 (114.88, 142.85)	0.2 (0.2, 0.2)	181.06 (173.42, 188.70)	0.3 (0.2, 0.3)

A$, Australian Dollars; 95%CI, 95% confidence interval.

[a]Per capita estimates are based on all persons aged >11 years in the household.

[b]For all analyses, the sample is divided uniformly into income quintiles in order from the household with the lowest equivalized annual income to the household with the highest equivalized annual income.

Table 5. Estimated effects of a MUP of A$1.00 per standard drink by product category and quintile of equivalized annual household income[a]

Income quintile	Mean annual change in alcohol spending per capita[b]		Mean annual change in apparent alcohol consumption per capita[b]	
	A$ (95% CI)	% of income (95% CI)	Standard drinks (95% CI)	% change (95% CI)
Beer				
First quintile	145.42 (111.10, 179.74)	1.9 (1.3, 2.5)	−298.5 (−264.6, −332.4)	−79.4 (−74.3, −84.6)
Second quintile	1200.73 (934.07, 1467.40)	5.5 (4.3, 6.7)	−447.2 (−374.5, −519.9)	−45.2 (−42.6, −47.9)
Third quintile	940.05 (835.37, 1044.73)	2.9 (2.6, 3.2)	−577.0 (−531.6, −622.3)	−59.2 (−57.2, −61.2)
Fourth quintile	251.06 (207.91, 294.21)	0.7 (0.6, 0.8)	−332.2 (−298.5, −365.9)	−63.4 (−60.5, −66.3)
Fifth quintile	360.42 (317.99, 402.86)	0.6 (0.5, 0.7)	−280.5 (−256.7, −304.2)	−44.9 (−42.9, −47.0)
Wine				
First quintile	279.98 (248.22, 311.75)	2.0 (1.8, 2.2)	−595.9 (−550.8, −641.0)	−42.7 (−40.9, −44.6)
Second quintile	136.72 (124.29, 49.16)	0.6 (0.6, 0.7)	−286.0 (−268.2, −303.9)	−39.4 (−37.0, −41.9)
Third quintile	141.69 (120.15, 163.23)	0.5 (0.4, 0.6)	−306.1 (−282.0, −330.1)	−41.3 (−38.7, −43.8)
Fourth quintile	41.26 (34.65, 47.87)	0.1 (0.1, 0.1)	−121.4 (−107.9, −34.8)	−34.2 (−29.2, −39.3)
Fifth quintile	73.66 (60.42, 86.89)	0.1 (0.1, 0.1)	−132.2 (−118.2, −146.2)	−33.8 (−29.0, −38.7)
Spirits				
First quintile	4.86 (3.70, 6.02)	0.1 (0.0, 0.1)	−5.0 (−4.0, −6.0)	−3.9 (−3.3, −4.6)
Second quintile	5.43 (4.08, 6.77)	0.0 (0.0, 0.0)	−4.6 (−3.4, −5.9)	−6.7 (−3.1, −10.2)
Third quintile	6.87 (5.96, 7.77)	0.0 (0.0, 0.0)	−7.7 (−6.3, −9.1)	−7.6 (−6.5, −8.7)
Fourth quintile	5.72 (4.59, 6.85)	0.0 (0.0, 0.0)	−35.3 (−21.7, −48.9)	−17.8 (−13.2, −22.5)
Fifth quintile	6.56 (4.12, 9.00)	0.0 (0.0, 0.0)	−4.1 (−2.9, −5.3)	−8.4 (−3.6, −13.3)
Total				
First quintile	355.49 (326.41, 384.57)	2.7 (2.4, 2.9)	−619.9 (−586.4, −653.4)	−43.0 (−41.5, −44.4)
Second quintile	713.04 (605.93, 820.15)	3.3 (2.8, 3.7)	−462.3 (−427.1, −497.4)	−36.0 (−34.3, −37.6)
Third quintile	490.73 (442.77, 538.70)	1.6 (1.4, 1.7)	−436.7 (−414.6, −458.7)	−40.7 (−39.4, −42.1)
Fourth quintile	173.36 (154.58, 192.13)	0.5 (0.4, 0.5)	−209.2 (−197.5, −220.9)	−34.4 (−31.6, −37.1)
Fifth quintile	202.22 (181.80, 222.64)	0.3 (0.3, 0.3)	−198.7 (−185.5, −212.0)	−31.4 (−28.8, −34.0)

A$, Australian Dollars; 95%CI, 95% confidence interval.

One standard drink contains 12.67 ml (10 g) of pure alcohol.

[a]For all analyses, the sample is divided uniformly into income quintiles in order from the household with the lowest equivalized annual income to the household with the highest equivalized annual income.

[b]Per capita estimates are based on all persons aged >11 years in the household.

wine consumers, the predicted change in consumption will be considerably less: around 2.5 standard drinks per week. Among those who purchase beer, the mean cost increases for the lowest-income consumers will be smaller than that for the highest-income consumers (around $2.80 compared with $6.90 per week, respectively). However, these costs represent a larger proportion of income for those in the lowest-income quintile. The predicted change in consumption among the lowest- and highest-income beer consumers will be similar: a reduction of around 5.7 and 5.4 standard drinks per week, respectively.

Specific taxation

Replacing the current *ad valorem* tax on wine with a specific tax of A$41.68 per LAL will lead to large increases in the mean annual alcohol costs for those who purchase wine, across all income quintiles (See Table 6). Similar to the effect of a MUP, these cost increases for consumers are driven by large price rises at the product level. For example, when a new specific tax is applied to 4-l casks of wine containing 36 standard drinks (or 0.456 l of pure alcohol), the estimated mean retail price per product would increase by 140% from A$12.38 to A$29.75. Additionally, there will be increases in the mean retail price of fortified wine (63%), table wine (30%) and sparkling wine (15%) under a new specific tax; more so than under a MUP policy. As a result, compared with a MUP, a specific tax on wine would lead to greater increases in mean annual costs per capita. Yet, a specific tax would produce less reduction in per capita consumption than a MUP, particularly for the lowest-income consumers.

The overall impact of a new specific tax on consumers of beer products would be minor, because the modelled tax rate does not differ from that currently applicable to regular-strength beer, and hence the mean retail price of beer products overall is largely unchanged. Any impacts will fall mainly on consumers of low-strength beer products, as these are currently subject to a lower tax rate. There is no direct impact on spirits consumers under this policy scenario as we have assumed the current specific tax rate on spirits (A$70.71 per LAL) to remain unchanged in the model.

Overall, while both policy alternatives are similarly regressive at the aggregate level, a MUP is particularly less regressive than a specific tax for those who purchase wine, and a MUP is also predicted to achieve greater reductions in wine consumption than a specific tax. For those who purchase beer, a MUP is more regressive than a specific tax, but a MUP is predicted to achieve much greater reductions in beer consumption than a specific tax.

Differential effects of policy changes by product type and consumption level

Product type

While estimating the aggregate effects of the policies is important given most consumers purchase from across a range of product categories, analysis of the disaggregated effects at the product category level provides a deeper insight into whether consumption of particular products will lead to more regressive policy effects. By disaggregating wine products into five quality grades recognized in the Australian

Table 6. Estimated effects of a specific tax (A$41.68 per LAL) on beer and wine by product category and quintile of equivalized annual household income[a]

Income quintile	Mean annual change in alcohol spending per capita[b]		Mean annual change in apparent alcohol consumption per capita[b]	
	A$ (95% CI)	% of income (95% CI)	Standard Drinks (95% CI)	% change (95% CI)
Beer				
First quintile	17.85 (15.60, 20.10)	0.2 (0.2, 0.2)	−4.7 (−4.3, −5.2)	−2.1 (−2.0, −2.2)
Second quintile	74.16 (59.54, 88.78)	0.3 (0.3, 0.4)	−12.5 (−10.4, −14.5)	−1.8 (−1.7, −1.9)
Third quintile	61.97 (56.19, 67.75)	0.2 (0.2, 0.2)	−15.7 (−14.5, −16.9)	−2.2 (−2.1, −2.2)
Fourth quintile	27.31 (24.45, 30.18)	0.1 (0.1, 0.1)	−7.5 (−6.9, −8.2)	−2.2 (−2.2, −2.3)
Fifth quintile	30.04 (27.35, 32.72)	0.1 (0.0, 0.1)	−8.4 (−7.8, −9.1)	−2.1 (−2.0, −2.1)
Wine				
First quintile	330.85 (300.97, 360.74)	2.4 (2.2, 2.6)	−358.7 (−334.9, −382.4)	−35.0 (34.0, −36.0)
Second quintile	177.23 (164.74, 189.73)	0.8 (0.7, 0.8)	−191.4 (−182.0, −200.7)	−34.6 (−33.3, −36.0)
Third quintile	136.68 (121.20, 152.16)	0.5 (0.4, 0.5)	−172.3 (−160.5, −184.1)	−33.6 (−32.2, −34.9)
Fourth quintile	91.51 (82.26, 100.75)	0.2 (0.2, 0.2)	−97.0 (−89.4, −104.6)	−30.4 (−28.2, −32.6)
Fifth quintile	96.87 (85.05, 108.69)	0.1 (0.1, 0.2)	−90.0 (−82.8, −97.2)	−29.6 (−27.5, −31.7)
Total				
First quintile	289.23 (264.10, 314.36)	2.1 (1.88, 2.21)	−363.1 (−341.9, −384.2)	−31.0 (−30.1, −32.0)
Second quintile	174.37 (159.16, 189.58)	0.8 (0.71, 0.84)	−209.5 (−199.1, −219.9)	−29.9 (−28.7, −31.0)
Third quintile	122.30 (112.49, 132.10)	0.4 (0.4, 0.4)	−129.5 (−121.3, −137.6)	−20.7 (−19.8, −21.6)
Fourth quintile	90.27 (82.54, 98.00)	0.2 (0.2, 0.3)	−87.8 (−81.7, −94.0)	−22.5 (−20.9, −24.1)
Fifth quintile	94.70 (85.06, 104.34)	0.1 (0.1, 0.1)	−89.5 (−82.4, −96.7)	−21.3 (−19.8, −22.8)

A$, Australian Dollars; 95%CI, 95% confidence interval.

One standard drink contains 12.67 ml (10 g) of pure alcohol.

[a]For all analyses, the sample is divided uniformly into income quintiles in order from the household with the lowest equivalized annual income to the household with the highest equivalized annual income.

[b]Per capita estimates are based on all persons aged >11 years in the household.

wine industry (WGGA, 2009) and estimating the effect of a MUP and a specific tax on each grade of wine, we find that 'basic'-grade wine (which is predominantly cask wine products) will be the product most affected. This is because, on average, cask wine products have low value and are currently subject to the lowest tax rate of all alcohol products (mean tax of A$0.03 per standard drink), and are therefore usually purchased for considerably less than A$1.00 per standard drink (mean price of A$0.51 per standard drink in our sample). Furthermore, because the lowest-income consumers purchase the most cask wine, they will experience the greatest increases in mean alcohol costs per capita from the introduction of a MUP or specific tax on basic wine (see Supplementary Information S7). However, notwithstanding this regressive effect, we predict that either a MUP or a specific tax on cask wine would lead to substantial reductions in alcohol consumption among the lowest-income consumers.

With regard to sub-categories of beer, the estimated effect of a MUP on per capita spending is greatest among lower-income consumers, across all beer sub-categories (see Supplementary Information S8). Regular-strength beer is the sub-category most affected by a MUP, but the effect is very similar to that predicted for total beer consumption overall, reported earlier.

Consumption level

The heaviest consumers, generally irrespective of their income, will be most affected by a MUP and a specific tax. Likewise, the lightest consumers, irrespective of their income, will incur very small spending increases under either policy. For example, among those in the lowest-income quintile who are heavy consumers of wine, a MUP would lead to a mean spending increase of around A$16.70 per week (6.0% of income), compared with an increase of around A$0.05 per week (<0.1% of income) for those in the lowest-income quintile who are light consumers of wine (see Supplementary Information S9). Importantly, we predict that those in the lowest-income quintile who are heavy consumers of wine will reduce their consumption of wine by around 3.6 standard drinks per week under a MUP policy. Effects of a generally similar pattern, albeit varying in magnitude, are also found when applying a MUP to beer, and applying a specific tax to wine.

Robustness checks

As a further check of the robustness of our results, we apply alternative inputs and assumptions in calculating our estimations, including alternative price elasticities, pass-through rates, tax rates and minimum price thresholds (see Supplementary Information S4, S6, S10 and S11). Results of these robustness checks support our main findings and conclusions.

DISCUSSION

The central finding of this study is that while alcohol taxation and pricing policies can have some regressive effects, these effects are limited, as they are concentrated among the heaviest alcohol consumers. Furthermore, the magnitude of tax costs for the lowest-income consumers is small (currently around $5.50 per week) relative to their mean equivalized household income (around $240 per week). The magnitude of total spending increases for these consumers will also be small under either a MUP (around A$5.60 per week) or a new specific tax policy (around A$6.80 per week). These findings challenge the claim made by some commentators that alcohol taxation and pricing policies are highly regressive. Our study highlights the importance of considering the differential level of alcohol consumption across income groups and the actual dollar value of tax costs, rather than only consumers' tax costs as a proportion of their income, when examining the regressivity of policies.

Importantly, we show that the aggregate tax costs for consumers, and any regressive effects, are shaped by differences between consumers in their spending and consumption across product categories, and by the disparity in current tax rates across product categories. In particular, heavy consumption of low-quality cheap wine, and the very low effective rate of tax currently applicable to it, contributes substantially to how the costs for the lowest-income consumers would be affected by alternative taxation and pricing policies.

With regard to the two policy alternatives we examine, while the costs as a proportion of income resulting from either a MUP or a specific tax are greater for the lowest-income consumers than the highest-income consumers, the differences in these proportional costs are much larger across the alcohol consumption quintiles (i.e. from the lightest to the heaviest consumers) rather than across income quintiles. This is consistent with studies from the USA (Daley *et al.*, 2012) and the UK (Holmes *et al.*, 2014), which show heavy consumption to be a key determinant of whether the lowest-income consumers incur proportionately more alcohol tax costs than the highest-income consumers. Compared with specific taxation, a MUP is more effective for reducing alcohol consumption, especially for consumers in the lowest-income quintile, and it is also less regressive overall. This is primarily because a MUP is singularly targeted at increasing the price of the cheapest products, whereas a specific tax can lead to larger price increases across a wider range of products. Overall, our findings suggest that there is considerable scope for policies that raise the price of cheap alcohol to reduce heavy consumption without substantially increasing regressivity.

We predict that health improvements (i.e. reductions in consumption) across the population resulting from a MUP or a specific tax are likely to be concentrated disproportionately among the poorest consumers who, as shown by other studies, have a greater risk of experiencing alcohol-related harm (Probst *et al.*, 2014). Furthermore, as others have found (see Holmes *et al.*, 2014; Ludbrook *et al.*, 2012), we conclude that the impact of policies that increase the price of the cheapest alcohol depends fundamentally upon who are the main purchasers of cheap alcohol, how much of this they purchase and how strongly they respond to price changes.

It is possible that the degree of regressivity we find is inflated, given that our study includes only off-trade alcohol purchasing, which is more predominant than on-trade alcohol purchasing among low income populations compared with high income populations (Livingston, 2012; Morrison *et al.*, 2015). It is also possible that alcohol taxes would be found to be less regressive if measured relative to lifetime income, rather than annual income as we have done (Lyon and Schwab, 1995). Additionally, we note that the degree of regressivity in current alcohol taxes and either alternative policy is relatively low when compared with tobacco tax, for example, which in Australia is concentrated among a small proportion of the population and represents 10–20% of individual income for pack-a-day smokers earning a minimum wage (The Treasury, 2013).

A strength of our study over some previous research into the differential effects of alcohol taxation and pricing policies is our use of highly detailed scanner data on product and household-level alcohol spending in order to produce accurate estimates of policy effects. Some limitations of our study include the lack of matched data on individual household members' product preferences, their drinking patterns, their household's on-trade alcohol purchases, and how the latter would be affected by alternative taxation and pricing policies. In the absence of reliable Australian estimates of cross-price elasticities, we have not examined substitution between products, and without detailed data on households' on-trade purchases and prices, we have been unable to examine substitution between the off- and on-trade. Other data limitations in our study include possible under-reporting of some off-trade alcohol purchases, our assumption that all persons aged >11 years consume an equal share of each household's alcohol purchases, and possible errors and bias in recording alcohol expenditure by some shoppers. Notwithstanding these limits, a validation study of HomeScan data found that households reported purchases highly accurately (Einev *et al.*, 2008).

A priority for further research in this area will be to estimate the own- and cross-price elasticities and income elasticities of demand for alcohol, including between on- and off-trade alcohol, and how these vary depending on beverage type and consumption level. This is an under-researched area in an Australian context and in many other countries that will be valuable for informing taxation and pricing policy.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Alcohol and Alcoholism* online.

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CONFLICT OF INTEREST STATEMENT

None declared.

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