Econtech Pty Ltd
ACN: 056 645 197 ABN: 35 243 850 072

MODELLING HEALTH-RELATED REFORMS TO TAXATION OF ALCOHOLIC BEVERAGES

This report was prepared for the Alcohol and other Drugs Council of Australia by Econtech Pty Ltd with assistance from Rob Preece.

26 November 2004

Econtech was commissioned by ADCA to model taxation policy options to address the concerns of the health sector in the alcoholic beverages market. This Report sets out Econtech's findings. Econtech makes no representations to, and accepts no liability for, reliance on this work by any person or organisation other than ADCA. Any person, other than ADCA, who uses this work does so at their own risk and agrees to indemnify Econtech for any loss or damage arising from such use.

CANBERRA HEAD OFFICE
P.O. Box 4129,
Kingston ACT 2604
Phone: (02) 6295-0527
Fax: (02) 6295-8513
E-mail: office@econtech.com.au

Web-site: www.econtech.com.au

SYDNEY OFFICE
Suite 304, 66 Berry Street
North Sydney NSW 2060
Phone: (02) 9929-4700
Fax: (02) 9929-4793
E-mail: sydney@econtech.com.au

CONTENTS

Executive Summary

Econtech was commissioned by the Alcohol and other Drugs Council of Australia (ADCA) under ADCA's agreement with Alcohol Education and Rehabilitation Foundation (AERF) to undertake a study on Modelling Health-related Reforms to Taxation of Alcoholic Beverages. The broad aim of ADCA's proposed reforms to taxation of alcoholic beverages is to lower consumption of alcohol without adding to the tax burden on any of the three broad categories of alcoholic beverage – beer, wine and spirits. This involves strengthening the link between tax rates and alcohol content within each broad category of alcoholic beverage. The purpose of this study is to illustrate some individual components of ADCA's current alcohol taxation policy stance on both alcohol consumption and government revenue.

This study estimates a broad sales model that distinguishes beer, wine and spirits using the Almost Ideal Demand System (AIDS). The results agree closely with earlier Australian and international studies on the price sensitivity of demand for these alcoholic beverages. Spirits consumption is the most price sensitive with a price elasticity of around -1, so that a price rise of one per cent will reduce consumption by one per cent. Price elasticities for beer and wine are only around one-half of this value. This study also finds strong substitution effects between beer, wine and spirits.

Because this study focuses on reforming taxation of alcohol within each of the three broad categories, it needed to go beyond previous Australian demand studies by distinguishing different types of beer, wine and spirits. This involved making certain assumptions to disaggregate the broad sales model from its three categories of alcoholic beverages to a detailed sales model that distinguishes seven alcoholic beverages, as shown in Table A.

Table A
Broad and Detailed Categories of Alcoholic Beverages

Broad category	Detailed category
Beer	Beer – low strength
	Beer – mid strength
	Beer – normal strength
Wine	Wine – premium
	Wine – cask and cider
Spirits	Spirits – normal strength
	Spirits – RTDs

The assumptions made in the disaggregation are:

- the income elasticities for every member of a broad category are the same as for the broad category as a whole;
- the elasticities of substitution between members of different broad categories are the same as for the broad categories as a whole; and
- the elasticities of substitution between members of the same broad category take particular assumed values.

These assumptions represent neutral assumptions in the absence of better information and ensure that the detailed demand system is consistent with the broad demand system at a particular point.

ADCA's main policy stance is to move to a volumetric tax on all alcoholic beverages and to enhance incentives to consume low alcohol products. This report illustrates some individual components of this policy stance. However, some elements of ADCA's policy are not able to be addressed within the model. For example, the level of detail provided in the model is not able to distinguish the impact of the addition of the tax free threshold on low and medium strength ready to drink products.

A total of five scenarios were modelled using the detailed sales model, supported by other models covering pricing and taxation revenue from alcoholic beverages.

The most significant of these scenarios is scenario 1, which models a shift in the taxation of wine from one based on value to one based on the volume of alcohol. The wine tax reform is designed to fully fund a cut in the nominal Wine Equalisation Tax (WET) rate from 29 per cent to 8 per cent of wholesale value by introducing a volumetric wine tax set at $8.35 per litre of pure alcohol. Shifting the wine tax base away from taxing wine value and towards taxing wine alcohol would be expected to reduce consumption of wine alcohol. The key findings from simulating this proposal for wine tax reform are:

- no net change in tax collections from wine in total and from other alcoholic beverages;
- the price of cask wine up 12.8 per cent and the price of premium wine down 2.7 per cent;
- consumption of cask wine down 9.7 per cent and consumption of premium wine up 2.4 per cent;

- total value of wine consumption (and therefore the wine industry in aggregate) unaffected; and
- annual consumption of wine alcohol down 1.27 million litres of alcohol, representing 2.7 per cent of wine alcohol consumption and 0.80 per cent of total alcohol consumption.

The tax rate settings for all five scenarios are shown in Box A. Each of the scenarios are used to illustrate a component of ADCA's broad policy stance and also demonstrate the capabilities of the model. As previously mentioned, none of these scenarios, either individually or jointly, can be taken as representive of ADCA's current policy stance. Some key results for the five scenarios are summarised in Charts A and B.

Box A

Five Scenarios for Taxation of Alcoholic Beverages

1. This is a wine tax reform proposal under which a cut in the nominal WET rate from 29 per cent to 8 per cent is funded by the introduction of a volumetric wine tax set at $8.35 per litre of pure alcohol.
2. This second scenario includes scenario one and the introduction of a 1.15% excise free threshold applied to all RTDs, as already applies to beer.
3. This third scenario includes scenario one and a 30 per cent decrease in the excise rates for low strength beer funded by a 2 per cent increase in the excise rates for high strength beer.
4. This fourth scenario extends scenario one by fully abolishing WET and funding this by the introduction of a volumetric wine tax set at $11.65 per litre of pure alcohol.
5. This fifth scenario extends scenario four by also reducing the excise on low to mid strength beer and removing the tax free threshold on high strength beer.

Chart A shows that the wine tax proposal (i.e. scenario 1) significantly reduces consumption of alcohol, as noted above. This reduction could be boosted by going a step further and fully replacing WET by volumetric wine tax, as shown in scenario 4. It could also be slightly increased by increasing the differentiation between tax rates for normal and low strength beer, as in scenario 3. Each of these three scenarios – scenarios 1, 3 and 4 – are designed to be revenue-neutral and this outcome is confirmed by Chart B.

Scenario 2 combines the revenue-neutral ADCA wine tax proposal of scenario 1 with an excise-free threshold for RTDs. The latter measure leads to a loss in annual tax revenue of

$98 million, and little change to the impact on alcohol consumption already seen in scenario 1.

The remaining scenario looks at further shifts towards a reduction in the excise rate on low to mid strength beer and a removal of the tax free threshold on high strength beer. This scenario is increases annual tax revenue by $282 milliion and has the most significant impact on alcohol consumption, reducing it by 2 million litres per year.

Chart A
Impact on Alcohol Consumption by Scenario
(million litres of alcohol per year)

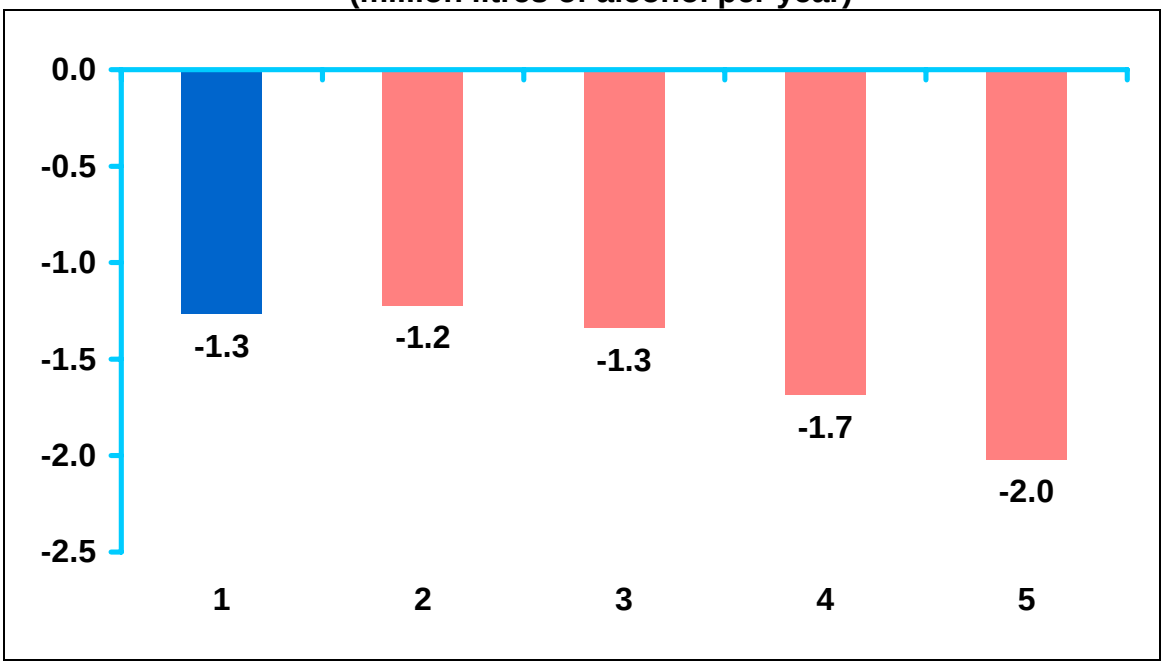
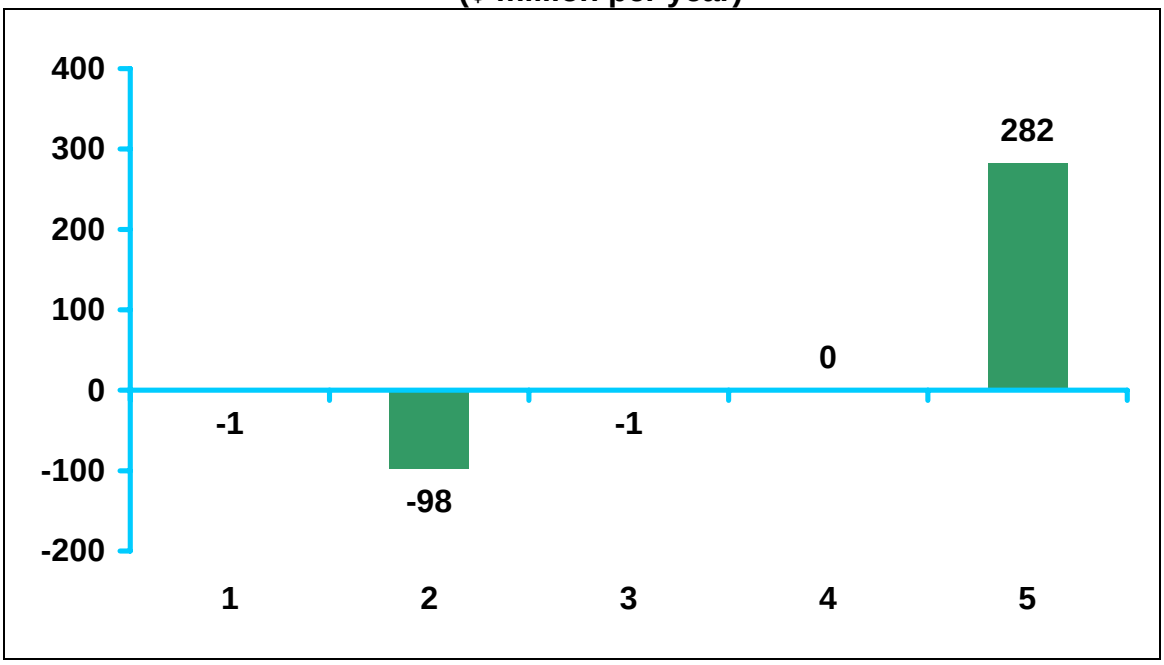


Chart B
Impact on Alcohol-specific Taxation Revenue by Scenario
($ million per year)



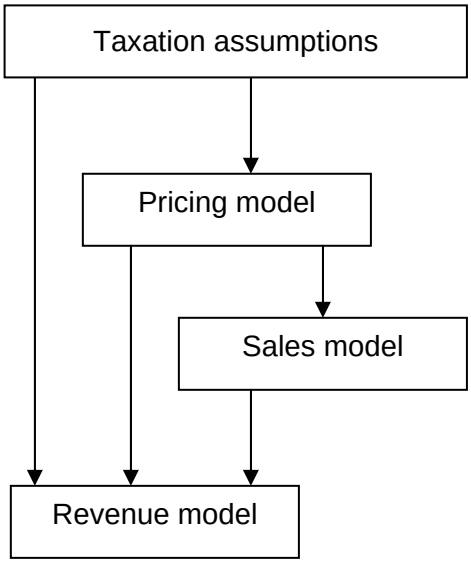
1. Introduction

Econtech was commissioned by the Alcohol and other Drugs Council of Australia (ADCA) under ADCA's agreement with Alcohol Education and Rehabilitation Foundation (AERF) to undertake a study on Modelling Health-related Reforms to Taxation of Alcoholic Beverages.

The broad aim of ADCA's proposed reforms to taxation of alcoholic beverages is to lower consumption of alcohol without adding to the tax burden on any of the three main categories of alcoholic beverage – beer, wine and spirits. This involves strengthening the link between tax rates and alcohol content within each category of alcoholic beverage, which is expected to achieve health benefits by lowering consumption of alcohol. It also involves calibrating the proposed tax rates to achieve approximate revenue neutrality for each of the three categories, to promote acceptance of the reforms in the beer, wine and spirits industries.

Econtech's role is to "conduct economic modelling that will seek to ensure that the proposed tax changes will maintain government revenue neutrality; minimise dramatic shifts in market share between beverage types; and address the concerns of the health sector".

This modelling approach taken involves four stages. Proposed tax rates are formulated based on ADCA's policy. A pricing model links the price of each alcoholic beverage to its taxation treatment. A sales model links sales volumes for each alcoholic beverage to prices for each alcoholic beverage. A revenue model uses the proposed tax rates and outcomes for prices and sales volumes to model taxation revenue from alcoholic beverages. These linkages are shown in the following diagram.



The need to model demand for alcoholic beverages at a detailed level posed the main challenge for this study. Earlier Australian studies of demand for alcoholic beverages, including studies by Murphy (1981) and Clements, K.W. and Johnson, L.W. (1983), have focussed on the three broad categories of beer, wine and spirits. However, this study focuses on reforming taxation of alcohol within each of the three broad categories. This requires a model that distinguishes seven detailed categories of alcoholic beverages – beer-low strength, beer-mid strength, beer-normal strength, wine-cask, wine-premium, spirits-RTDs, and spirits-normal strength. Unfortunately, the historical data needed to econometrically model demand at this more detailed level is not available. To overcome this problem, this study econometrically models demand for the three broad categories and then develops and applies a method to disaggregate this demand system to the seven detailed categories.

This report illustrates some individual components of ADCA's policy stance by a range of scenarios. However, some elements of ADCA's policy are not able to be addressed within the model. For example, the level of detail provided in the model is not able to distinguish the impact of the addition of the tax free threshold on low and medium strength ready to drink products. Each of the scenarios are used to illustrate a component of ADCA's broad policy stance and also demonstrate the capabilities of the model. None of these scenarios, either individually or jointly, can be taken as representive of ADCA's current policy stance.

This report is set out as follows. Section 2 looks at the current alcohol taxation arrangements and describes various alcohol tax scenarios, including the ADCA wine tax proposal. Section 3 presents data on sales and prices of alcoholic beverages in Australia – this data is used in the modelling presented in subsequent sections. Section 4 presents the specification of the model covering the three broad categories of alcoholic beverages. Section 5 provides the results from econometrically estimating this broad model, highlighting the price effects on demand. Section 6 describes the method that has been developed to disaggregate the demand system from three broad categories to seven detailed categories of alcoholic beverages. Section 7 provides the estimates of price and income effects on demand in the detailed model. The detailed model is then used in section 8 to model the various policy scenarios that were set out in section 2. This shows estimates of the effects of each tax reform scenario on prices and volumes of alcoholic beverages, consumption of pure alcohol, and on Commonwealth Government revenue.

While all care, skill and consideration has been used in the preparation of this report, the findings are based on the strict instructions of ADCA and are designed to be used only for the specific purpose set out below. If you believe that your instructions are different from those set out below, or you wish to use this work or information contained within it for another purpose, please contact us.

The specific purpose of this report is to estimate the impact of specific proposals to reform taxation of alcoholic beverages on prices and volumes of alcoholic beverages, consumption of pure alcohol, and the Commonwealth Government budget. The findings in this report are subject to unavoidable statistical variation. While all care has been taken to ensure that the statistical variation is kept to a minimum, care should be taken whenever using this information. Should you require clarification of any material, please contact us.

2. Policy scenarios for taxation of alcoholic beverages

This section looks at the current alcohol taxation arrangements and describes various alcohol tax scenarios. Each of the scenarios are used to illustrate a component of ADCA's broad policy stance and also demonstrate the capabilities of the model. None of these scenarios, either individually or jointly, can be taken as representive of ADCA's current policy stance..

The current taxation arrangements are considered first.

Beer and spirits are subject to a volumetric excise tax levied under the *Excise Act* (1901). These excise rates are expressed per litre of pure alcohol. The highest rate is for full strength spirits at $60.20 per litre of alcohol[1], followed by ready-to-drink (RTDs) beverages at $35.53 per litre of alcohol, followed by full-strength packaged beer, which is also taxed at $35.53 per litre of alcohol, but with this tax only applied to alcohol content (by volume) in excess of 1.15 per cent.

There are further complications in the taxation of beer. On health grounds, lower rates of tax are applied to lower strength beer compared with full strength beer. As a result of political negotiations over the introduction of the New Tax System, lower rates of tax are also applied to draught beer compared with packaged beer.

The rates of excise on beer and spirits increase in line with movements in the CPI in February and August each year under the indexation provisions of the *Excise Tariff Act* (1921). Changes to excise on domestically-produced alcoholic beverages are mirrored in changes to customs duty applied to imported alcoholic beverages. In all there are ten different rates of excise for beer, spirits and other alcoholic products as detailed in the Data Appendix.

Wine is not subject to excise, but is instead subject to the wine equalisation tax (WET). Unlike excise rates on beer and spirits, which are based on alcohol content, the WET is expressed as a percentage of the wholesale value of wine and is currently set at 29 per cent. This value basis of taxation means that the implied rate of tax on the alcohol in cask wine is generally much lower than for bottled wine, because cask wine is cheaper than bottled wine.

[1] Brandy is an exception being taxed at $56.21 per litre of alcohol, below the standard rate for spirits of $60.20 per litre of alcohol.

In fact, the implied rate of tax on the alcohol content of cask wine is lower than for any other alcoholic beverage.

The main complication in the WET is the new producer rebate that was introduced on 1 October 2004. This new rebate provides a full refund to a wine producer of WET payable on the first $1,000,000 in wholesale value of annual domestic sales. The producer rebate, which largely replaces less generous Commonwealth and State Government rebates that applied to cellar door sales only, reduces the average effective rate of WET from 29 to about 25 per cent.

The main taxation reform proposed by ADCA is to move towards taxing wine on the basis of alcohol content rather than value. This would bring the basis for taxing wine more into line with the basis for taxing beer and spirits. By making cask wine more expensive, it may also lower alcohol consumption, which is ADCA's aim in making this proposal. The modelling outcomes reported in section 8 test whether the ADCA proposal would achieve its stated aim.

At one extreme, the current WET could be fully replaced with a volumetric wine tax expressed per litre of alcohol. For this change to be revenue neutral, the volumetric wine tax rate would be set at $11.65 per litre of alcohol. This scenario is modelled in this report as scenario 4.

ADCA is instead proposing only a partial shift from the WET to a volumetric wine tax. The nomimal WET rate would be cut from 29 to 8 per cent, implying a cut in the effective WET rate from about 25 per cent to about 7 per cent. To maintain revenue neutrality, the volumetric wine tax would be set at the lower rate of $8.35 per litre of alcohol. This policy proposed by ADCA is scenario 1 in this report.

Scenarios 2 and 3 are designed to investigate the effects on alcohol consumption of various alterations to the ADCA scenario. That is, they both incorporate not only the ADCA proposal to fund a reduction in the nominal WET rate from 29 to 8 per cent using a volumetric wine tax, they also include other changes to alcohol taxation.

Under Scenario 2, RTD excise is only applied to alcohol content (by volume) in excess of 1.15 per cent. This is already the case for beer excise. As noted earlier, RTDs and full-

strength packaged beer already share the same excise rate of $35.53 per litre of pure alcohol, so this measure would bring taxation of RTDs into closer alignment with taxation of beer. However, beer would continue to enjoy other concessions not available for RTDs, namely concessional excise rates for lower strength and draught beverages.

Scenario 3 introduces a stronger distinction between excise rates on low strength and full strength beer. In a revenue-neutral shift, excise rates on low strength beer are cut by 30 per cent while excise rates on normal strength beer are raised by 2 per cent. The aim of this policy is to further reduce alcohol consumption.

Scenario 5, which does not incorporate the ADCA wine tax proposal, investigates the effects of reverting to the pre-New tax System situation where RTDs were taxed on the same basis as full strength spirits. This is to investigate the possible effects on alcohol consumption.

These five alternative scenarios are summarised below. The full settings for alcohol taxation under each scenario are shown in Table 1.

1. The first scenario is the ADCA wine tax reform proposal under which a cut in the nominal WET rate from 29 per cent to 8 per cent is funded by the introduction of a volumetric wine tax set at $8.35 per litre of pure alcohol.

2. The second scenario includes scenario one and the introduction of a 1.15% excise free threshold applied to all RTDs, as already applies to beer.

3. The third scenario includes scenario one and a 30 per cent decrease in the excise rates for low strength beer funded by a 2 per cent increase in the excise rates for high strength beer.

4. The fourth scenario extends scenario one by fully abolishing WET and funding this by the introduction of a volumetric wine tax set at $11.65 per litre of pure alcohol.

5. The fifth scenario extends scenario four by also reducing the excise on low to mid strength beer and removing the tax free threshold on high strength beer..

Table 1
Tax Reform Scenarios

Excise Rates ($ per litre of alc.)	Current	1	2	3	4	5
Packaged beer low	30.49	30.49	30.49	21.34	30.49	11.65
Packaged beer mid	35.53	35.53	35.53	35.53	35.53	11.65
Packaged beer high	35.53	35.53	35.53	36.24	35.53	35.53
Draught beer low	6.09	6.09	6.09	4.26	6.09	6.09
Draught beer mid	19.12	19.12	19.12	19.12	19.12	11.65
Draught beer high	25.02	25.02	25.02	25.52	25.02	25.02
Wine WET (effective) (%)	25%	7%	7%	7%	0%	0%
Wine excise	0.00	8.35	8.35	8.35	11.65	11.65
Spirits	60.20	60.20	60.20	60.20	60.20	60.20
RTDs	35.53	35.53	35.53	35.53	35.53	35.53
Excise Exclusive Threshold (% of alcohol by volume)						
Packaged beer low	1.15%	1.15%	1.15%	1.15%	1.15%	1.15%
Packaged beer mid	1.15%	1.15%	1.15%	1.15%	1.15%	1.15%
Packaged beer high	1.15%	1.15%	1.15%	1.15%	1.15%	0.00%
Draught beer low	1.15%	1.15%	1.15%	1.15%	1.15%	1.15%
Draught beer mid	1.15%	1.15%	1.15%	1.15%	1.15%	1.15%
Draught beer high	1.15%	1.15%	1.15%	1.15%	1.15%	0.00%
Wine	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Spirits	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
RTDs	0.00%	0.00%	1.15%	0.00%	0.00%	0.00%

Sources: ATO, Econtech, ADCA.

3. Data on sales and prices of alcoholic beverages

This section reviews the historical data relating to prices, consumption and spending for the three broad categories of alcoholic beverages – beer, wine and spirits. The data is used in section 5 to econometrically estimate the responsiveness of consumption of each broad category of alcoholic beverage to changes in prices and income. The construction of this data is explained in Appendix B.

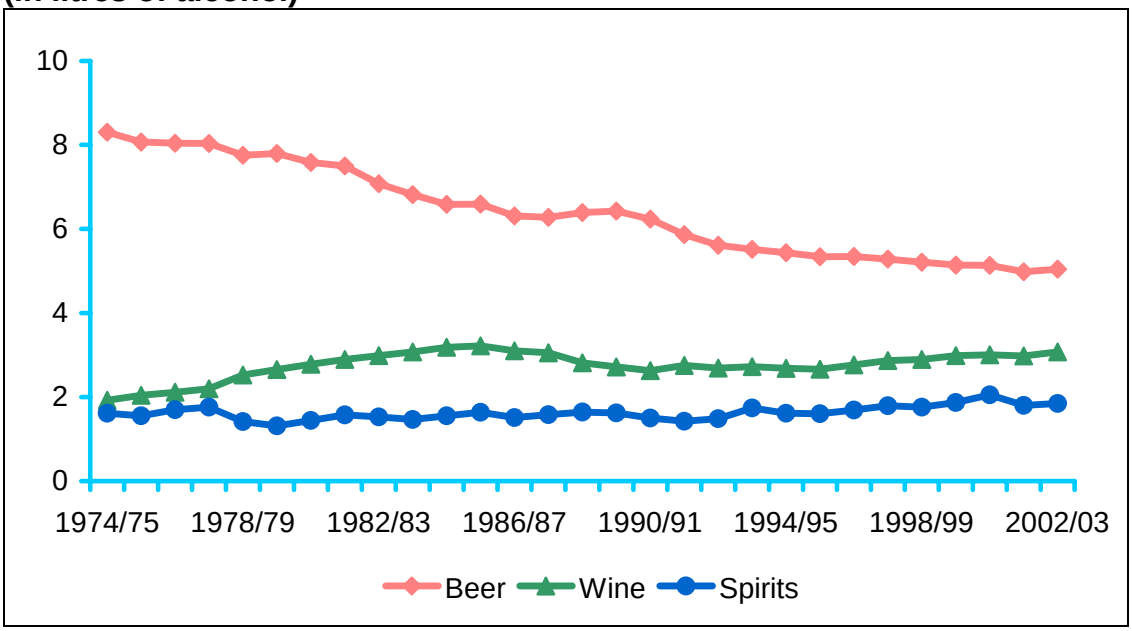
Chart 1 and Chart 2 show historical data extending from 1973/74 to 2002/03 on per capita consumption of each alcoholic beverage. Chart 1 is based on litres of alcohol and Chart 2 is in terms of dollars of annual consumption expenditure in real terms.

Beer shows a downward trend, leaving per capita consumption in 2002/03 as much as 38 per cent below its level in 1973/74. The downward trend was most pronounced up until the mid 1980s and is largely mirrored by a rising trend in wine consumption. Thus Chart 1 shows that per capita consumption of wine rose strongly to reach a plateau in the mid 1980s: in 2002/03 it was 78 per cent higher than in 1973/74. By comparison, per capita consumption of spirits has not shown a marked trend, rising only 9 per cent over the same period. However, per capita consumption of spirits fluctuated wildly in the late 1970s.

The major swing from beer to wine consumption appears to be partly explained by price movements. Specifically, Chart 4 shows that from 1973/74 to the mid 1980s, the real price of wine fell while the real price of beer rose, helping to explain the swing in consumption from beer to wine over the same period. However, it has also been suggested that this swing in consumption to wine may be partly explained by an increasing European influence on Australian tastes. Thus the sales model needs to take into account effects from both changes in prices and time-related changes in tastes.

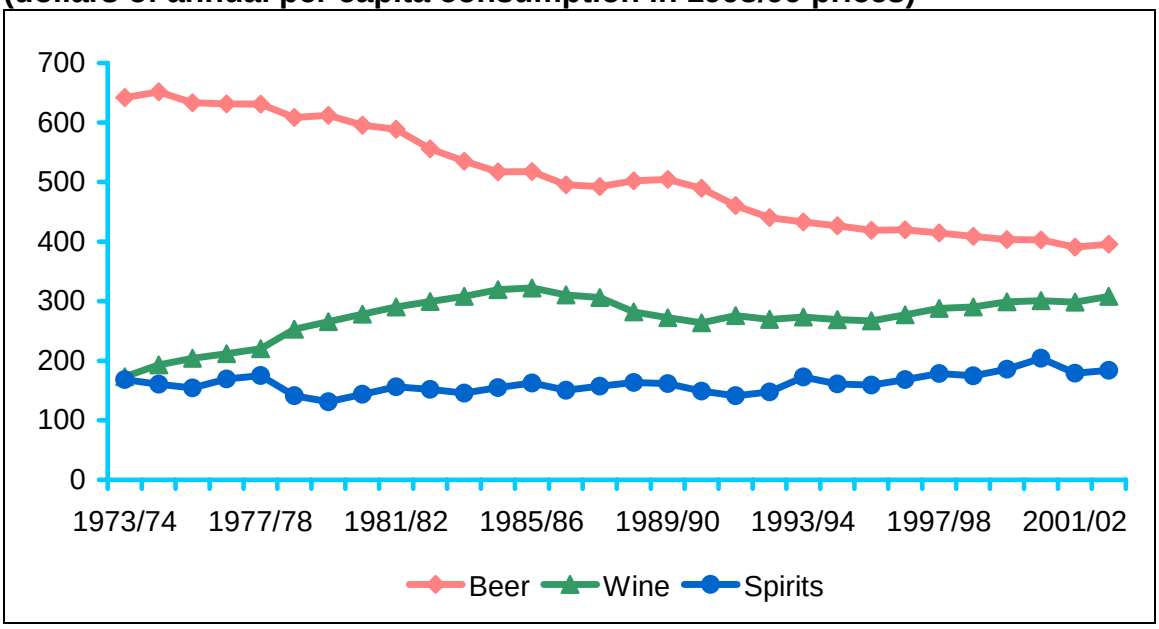
Chart 4 shows the sharp increase of 23 per cent in real spirits prices that followed the major hike in spirits excise in the 1978/79 Budget. Chart 1 shows this lead to a sharp fall in spirits consumption. However, these price and volume changes had largely offsetting effects on the value of spirits consumption, so Chart 3 shows that the nominal budget share for spirits was broadly unchanged. This suggests that the own-price elasticity of demand for spirits may be around unity, meaning that a one per cent rise in price leads to a one per cent fall in the volume of sales, leaving the value of sales unchanged. These issues are taken up further in estimating the broad sales model in section five.

Chart 1
Consumption of alcoholic beverages
(in litres of alcohol)



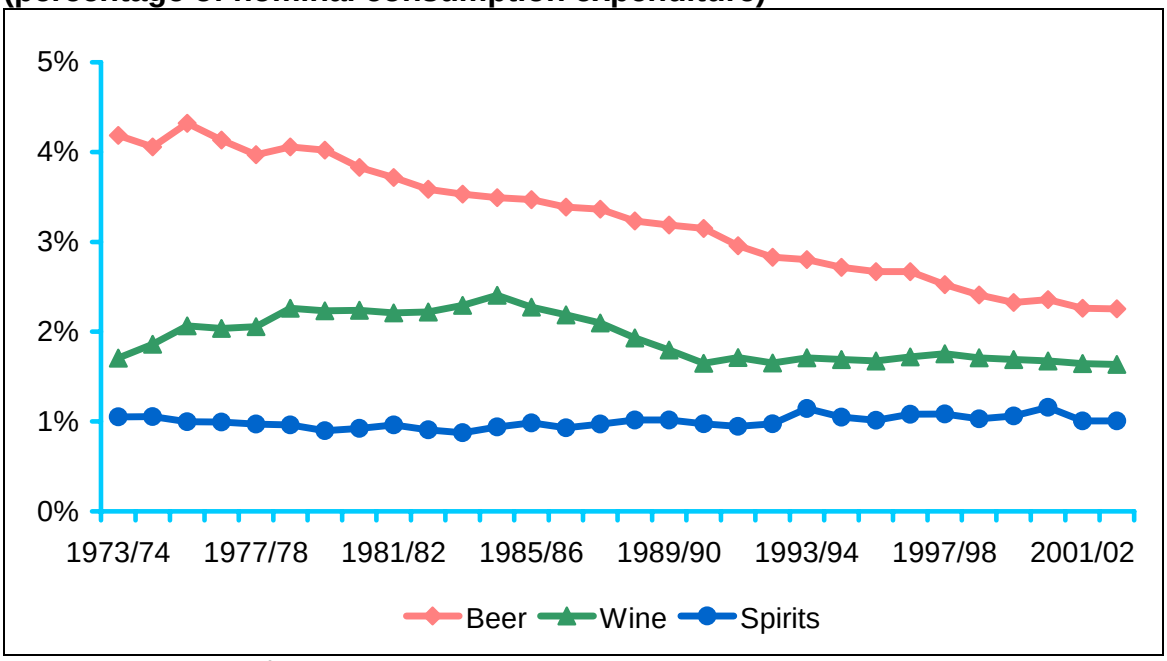
Note:
Consumption in litres of alcohol is calculated from litres of consumption by assuming an average alcohol content of 4.4 per cent for beer and 11.5 per cent for wine. Spirits consumption is recorded in terms of litres of alcohol.

Chart 2
Real consumption of alcoholic beverages
(dollars of annual per capita consumption in 1998/99 prices)



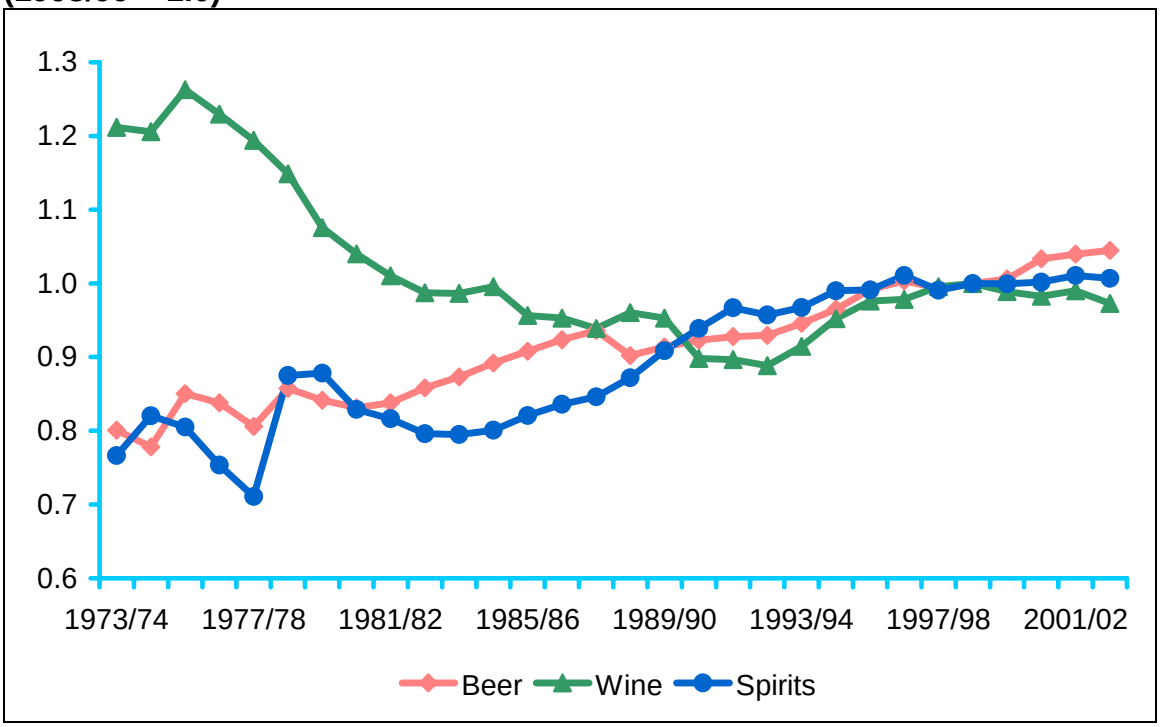
Note:
Real consumption in 1998/99 prices is calculated by applying the following 1998/99 prices for each alcoholic beverage to ABS data on the volume of consumption in litres (for beer and wine) or litres of alcohol (for spirits).
Beer: $3.48 per litre Wine: $11.57 per litre Spirits: $99.48 per litre of pure alcohol
Per capita consumption is then obtained by dividing by the population aged 15 and over.

Chart 3
Nominal budget shares of alcoholic beverages in consumption expenditure (percentage of nominal consumption expenditure)



Source: ABS, Econtech

Chart 4
Prices of alcoholic beverages relative to other consumption (1998/99 = 1.0)



Source: ABS, Econtech

4. A broad sales model distinguishing three alcoholic beverages

This section gives a general explanation of the broad sales model distinguishing the three alcoholic beverages of beer, wine and spirits. The data used to estimate this model was described in section three, while the results of that estimation are given in section five.

Basic economic principles suggest that consumer demand for a good will depend upon its price, prices of complementary/substitute goods and income. It may also be affected by shifts in underlying consumer tastes. The literature provides a range of alternative functional forms for consumer demand systems. For this study we have used the Almost Ideal Demand System (AIDS) that was first proposed by Deaton and Muellbauer (1980), extended to allow for shifts in tastes as these have been important in the alcohol market. The AIDS model was first used to study the demand for alcoholic beverages in Australia by Murphy (1981) and since that time it has become well established in the literature, being used in a wide range of demand studies in many countries. Here it has been selected for the following reasons:

- it is flexible functional form, meaning that it allows for different degrees of substitutability/complementarity between each pair of goods;
- ease of comparison with other studies; and
- ease of estimation, it being essentially linear in parameters.

The AIDS model explains the share of a consumer's budget allocated to each product. For the broad sales model, the four products are beer, wine, spirits and all other expenditure ("other"). These four budget shares must sum to unity, so under the "adding up" condition of demand theory only three equations are estimated, the fourth equation being derivable from the first three equations. We have estimated equations for beer, wine and spirits.

Our system of equations is derived in Appendix A so only a general explanation of the final equations is given here. Equations (11b), (11w) and (11s) of Appendix A are represented in Table 2. The first column of Table 2 shows the variables that appear in each budget share equation, and the corresponding parameters of the three equations are shown in the other three columns. The first column indicates that each budget share is modelled to depend on:

- changes in consumer tastes that are assumed to depend in a flexible way on time;
- the price of each alcoholic beverage relative to the price of the other good (the use of relative prices reflects the homogeneity condition of demand theory); and

- real per capita total expenditure, X/P*.

Table 2
Broad Sales Model for Alcoholic Beverages: Parameters

	Beer	Wine	Spirits
Dependant Variable:	W_b	W_w	W_s
Constant	α_{0b}	α_{0w}	α_{0s}
Time	α_{1b}	α_{1w}	α_{1s}
exp(α_3*Time)	α_{2b}	α_{2w}	α_{2s}
ln (X/P*)	β_b	β_w	β_s
ln (P_b/P_o)	$\gamma_{b,b}$	$\gamma_{w,b}$	$\gamma_{s,b}$
ln (P_w/P_o)	$\gamma_{b,w}$	$\gamma_{w,w}$	$\gamma_{s,w}$
ln (P_s/P_o)	$\gamma_{b,s}$	$\gamma_{w,s}$	$\gamma_{s,s}$

Source: AIDS model of Deaton and Muellbauer (1980) and Econtech.
Notes:
1. In estimation, the following symmetry restriction from Appendix A is imposed $\gamma_{b,w} = \gamma_{w,b}$; $\gamma_{b,s} = \gamma_{s,b}$; $\gamma_{w,s} = \gamma_{s,w}$.
2. In the table, α_3 is a parameter to be estimated.

Table 2 and its notes imply that there are a total of 19 independent parameters to estimate.

5. Estimated price and income effects in the broad sales model

The parameters of the broad sales model of section four were estimated by applying statistical methods using an econometrics software package called Eviews. The econometric estimation method chosen was Full Information Maximum Likelihood. The model was estimated for the period 1973/74 to 2002/03.

Not surprisingly, with as many as 19 parameters to estimate, not all of the initial results of the estimation were plausible. It was necessary to impose the values of two parameters and then re-estimate the values of the remaining 17 parameters. The two parameters that were imposed govern the sensitivity of beer consumption to the price of beer, and the degree of substitutability between wine and spirits. The parameter values were selected using previous Australian and international studies as a guide. The imposed values fall well within a 95 per cent confidence interval of the freely-estimated values.

The final values for the parameters are shown in Table 3, which follows the same format as Table 2.

Table 3
Broad Sales Model for Alcoholic Beverages: Estimation Results

Dependant Variable:	Beer W_b	Wine W_w	Spirits W_s
Constant	0.0188	-0.0041	0.0329
Time	-0.0010	-0.0005	0.0001
exp(-0.245*Time)	-0.0048	-0.0163	0.0030
ln (X/P*)	0.0034	0.0035	-0.0026
ln (P_b/P_o)	0.0150*	0.0042(1)	0.0040(2)
ln (P_w/P_o)	0.0042(1)	0.0101	0.0010*(3)
ln (P_s/P_o)	0.0040(2)	0.0010*(3)	0.0000

Notes:
* indicates imposed value
(1), (2) and (3) are used to indicate pairs of parameters that are equal due to the symmetry condition.

The practical implications of these results are best judged by the calculation of the relevant elasticities showing the sensitivity of consumer demand for each alcoholic beverage to movements in income, its own price and prices of other alcoholic beverages. The formulae used to calculate these elasticities using the parameter values in Table 3 are presented in equations (7), (8) and (9) of Appendix A.

The implied values for income and own price elasticities are shown in Table 4.

The values for the estimated income elasticities are not statistically significantly different from unity. This means that a one per cent increase in real total consumption per capita will lead to around a one percent increase in consumption of each of beer, wine and spirits.

Of more importance for this study are the estimated price elasticities, as these determine the response of consumer demand to different taxation policies for alcoholic beverages. The own price elasticity of demand for wine is estimated at -0.4. This means that an increase in wine prices of 1.0 per cent will reduce the volume of wine sales by 0.4 per cent. The estimated own price elasticity of demand for spirits is higher at -1.0, so sales of spirits are more price sensitive. Specifically, a 1.0 per cent rise in spirits prices will reduce the volume of spirits sales by 1.0 per cent, leaving the value of sales unaffected. As shown in section 3, this is consistent with historical experience following the sharp increase in spirits prices brought about by the 1978/79 Federal Budget. The own price elasticity of demand for beer is -0.3. However, as noted above, the underlying parameter governing this elasticity was imposed.

Table 4
Income and Price Elasticities: Broad Model

	Income	Compensated Own Price
Beer	1.1	-0.3
Wine	1.2	-0.4
Spirits	0.7	-1.0

Source: Econtech.

In terms of the degree of substitutability between alcoholic beverages, the Hicks-Allen Elasticities of Substitution (HAES) is the best measure to use. The HAES for the broad sales model are shown in Table 5. The results suggest that beer, wine and spirits are all close substitutes, with HAES well above unity. As noted above, the elasticities of substitution involving beer were freely estimated, while the parameter governing the HAES between wine and spirits was imposed.

Table 5
Elasticities of Substitution: Broad Model

	Beer	Wine	Spirits
Beer	na	13	18
Wine		na	7
Spirits			na

Source: Econtech.

The own price elasticities from this study are compared with earlier studies by Clements (1997)[2] and Murphy (1981) in Table 6. Clements presented results for both Australia and an international average based on seven countries including Australia. The time frames used by Clements varied between countries but typically the estimation period included the period from 1960 to 1985. Murphy used quarterly data extending from 1975.3 to 1980.4. Compared with these earlier studies, possible advantages of this study are that it uses more up-to-date data (from 1973/74 to 2002/03) and allows in a more flexible way for changes in tastes.

Table 6
Comparison of Estimates of Own Price Elasticities

	this study Australia	Murphy (1981) Australia	Clements (1997) Australia	Clements (1997) international
Beer	-0.3	-0.4	-0.4	-0.4
Wine	-0.4	-0.3	-0.5	-0.7
Spirits	-1.0	-1.4	-0.9	-1.0

Table 6 shows that this study agrees closely with the earlier studies on the values for the own price elasticities of demand. Spirits is the most price sensitive with a price elasticity of around -1. Price elasticities for beer and wine are only around one-half of this value.

[2] Ken Clements, Wana Yang and Simon Zheng, "Is Utility Additive? The Case of Alcohol", (1997) Economic Research Centre, Department of Economics, University of Western Australia.

6. A detailed sales model distinguishing seven alcoholic beverages

The broad sales model presented in section five is a useful starting point in modelling the effects of alternative taxation policies towards alcoholic beverages. However, it only identifies beer, wine and spirits as three broad categories of alcoholic beverages, whereas this study focuses on reforming taxation of alcohol within each of the three broad categories. For example, the scenario to reform wine taxation by funding a cut in the WET with the introduction of a volumetric wine tax would make cask wine more expensive and bottled wine cheaper.

Investigating such tax proposals requires a more detailed sales model that distinguishes seven detailed categories of alcoholic beverages, as shown in Table 7.

Table 7
Broad and Detailed Categories of Alcoholic Beverages

Broad category	Detailed category
Beer	Beer – low strength Beer – mid strength Beer – normal strength
Wine	Wine – premium Wine – cask and cider
Spirits	Spirits – normal strength Spirits – RTDs

The historical data needed to econometrically model demand at this more detailed level is not available. To overcome this problem, this study applies a method to disaggregate from the three categories of the broad sales model to the seven categories of a detailed sales model.

The following two general assumptions are made in disaggregating the broad sales model to a detailed sales model.

- The income elasticities for every member of a broader category are the same as for the broader category as a whole. For example, premium and cask wine both inherit the wine income elasticity from Table 4 of 1.2.

- Similarly, the elasticities of substitution between members of different broad categories are the same as for the broad categories as a whole. For example, the elasticity of substitution between cask wine and RTDs is inherited from the broader elasticity of substitution between wine and spirits from Table 5 of 7.

These two assumptions are adopted for two reasons. First, they are consistent with the principle that the predicted budget share for, say, wine should be the same whether it is obtained using the original wine category equation or by adding together the predictions from the premium wine and cask wine equations. Second, they represent neutral assumptions in the absence of better information.

A third assumption is also needed to disaggregate from the equations for broad categories to detailed categories. This concerns the degree of substitutability between members of a broad category. For example, an assumption needs to be made about the elasticity of substitution between cask wine and premium wine. These within-category elasticities of substitution were chosen based on two considerations. First, elasticities of substitution should generally be higher within broad categories than between broad categories. The elasticities between broad categories were reported in Table 5. Second, the chosen elasticities should result in plausible results when simulating alternative tax proposals. The elasticities finally selected are shown in Table 8.

Table 8
Assumed elasticities of substitution within broad categories

Broad category	Detailed category pair	Elasticity of Substitution
Beer	low – mid	30
	mid – high	30
	low – high	15
Wine	premium – cask	30
Spirits	Normal – RTDs	30

Appendix C sets out the mechanics of constructing the detailed sales model from the broad sales model based on the three assumptions described above.

7. Price and income effects in the detailed sales model

The price and income elasticities in the detailed model can now be calculated. The formulae for the elasticities, which have already been applied to the broad sales model in section five, are presented in equations (7), (8) and (9) of Appendix A.

The income and own-price elasticities of the detailed model are shown in Table 9, and can be compared with the corresponding estimates for the broad model that were reported in Table 4.

Not surprisingly, the income elasticities for every member of a broader category are the same as for the broader category as a whole. As reported in section six, this was the first assumption that was built into the construction of the detailed model. So the income elasticity for all three categories of beer is 1.1, which is inherited from the estimated income elasticity for the broad beer category that was reported in Table 4.

Table 9
Income and Price Elasticities: Detailed Model

	Income	Compensated Own Price
beer - low	1.1	-0.6
beer - mid	1.1	-0.9
beer- normal	1.1	-0.4
wine - premium	1.2	-0.4
wine - cask	1.2	-0.8
spirits - full-strength	0.7	-1.1
spirits - RTDs	0.7	-1.1

Source: Econtech.

In contrast, the compensated own price elasticities of demand are higher in absolute magnitude for the detailed model than for the broad model. This is consistent with the familiar finding that the degree of price sensitivity of demand tends to rise with the degree of product disaggregation. For example, while Table 4 reported a price elasticity of demand for the broad beer category of –0.3, Table 9 shows that the more detailed categories of low, mid and normal strength beer have larger price elasticities of –0.6, –0.9 and –0.4. This is because if, say, the price of mid-strength beer alone increases, there is the possibility of substitution to low and normal strength beer, whereas this possibility does not exist for a generalised increase in beer prices. In Table 8 it was assumed that substitution does occur within broad categories, leading to higher price elasticities at finer levels of disaggregation.

The elasticities of substitution of the detailed model are shown in Table 10. These can be compared with the corresponding estimates for the broad model that were reported in Table 5 and with the assumed elasticities of substitution within categories that were presented in Table 8.

Table 10
Hicks Allen Elasticities of Substitution: Detailed Model

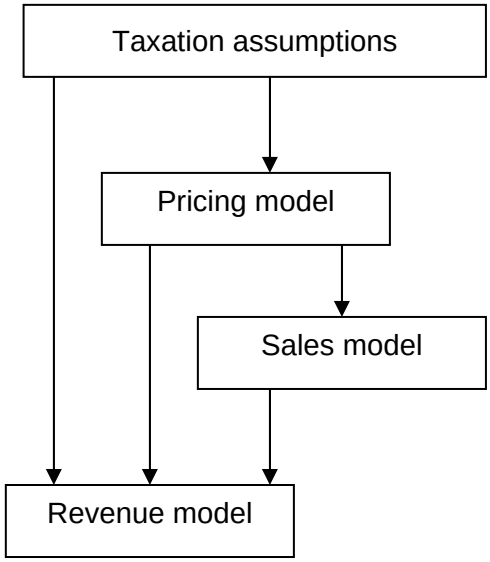
	Beer low	Beer mid	Beer high	Premium wine	Cask/ cider	Spirits	RTDs
Beer low		30	15	13	13	18	18
Beer mid	30		30	13	13	18	18
Beer high	15	30		13	13	18	18
Wine Premium	13	13	13		30	7	7
Wine cask/cider	13	13	13	30		7	7
Spirits	18	18	18	7	7		30
RTDs	18	18	18	7	7	30	

Source: Econtech.

Comparing Table 10 with Table 5, it can be seen that the elasticities of substitution between members of different broad categories are the same as for the broad categories as a whole. As reported in section six, this was the second assumption that was built into the construction of the detailed model. For example, the elasticity of substitution between cask wine and RTDs is inherited from the broader elasticity of substitution between wine and spirits from Table 5 of 7.

8. The prices, sales and revenue effects of the policy scenarios

The detailed sales model is now used in simulating the policy scenarios for taxation of alcoholic beverages that were outlined in section two. Most attention is paid to scenario 1, as it simulates a main component of ADCA's policy for health related reform of taxation of alcoholic beverages. Results for the other scenarios are discussed at the conclusion of this section.



8.1 Proposed Wine Tax Reform

The diagram from section one showing the overall structure of the modelling system is reproduced above for ease of reference. The wine tax reform proposal is to fund a cut in the nominal WET rate from 29 to 8 per cent by introducing a volumetric wine tax. These changes are fed into the modelling system as changes to the taxation assumptions. The changes in taxation assumptions for each scenario were set out in Table 1.

Scenario 1 involves setting the volumetric wine tax at the rate needed to achieve revenue neutrality in collections of alcohol-specific taxes. So alternative rates of volumetric wine tax were fed into the model and the revenue model was then used to observe the associated outcomes for tax collections. By this trial-and-error process, the volumetric wine tax rate was set at $8.35 per litre of alcohol. This is the rate needed to fully fund the cut in the nominal WET rate from 29 per cent to 8 per cent.

As shown in the diagram, the taxation assumptions also feed into the pricing model. The cut in the WET rate reduces prices for cask and premium wines by similar percentage amounts because the WET is a price-based tax. However, the volumetric wine tax, being based on alcohol content, adds a similar dollar amount to the price per litre of cask and premium wine. However, because cask wine is far cheaper than premium wine, this represents a much larger percentage price increase for cask wine than for premium wine. So the net impact of both tax changes is to raise the price of cask wine while lowering the price of premium wine. Specifically, the top panel of Table 11 shows that the ADCA proposal for reforming wine tax would raise the price of cask wine by 12.8 per cent while lowering the price of premium wine by 2.7 per cent.

As suggested by the diagram, these price impacts are fed into the detailed sales model to determine the effects on sales volumes. Higher prices for cask wine and lower prices for premium wine lead to a decrease in cask wine consumption of around 9.7 per cent and a rise in premium wine consumption of 2.4 per cent, as seen in the bottom panel of Table 11.

Table 11
Price and Quantity effects by scenario
(% deviation from current policy outcome)

Price Effects	1	2	3	4	5
Beer low	0.0%	0.0%	-3.5%	0.0%	-6.7%
Beer mid	0.0%	0.0%	0.0%	0.0%	-15.0%
Beer high	0.0%	0.0%	0.6%	0.0%	8.7%
Cask/cider	12.8%	12.8%	12.8%	18.0%	18.0%
Premium wine	-2.7%	-2.7%	-2.7%	-3.7%	-3.7%
Spirits	0.0%	0.0%	0.0%	0.0%	0.0%
RTDs	0.0%	-4.3%	0.0%	0.0%	0.0%

Source: alcohol pricing model

Quantity Effects	1	2	3	4	5
Beer low	0.0%	-0.4%	2.4%	0.0%	5.6%
Beer mid	0.0%	-0.4%	0.0%	0.0%	20.5%
Beer high	0.0%	-0.4%	-0.4%	0.0%	-4.9%
Cask/cider	-9.7%	-9.8%	-9.7%	-13.1%	-12.2%
Premium wine	2.4%	2.2%	2.4%	3.2%	4.3%
Spirits	0.0%	-0.7%	0.0%	0.0%	1.6%
RTDs	0.0%	5.0%	0.0%	0.0%	1.6%
Total MLals	-0.8%	-0.8%	-0.8%	-1.1%	-1.3%

Source: alcohol sales model

These sales responses are consistent with the model estimates of price elasticities reported in section seven. This can be seen by applying the price elasticities from Table 9 to the price changes reported in the top panel of Table 11 and comparing the outcomes with the volume

changes reported in the bottom panel of Table 11. For example, from Table 9, the cask wine own-price elasticity is estimated to be -0.76, which suggests that the increase in the price of cask wine of 12.8 per cent would reduce consumption by 9.7 per cent, which matches the outcome in the bottom panel of Table 11. For premium wine, applying the own-price elasticity of -0.45 to the decrease in price of 2.7 per cent gives a predicted increase in consumption of 1.2 per cent. Actual consumption of premium wine increases by more than this at 2.2 per cent, because the price increase for cask wine leads to substitution from cask wine to premium wine.

The wine tax reform scenario does not significantly impact on sales of alcoholic beverages besides wine. This is because it does not change the overall burden of tax on wine, but rather only reallocates some of that burden from premium wine to cask wine. With an unchanged tax burden on wine, there is no reason for a systematic shift in sales between wine and the two other broad categories of alcoholic beverages of beer and spirits.

These changes in sales impact on total consumption of pure alcohol. However, before considering those effects in detail, we consider the effects on tax revenue collected.

As shown by the diagram, revenue from alcohol-specific taxes in the revenue model depends on all three elements of the model: tax assumptions, pricing and sales. Tax rates play an obvious role, while pricing and sales influence the tax bases to which the tax rates are applied in calculating tax collections. WET is a value-based tax so WET collections depend on both wholesale prices of wine and the volume of wine sales. The other alcohol taxes are excises that are based on alcohol volumes, which depend on the volume of sales but not pricing.

Table 12
Alcohol-specific taxation revenue effects by scenario
($ million per annum, deviation from current policy outcome)

	1	2	3	4	5
Beer low	0	0	-28	0	-54
Beer mid	0	-1	0	0	-100
Beer high	0	-7	27	0	407
Cask/cider	72	71	72	97	99
Premium wine	-72	-73	-72	-97	-94
Spirits	0	-8	0	0	18
RTDs	0	-80	0	0	7
Change in Total Revenue	-1	-98	-1	0	282

Source: alcohol revenue model.
Note: Numbers in table don't add due to rounding.

Table 12 shows that the wine tax proposal in scenario 1 is approximately revenue neutral. A loss in annual tax revenue from premium wine of $72 million is fully offset by a gain in revenue from cask wine. This is not surprising because, as explained above, the volumetric wine tax rate was chosen by trial-and-error to achieve this revenue neutral outcome.

Finally, we return to the sales model to consider the changes in consumption of pure alcohol under the wine tax. Consumption of pure alcohol is estimated by applying typical alcohol contents to the modelled sales volumes.

Table 13
Alcohol consumption effects by scenario
(annual levels and deviations from current policy outcomes)

Level, Milllion Lals	Current	1	2	3	4	5
Beer low	6.59	6.59	6.57	6.76	6.60	6.97
Beer mid	7.62	7.62	7.59	7.62	7.62	9.19
Beer high	66.41	66.41	66.12	66.16	66.42	63.18
Cask/cider	19.80	17.88	17.85	17.88	17.21	17.38
Premium wine	27.83	28.49	28.45	28.49	28.73	29.04
Spirits	18.13	18.13	18.01	18.14	18.14	18.43
RTDs	11.75	11.75	12.34	11.76	11.75	11.95
Total MLals	158.1	156.9	156.9	156.8	156.5	156.1
Change in quantity		-1.27	-1.22	-1.34	-1.69	-2.02
% change in quantity		-0.80%	-0.77%	-0.85%	-1.07%	-1.28%

Change, Milllion Lals	1	2	3	4	5
Beer low	0.00	-0.03	0.16	0.00	0.37
Beer mid	0.00	-0.03	0.00	0.00	1.56
Beer high	0.00	-0.29	-0.25	0.01	-3.24
Cask/cider	-1.92	-1.95	-1.92	-2.59	-2.41
Premium wine	0.66	0.61	0.66	0.90	1.20
Spirits	0.00	-0.13	0.00	0.00	0.30
RTDs	0.00	0.59	0.00	0.00	0.19
Total MLals	-1.27	-1.22	-1.34	-1.69	-2.02

Source: alcohol sales model

The wine tax proposal in scenario 1 is estimated to reduce annual consumption of alcohol in the form of wine by 1.27 million litres of alcohol. This represents a drop of 2.7 per cent in wine alcohol consumption or 0.80 per cent in total alcohol consumption. The drop in annual wine alcohol consumption occurs because a drop in cask wine alcohol consumption of 1.92 million litres of alcohol more than offsets an increase in premium wine alcohol consumption of 0.66 million litres of alcohol. These results are unsurprising. Shifting the wine tax base from taxing wine value to taxing wine alcohol would be expected to reduce consumption of wine alcohol.

While the wine tax reform does reduce the volume of wine consumption, it does not affect the value of wine consumption. Again, this is because it does not change the overall burden of tax on wine, but rather only reallocates some of that burden from premium wine to cask wine. So this reform is neutral for the wine industry as a whole. However, it would improve the position of premium wine producers at the expense of cask wine producers.

8.2 Other Policy Scenarios

Scenarios 2 and 3 extend the wine tax reform of scenario 1 in alternative directions.

Under Scenario 2, RTD excise is only applied to alcohol content (by volume) in excess of 1.15 per cent to bring taxation of RTDs into closer alignment with taxation of beer. While the fully-funded wine tax reform of scenario 1 is also included, the cut to RTD excise is unfunded so this scenario has an annual cost to the budget of $98 million, as seen in Table 12.

Table 11 shows that the cut in RTD excise reduces the price of RTDs by 4.3 per cent, leading to an increase in RTD consumption of 5.0 per cent. However, this increase in RTD consumption is mainly at the expense of consumption of other alcoholic beverages. This is seen clearly in Table 13. Even though, annual consumption of alcohol in the form of RTDs is up by 0.59 million litres of alcohol, total consumption of alcohol is only 0.05 million litres of alcohol above the level in scenario 1.

Scenario 3 introduces a stronger distinction between excise rates on low strength and full strength beer. Excise rates on low strength beer are cut by 30 per cent and this is fully funded by raising excise rates on full strength beer by 2 per cent. Scenario 3 also includes the fully-funded wine tax reform of scenario 1. Since both proposals in scenario 3 are fully funded, Table 12 shows that scenario 3 involves no net cost to the budget.

Table 11 shows that the proposed beer tax reform reduces the price of low-strength beer by 3.5 per cent while raising the price of normal strength beer by 0.6 per cent. The increases consumption of low-strength beer by 2.4 per cent while reducing consumption of full-strength beer by 0.4 per cent. This switch produces a net reduction in annual consumption of beer alcohol, as seen in Table 13. A drop in full-strength beer alcohol consumption of 0.25 million litres of alcohol more than offsets an increase in low-strength beer alcohol consumption of 0.16 million litres, giving a net reduction of 0.09 million litres of alcohol.

This is a clear reduction, although it is small compared with the reduction of 1.27 million litres of alcohol from the proposed wine tax reform.

Scenario 4 takes the wine tax reform of scenario 1 a step further by abolishing the WET rather than simply reducing it from 29 per cent to 8 per cent. This increases the volumetric wine tax rate needed to achieve a revenue-neutral outcome from $8.35 per litre of alcohol to $11.75 per litre of alcohol.

This extended version of the wine tax reform leads to effects that are qualitatively the same but about 30 per cent larger than for the main version of the proposal. It is therefore unnecessary to repeat the same explanation for these effects. The main results from this extended version of wine tax reform are as follows, where the corresponding results for the main version are given in parentheses:

- price of cask wine up 18.0 per cent (12.8 per cent) and price of premium wine down 3.7 per cent (2.7 per cent);
- consumption of cask wine down 13.1 per cent (9.7 per cent) and consumption of premium wine up 3.2 per cent (2.4 per cent);
- total value of wine consumption unaffected in both scenarios; and
- annual consumption of wine alcohol down 1.69 million litres of alcohol (1.27 million litres of alcohol).

Scenario 5 adds to the wine tax reform of scenario 4 by reducing the excise rate on low and mid strength beer and removing the tax free threshold on high strength beer.

Table 11 shows that this decreases the price of low and mid strength beer and increases the price of high strength beer. These price changes in turn increase consumption of low and mid strength beer and reduce consumption of high strength beer. This is associated with a significant shift in consumption in favour of other alcoholic beverages in comparison with scenario 4.

Table 12 shows an increase in annual alcohol tax collections of $282 million. This occurs because the positive revenue effects of the removal of the excise free threshold on high strength beer and the additional consumption of other alcoholic beverages outweighs the negative revenue effects of reduced excise rates on low and mid strength beer and reduced consumption of high strength beer.

At the same time, Table 13 shows that this policy is effective in reducing consumption of alcohol. A reduction in high strength beer consumption of 3.2 million litres of alcohol and a reduction of cask wine consumption of 2.4 million litres of alcohol is not fully offset by increases in other types alcohol consumption (mainly premium wine and mid strength beer), leaving an overall decrease in annual consumption of alcohol of 2.0 million litres of alcohol.

The effects on annual consumption of alcohol by beverage are shown for each scenario in Charts 4-8 respectively. This same information can also be found in Table 13. These effects have all been discussed above.

Chart 4
Scenario 1 - change in consumption (in millions of litres of alcohol)

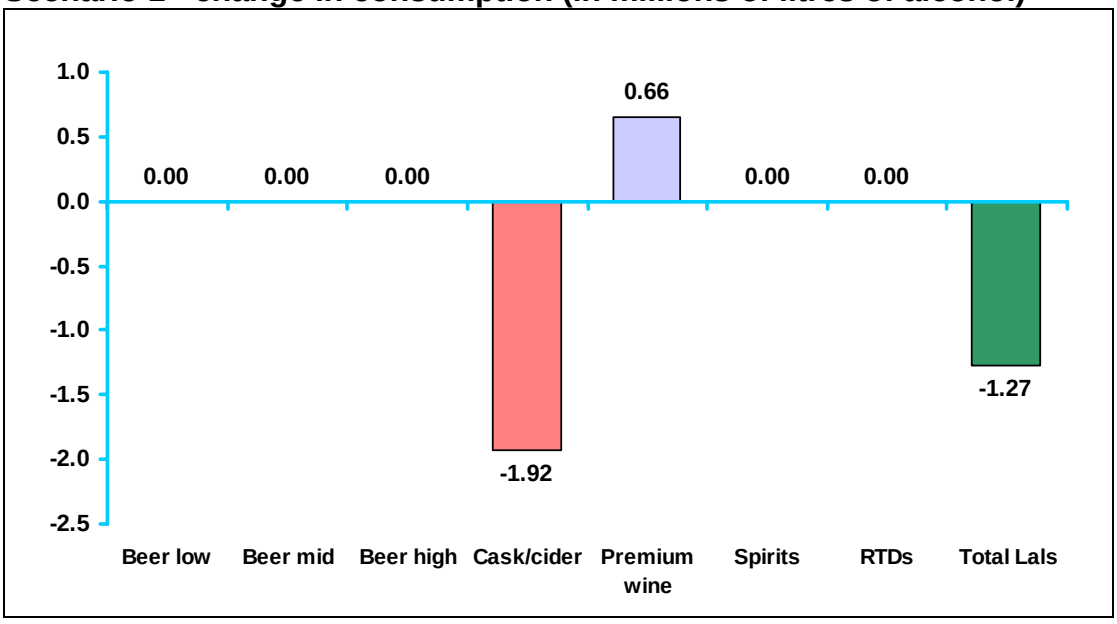


Chart 5
Scenario 2 - change in consumption (in millions of litres of alcohol)

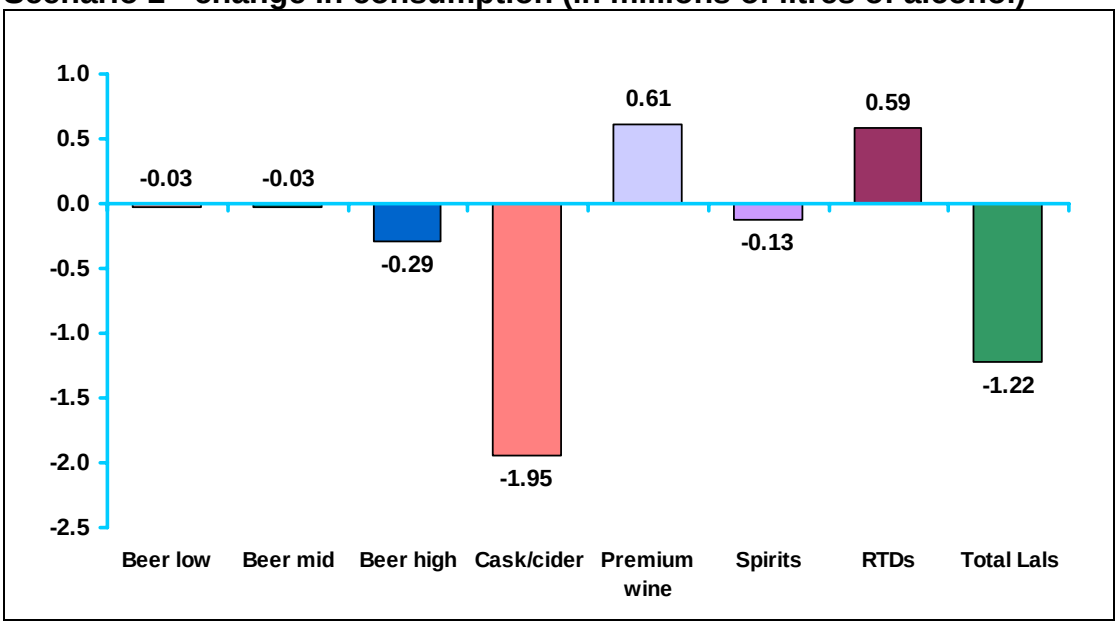


Chart 6
Scenario 3 - change in consumption (in millions of litres of alcohol)

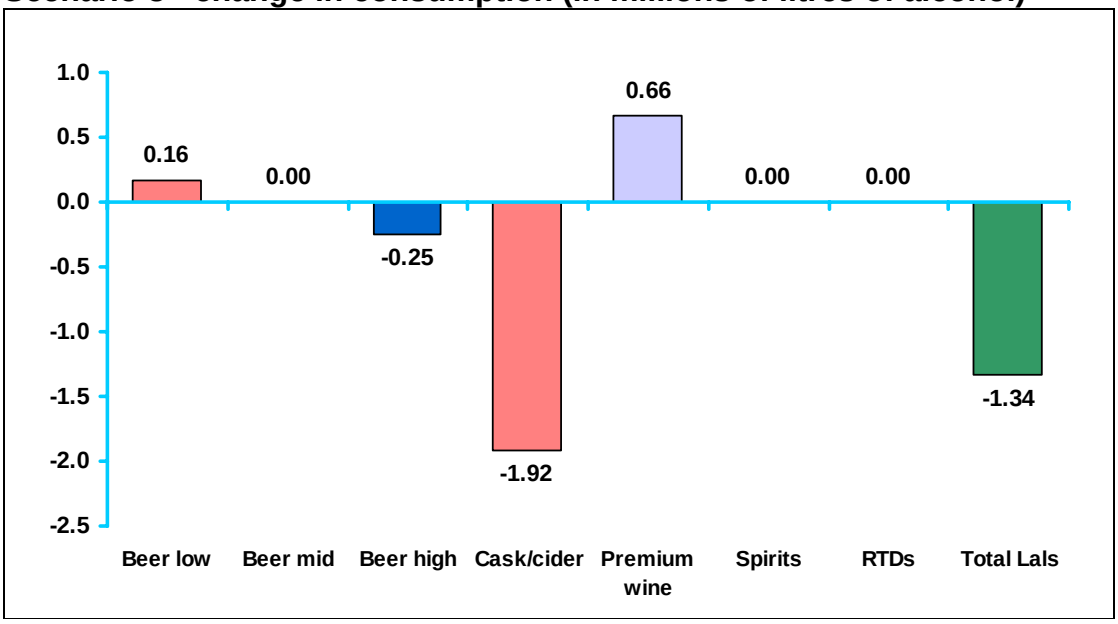


Chart 7
Scenario 4 - change in consumption (in millions of litres of alcohol)

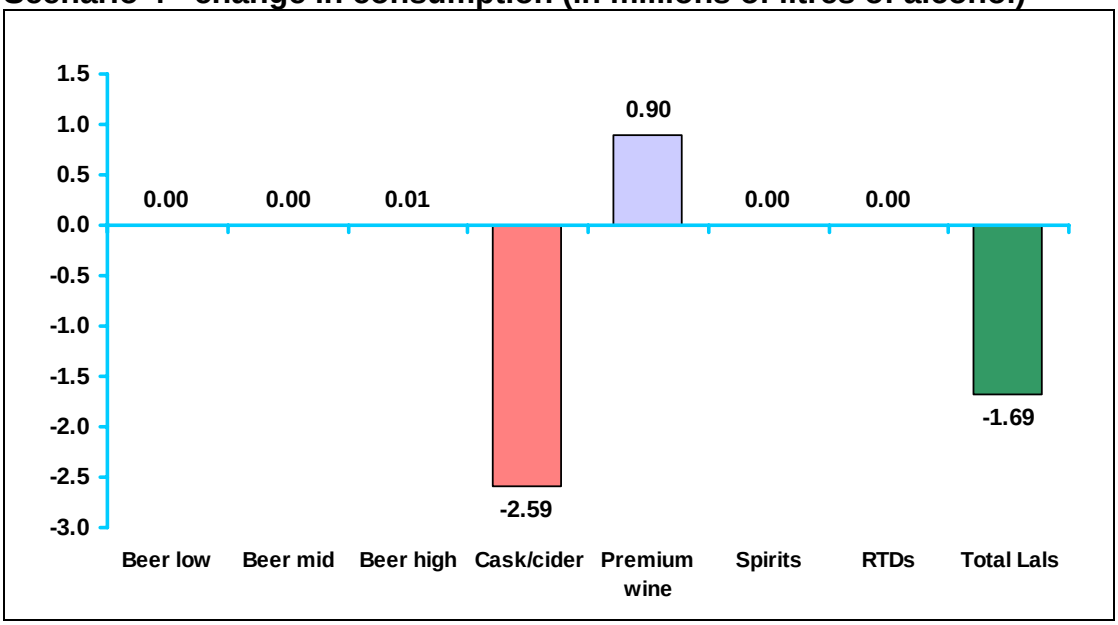
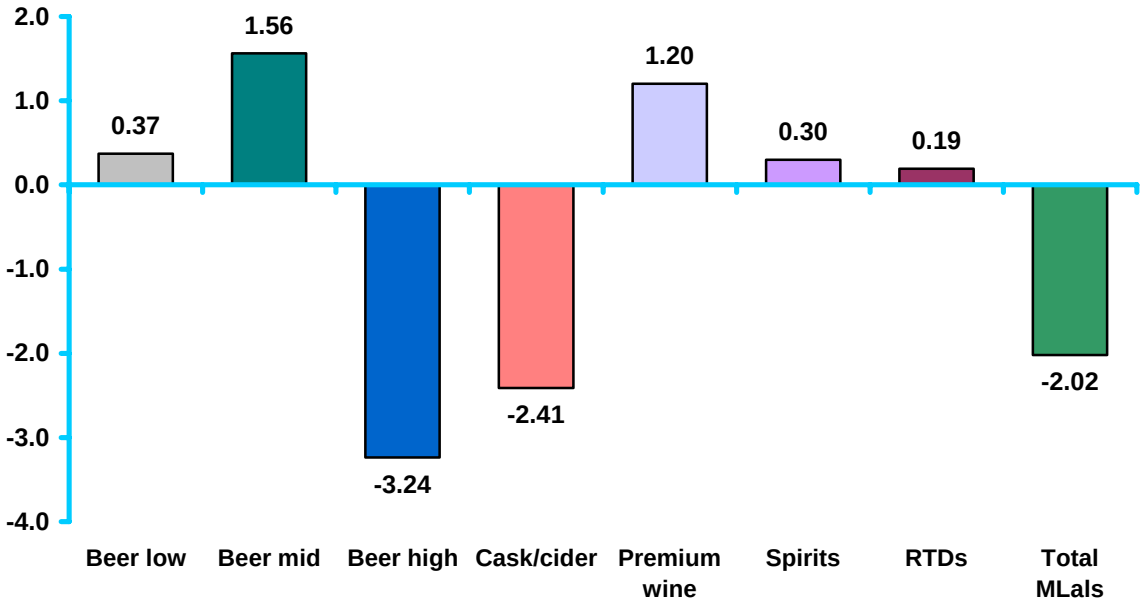


Chart 8
Scenario 5 - change in consumption (in millions of litres of alcohol)



Appendix A – Literature review

The study of alcohol consumption and taxation is of interest to economists and policy makers for two reasons. First, taxes that are specific to alcoholic beverages are a major source of taxation revenue. Second, such taxes provide a means for curbing excessive consumption of alcoholic beverages and the associated negative externalities. For both of these reasons, there is keen interest in understanding how the price changes brought about by taxes on alcoholic beverages influence sales of alcohol.

There are two possible approaches to modelling demand for alcoholic beverages. These are demand analysis based on product characteristics and traditional demand analysis.

Lancaster's Characteristics Approach is based on the notion that consumers do not directly derive utility from the consumption of some goods but rather from attributes or characteristics associated with those goods. For example, Lusk and Fox (2001) used Lancaster's framework to investigate consumer demand for several beef rib-eye steak attributes in the US. Extending this approach to demand for alcoholic beverages would recognise taste, alcohol content, and service (whether the beverage is served to the consumer in a hotel or restaurant or sold in packaged form in a liquor store for subsequent self-service) as attributes that vary between choices of alcoholic beverages. There are conceptual arguments in favour of this approach, but so far researchers on alcohol demand have generally favoured traditional demand analysis, which is also the approach used here.

Traditional consumer demand analysis assumes that consumption of products rather than bundles of characteristics yielded by products are where consumers derive their utility or satisfaction. It implies that demand for a product depends on income, the price of the product and prices for substitute and complementary products.

This study follows Murphy (1981) in using the Almost Ideal Demand System (AIDS) to model consumer demand for alcoholic beverages in Australia. The AIDS model was first introduced into the literature by Deaton and Muellbauer (1980) as an extension to the expenditure share model. This model is derived from duality theory and allows for a full range of cross-substitution effects.

The AIDS model has a number of beneficial economic properties in the study of consumer demand. First, the functional form is general, allowing each pair of beverages to be either substitutes or complements. Second, a simplified version of the system is linear in the

parameters and hence simple to estimate. Third, in this model the theoretical restrictions of homogeneity and symmetry are tested easily as linear restrictions on fixed parameters.

Since Deaton and Muellbauer (1980b), the AIDS model has been widely applied in many empirical studies of consumer behaviour using both cross-sectional and time series data. Part of the reason for the popularity of this demand system (Clements *et al*. 1996) is the ease with which it can be estimated and used for testing the predictions of consumer demand theory (Chambers and Nowman 1997).

This system of AIDS demand equations, in budget share form, is expressed as follows.

$$w_i = \alpha_i + \Sigma_j \gamma_{ij} \ln p_j + \beta_i \ln (X/P), \quad i=1,\ldots,n \tag{1}$$

In the above, w_i is the budget share for good i, p_j is the retail price for good j, X is total expenditure per head, and P is an aggregate price index defined as

$$\ln P = \alpha_0 + \Sigma_k \alpha_k \ln p_k + \tfrac{1}{2} \Sigma_j \Sigma_k \gamma_{kj} \ln p_k \ln p_j, \tag{2}$$

and α_i, γ_{ij} and β_i are parameters to be estimated.

The restrictions from demand theory that can be imposed on equation (1) are:

Homogeneity restriction: $\Sigma_j \gamma_{ij} = 0$, (3)

Symmetry restriction: $\gamma_{ij} = \gamma_{ji}$, for $i \neq j$; and (4)

Adding-up restriction: $\Sigma\alpha_i = 1$, $\Sigma_i \gamma_{ij} = 0$, and $\Sigma\beta_i = 0$. (5)

Elasticities are calculated using the following formulae.

Expenditure elasticity: $n_i = 1 + \beta_i / w_i$; (7)

Compensated own-price elasticity: $e_{ii} = -1 + w_i + [\gamma_{ii} + \beta_i^2(\ln(X) - \ln P)]/w_i$; and (8)

Compensated elasticity of substitution: $\sigma_{ij} = 1 + [\gamma_{ij} + \beta_i\beta_j(\ln(X) - \ln P)]/[w_i w_j]$ (9)

Because equation (1) is non-linear in the parameters, the Stone price index is commonly used to replace the price index P of equation (2) to simply estimation. The Stone price index P* is defined by equation (6).

$$\ln (P^*) = \Sigma w_k \ln p_k \tag{6}$$

This simplification gives the 'linearised' or 'linear approximate' version of the AIDS model (LA/AIDS).

As noted in earlier studies, gradual changes in tastes have also affected consumption of alcoholic beverages. These can be taken into account by modelling as a function of time, T, the intercept term, α_i, appearing in the budget share equation given by equation (1). After some experimentation, the following formulation for the intercept term was adopted.

$$\alpha_i = \alpha_{0i} + \alpha_{1i}\, T + \alpha_{2i} \exp(\alpha_3 * T) \qquad (10)$$

The final demand system to be estimated is obtained by using equation (10) to eliminate α_i in equation (1), subscripting the four products to be included in the system of beer, wine, spirits and other as b, w, s and o respectively, and applying the homogeneity restriction of equation (3). This estimated system is given by equations (11b), (11w) and (11s).

$$w_b = \alpha_{0b} + \alpha_{1b}\, T + \alpha_{2b} \exp(\alpha_3 * T) + \gamma_{b,b} \ln(p_b/p_o) + \gamma_{b,w} \ln(p_w/p_o) + \gamma_{b,s} \ln(p_s/p_o) + \beta_b \ln(X/P) \qquad (11b)$$

$$w_w = \alpha_{0w} + \alpha_{1w}\, T + \alpha_{2w} \exp(\alpha_3 * T) + \gamma_{w,b} \ln(p_b/p_o) + \gamma_{w,w} \ln(p_w/p_o) + \gamma_{w,s} \ln(p_s/p_o) + \beta_w \ln(X/P) \qquad (11w)$$

$$w_s = \alpha_{0s} + \alpha_{1s}\, T + \alpha_{2s} \exp(\alpha_3 * T) + \gamma_{s,b} \ln(p_b/p_o) + \gamma_{s,w} \ln(p_w/p_o) + \gamma_{s,s} \ln(p_s/p_o) + \beta_s \ln(X/P) \qquad (11s)$$

The fourth equation in the system is the equation for other, but it is redundant under the adding up restriction of equation (5). Since budget shares must sum to unity, we only need to model three out of the four budget shares.

The symmetry restriction of equation (4) is the final restriction from demand theory and it requires that we impose the following three parameter restrictions in estimating equations (11b), (11w) and (11s).

$$\gamma_{b,w} = \gamma_{w,b}\ ;\ \gamma_{b,s} = \gamma_{s,b};\ \gamma_{w,s} = \gamma_{s,w}$$

The symmetry restriction of equation (4) is the final restriction from demand theory and it requires that we impose the following three parameter restrictions in estimating equations (11b), (11w) and (11s).

We these restrictions, there are a total of 19 independent parameters to estimate. These parameters are estimated using full information maximum likelihood.

Appendix B – Data Appendix

This appendix summarises the data sources and data construction for the three models covering pricing, sales and revenue. The sales or demand model is estimated econometrically using data covering the period 1973/74 to 2002/03. The sources of this time series data are described in section one below. The pricing and taxation revenue models use the point-in-time tax rates and prices described in section two below.

1) Time series data for sales (or demand) model

This part describes the time series data for the period 1973/74 to 2002/03 that is used to estimate the alcohol demand system. This system determines the budget shares of four categories of consumer spending: beer, wine, spirits and other consumer spending. For this purpose, consumer spending is defined as total consumption expenditure excluding durables and housing services. The budget shares are influenced by prices for each of the four categories and real per capita consumer spending. Thus data is needed for prices, volumes and values of beer, wine, spirits and other as well as for real per capita consumer spending.

a) Prices of beer, wine and spirits. Quarterly price indexes for these items are produced by the ABS in compiling the Consumer Price Index (ABS Cat. 6401.0). These price indexes were converted to financial year data by averaging and then re-scaled to equal 1.0 in our base year of 1998/99.

b) Volumes of beer, wine and spirits. Financial year data on consumption of beer and wine in litres and consumption of spirits in litres of alcohol were obtained from "Apparent Consumption of Alcohol, Australia", ABS Cat. No. 4307.0.55.001, 9 September 2004.

c) Volumes of beer, wine and spirits in (b) were rescaled from litres (or litres of alcohol in the case of spirits) to values expressed in 1998/99 prices, 1998/99 being our base year. This requires estimates of the value of beer, wine and spirits consumption in 1998/99. These values were obtained by multiplying the CPI weights for beer, wine and spirits by the value of total consumption expenditure in 1998/99. Note that the ABS Household Expenditure Survey (HES) cannot be used to estimate consumer spending on alcoholic beverages because ABS cross-checks show that consumers in the HES under-report their spending on items such as alcoholic beverages and gambling.

d) Values of beer, wine and spirits are obtained simply by multiplying the price indexes constructed in (a) by the adjusted volumes constructed in (c).

e) Consumer spending excluding durables and housing services was obtained from the annual national accounts (ABS Cat No. 5204.0) in both current prices and in 2001/02 prices. The latter was rescaled to 1998/99, 1998/99 being our base year.

f) Volumes and values of "other" were calculated as the totals from (e) less the contributions of beer, wine and spirits as obtained in (c) and (d) respectively. The price of other is then obtained as the ratio of the value to the volume.

g) Real consumption per capita is calculated as the volume from (e) divided by the population aged 15 and over obtained from ABS Cat. 3201.0, Table 9.

2) Taxation and Pricing of Alcoholic Beverages

Table 1
Rates of excise duty

Beer, spirits and other alcoholic drinks (excluding wines)	
Beer, in individual containers **not** exceeding 48 litres, **not** exceeding 3% by volume of alcohol	$30.49 per litre of alcohol, calculated on the amount by which the alcohol content (by volume) exceeds 1.15%
Beer, in individual containers **not** exceeding 48 litres, exceeding 3% but **not** exceeding 3.5% by volume of alcohol	$35.53 per litre of alcohol, calculated on the amount by which the alcohol content (by volume) exceeds 1.15%
Beer, in individual containers **not** exceeding 48 litres, exceeding 3.5% by volume of alcohol	$35.53 per litre of alcohol, calculated on the amount by which the alcohol content (by volume) exceeds 1.15%
Beer, in individual containers exceeding 48 litres, **not** exceeding 3% by volume of alcohol	$6.09 per litre of alcohol, calculated on the amount by which the alcohol content (by volume) exceeds 1.15%
Beer, in individual containers exceeding 48 litres, exceeding 3% but **not** exceeding 3.5% by volume of alcohol	$19.12 per litre of alcohol, calculated on the amount by which the alcohol content (by volume) exceeds 1.15%
Beer, in individual containers exceeding 48 litres, exceeding 3.5% by volume of alcohol	$25.02 per litre of alcohol, calculated on the amount by which the alcohol content (by volume) exceeds 1.15%
Other alcoholic drinks, **not** exceeding 10% alcohol content (includes ready to drink or pre-mixed spirits)	$35.53 per litre of alcohol
Brandy	$56.21 per litre of alcohol
Fruit brandy, whisky, rum and liqueurs	$60.20 per litre of alcohol
Other spirits and alcoholic drinks, exceeding 10% alcohol content	$60.20 per litre of alcohol

Source: ATO August 2004

Both the pricing and revenue models require tax rates as inputs. Excise rates for beer and spirits were sourced from the ATO. These excise rates are adjusted each August and February in line with half yearly CPI movements. The rates of excise duty shown below in Table 1 were effective from 2 August 2004 and will change with the next indexation adjustment due in February 2005.

For wine, the nominal WET rate is currently 29 per cent. For modelling purposes, this is reduced to an effective WET rate that allows for the Commonwealth Government's rebate of WET on the first $1,000,000 of the wholesale value of domestic sales of each wine producer, as well as remaining state government rebates. The effective WET rate is calculated at just under 25 per cent.

The pricing model simulates retail prices using information on wholesale prices, tax rates and transport and retail margins. The tax rates data used in the model is as set out in Table 1 above. Current retail prices for major brands of the seven categories of alcoholic beverages were obtained in an Econtech survey of liquor store web sites. For distribution and retail margins, Econtech used data that it already had to hand.

In calibrating the model, the information on retail prices, current tax rates, transport and retail margins was used to derive wholesale prices. In contrast, in simulating the model, alternative scenarios for tax rates are used to simulate alternative scenarios for retail prices.

Appendix C – Construction of Detailed Sales Model

Section six of the main report explained the three assumptions used to disaggregate the broad sales model of three alcoholic beverages to the detailed sales model distinguishing seven alcoholic beverages. This appendix sets out the mechanics of constructing the detailed sales model from the broad sales model based on the three assumptions.

Under the three assumptions, it is straightforward to derive the values for non-price related parameters in the disaggregated equations. This can be illustrated using the constant term in the low strength beer equation as an example. From Table 3, the constant term in the aggregate beer equation is 0.0188. Multiplying this constant term by the share of low strength beer in the value of total beer consumption (11.28 per cent in 2002/03) gives the constant term for the low strength beer equation. The sample principle is applied to construct all non-price parameters in each of the disaggregated equations. This is spelt out in Table A below. In Table A, where the parameters α, γ and β use the broad category subscripts of b, w and s, they are taken from the broad sales model parameters of Table 2.

Table A also covers the construction of the price-related parameters in the disaggregated equations. As shown in Table A, substitution parameters between members of different broad categories are constructed from the associated broad level parameter as follows, using low-strength beer and premium wine as an example.

$$\gamma_{bl,wp} = s_{bl}\, s_{wp}\, \gamma_{b,w}$$

In the above, s_{bl} is the share of low-strength beer in the value of total beer consumption and s_{wp} is the share of premium wine in the value of total wine consumption.

Table A also includes parameters governing substitution within each broad category. The construction of these parameters (which is not shown in Table A) is illustrated using as an example the parameter governing substitution between low-strength beer and mid-strength beer.

$$\gamma_{bl,bm} = w_{bl}\, w_{bn}\, (\sigma_{bl,bm} - 1) - \beta_{bl}\, \beta_{bm}\, \ln(X/P^*)$$

In the above, $\sigma_{bl,bm}$ is the assumed elasticity of substitution between low-strength beer and mid-strength beer, which can be read from Table 8. This equation solves for the value of $\gamma_{bl,bm}$ needed to ensure that the associated elasticity of substitution takes its assumed value.

Table A
Detailed Sales Model for Alcoholic Beverages – Parameters as Functions of Broad Sales Model Parameters

Variable:	Low Beer W_{bl}	Mid Beer W_{bm}	Normal Beer W_{bn}	Premium Wine W_{wp}	Cask Wine W_{wc}	Full-strength Spirits W_{ss}	Spirits - RTDs W_{sr}
Constant	s_{bl} α_{0b}	s_{bm} α_{0b}	s_{bn} α_{0b}	s_{wp} α_{0w}	s_{wc} α_{0w}	s_{ss} α_{0s}	s_{sr} α_{0s}
T	s_{bl} α_{1b}	s_{bm} α_{1b}	s_{bn} α_{1b}	s_{wp} α_{1w}	s_{wc} α_{1w}	s_{ss} α_{1s}	s_{sr} α_{1s}
Exp(α_3*T)	s_{bl} α_{2b}	s_{bm} α_{2b}	s_{bn} α_{2b}	s_{wp} α_{2w}	s_{wc} α_{2w}	s_{ss} α_{2s}	s_{sr} α_{2s}
ln (X/P^*)	s_{bl} β_b	s_{bm} β_b	s_{bn} β_b	s_{wp} β_w	s_{wc} β_w	s_{ss} β_s	s_{sr} β_s
ln (P_{bl}/P_o)	s_{bl} $\gamma_{b,b}$ - $\gamma_{bl,bm}$ - $\gamma_{bl,bn}$	$\gamma_{bm,bl}$	$\gamma_{bn,bl}$	s_{wp} s_{bl} $\gamma_{w,b}$	s_{wc} s_{bl} $\gamma_{w,b}$	s_{ss} s_{bl} $\gamma_{s,b}$	s_{sr} s_{bl} $\gamma_{s,b}$
ln (P_{bm}/P_o)	$\gamma_{bl,bm}$	s_{bm} $\gamma_{b,b}$ - $\gamma_{bm,bl}$ - $\gamma_{bm,bn}$	$\gamma_{bn,bm}$	s_{wp} s_{bm} $\gamma_{w,b}$	s_{wc} s_{bm} $\gamma_{w,b}$	s_{ss} s_{bm} $\gamma_{s,b}$	s_{sr} s_{bm} $\gamma_{s,b}$
ln (P_{bn}/P_o)	$\gamma_{bl,bn}$	$\gamma_{bm,bn}$	s_{bn} $\gamma_{b,b}$ - $\gamma_{bn,bl}$ - $\gamma_{bn,bm}$	s_{wp} s_{bn} $\gamma_{w,b}$	s_{wc} s_{bn} $\gamma_{w,b}$	s_{ss} s_{bn} $\gamma_{s,b}$	s_{sr} s_{bn} $\gamma_{s,b}$
ln (P_{wp}/P_o)	s_{bl} s_{wn} $\gamma_{b,w}$	s_{bm} s_{wn} $\gamma_{b,w}$	s_{bn} s_{wn} $\gamma_{b,w}$	s_{wp} $\gamma_{w,w}$ - $\gamma_{wp,wc}$	$\gamma_{wc,wp}$	s_{ss} s_{wp} $\gamma_{s,w}$	s_{sr} s_{wp} $\gamma_{s,w}$
ln (P_{wc}/P_o)	s_{bl} s_{wc} $\gamma_{b,w}$	s_{bm} s_{wc} $\gamma_{b,w}$	s_{bn} s_{wc} $\gamma_{b,w}$	$\gamma_{wp,wc}$	s_{wc} $\gamma_{w,w}$ - $\gamma_{wc,wp}$	s_{ss} s_{wc} $\gamma_{s,w}$	s_{sr} s_{wc} $\gamma_{s,w}$
ln (P_{ss}/P_o)	s_{bl} s_{ss} $\gamma_{b,s}$	s_{bm} s_{ss} $\gamma_{b,s}$	s_{bn} s_{ss} $\gamma_{b,s}$	s_{wp} s_{ss} $\gamma_{w,s}$	s_{wc} s_{ss} $\gamma_{w,s}$	s_{ss} $\gamma_{s,s}$ - $\gamma_{ss,sr}$	$\gamma_{sr,ss}$
ln (P_{sr}/P_o)	s_{bl} s_{sr} $\gamma_{b,s}$	s_{bm} s_{sr} $\gamma_{b,s}$	s_{bn} s_{sr} $\gamma_{b,s}$	s_{wp} s_{sr} $\gamma_{w,s}$	s_{wc} s_{sr} $\gamma_{w,s}$	$\gamma_{ss,sr}$	s_{sr} $\gamma_{s,s}$ - $\gamma_{sr,ss}$

Source: Econtech.

References

Andrikopoulos, A., Brox, J. and Carvalho, E. (1997) "The demand for domestic and imported alcoholic beverages in Ontario, Canada: a dynamic simultaneous equation approach", *Applied Economics*, 29, 7, 945-954.

Barten, A. (1993) "Consumer allocation models: choice of functional form", *Empirical Economics*, 18, 129-158.

Berry, S. and A. Parkes, (2002) "The Pure Characteristics Discrete Choice Model of Differentiated Products Demand," *Preliminary NBER Working Paper*.

Buse, A. (1998) "Evaluating the linearised Almost Ideal Demand System", *American Journal of Agricultural Economics*, 80, 1, 208-217.

Chambers, M. and Nowman, K. (1997) "Forecasting with the Almost Ideal Demand System: evidence from some alternative dynamic specifications", *Applied Economics*, 29, 7, 935-947.

Chang, Hui-Shung (Christie), Garry Griffith, and Nicholas Bettington (2002) "The Demand for Wine in Australia Using a Systems Approach: Industry Implications", *Agribusiness Review* - Vol. 10.

Clements, K.W. and Selvanathan, E.A. (1987) "Alcohol consumption" in Theil, H.W. and Clements, K.W. (eds), *Applied Demand Analyses: Results from System-Wide Approaches*, Ballinger, Cambridge, MA

Clements, K.W. and Selvanathan, S. (1991) "The economic determinants of alcohol consumption", *Australian Journal of Agricultural Economics* 35, 209-231.

Clements, Ken, Wana Yang and Simon Zheng, (1997) "Is Utility Additive? The Case of Alcohol", *Economic Research Centre*, Department of Economics, University of Western Australia".

Deaton, A. S. and J. Muellbauer (1980a) "An Almost Ideal Demand System," *American Economic Review*, 70.

Jones, A. 1989, 'A systems approach to the demand for alcohol and tobacco', *Bulletin of Economic Research*, 41, 2, 85-101.

Murphy, C.W. (1981) "The Market for Alcoholic Beverages: Pricing, Demand and Taxation", Paper presented the *Tenth Conference of Economists*, Economic Society of Australia and New Zealand , 24-28 August 1981.