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Inform Alcohol Tax Policies**

**Preety Srivastava, Keith R. McLaren, Michael Wohlgenant
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February 2014

Working Paper 05/14

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Preety Srivastava¹, Keith R McLaren², Michael Wohlgenant^{2,3}, and Xueyan Zhao²

1. School of Economics, Finance & Marketing
RMIT University, Australia

2. Department of Econometrics & Business Statistics
Monash University, Australia

3. Department of Agricultural & Resource Economics
North Carolina State University, USA

Corresponding author:

Xueyan Zhao
Professor
Department of Econometrics and Business Statistics
Clayton Campus, Monash University
VIC 3800, AUSTRALIA
Phone: +61 3 99052415
FAX: +61 3 9905 5474
Email: xueyan.zhao@monash.edu

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Abstract

The paper presents estimates of price elasticities of demand for twelve disaggregated alcohol beverages in Australia: premium beer, full strength beer, low alcohol beer, and mid strength beer; red bottled wine, white bottled wine, sparkling wine, cask wine, and dark and light ready-to-drink (RTD); and dark and light spirits. These disaggregated categories correspond closely to the commodities of interest to public policymakers with respect to taxation and health policies. The system of demand equations is estimated with Nielsen data from Australia using the semiflexible AIDS model in order to impose negative semidefiniteness on the demand parameters. Results indicate elastic own-price elasticities for virtually all commodities. Morishma elasticities of substitution indicate premium beer, mid strength beer, and cask wine exhibit the largest elasticities of substitution. Low alcohol beer, light RTD, and light spirits show the lowest substitution. The elasticity estimates are used to illustrate the effect of a change in the current tax system toward taxation equalisation based on alcohol content. The policy simulation highlights the importance of having a complete system of demand elasticities because the mix of consumption of alcohol beverages changes in response to the type of alcohol policy.

JEL Classification: C3, D11, D12, I1

Keywords: alcohol, demand system, elasticities, semiflexible AIDS, tax.

1 Introduction

Alcohol consumption is an enjoyable and inseparable part of the Australian lifestyle, deeply ingrained in the sociocultural and economic structure of the society. However, the cost of adverse effects of alcohol abuse is huge. Risky alcohol consumption has resulted in significant numbers of hospital episodes and deaths (Chikritzhs et al., 2003), and alcohol abuse is also a major contributor to road accidents, violence, crimes, unemployment and suicides. According to Collins and Lapsley (2008), the annual cost of alcohol-related problems to Australia in 2004-05 was \$15.3 billion, including costs via workplace productivity loss, road accidents, crime and health. Latest statistics show that consumption of alcohol at harmful levels is increasing. According to data from the Australian National Drug Strategy Household Survey, in 2007, nearly 33% of the population binged at least once a year, with one out of five of them bingeing frequently at least three days a week (Srivastava and Zhao, 2010). In 2010, 31% binged once a year, with 1.2 out of five bingeing at least three days a week. Adding to the concern is evidence of a binge epidemic among the young and an increasing popularity of pre-mixed Ready to Drink (RTD, or ‘alcopop’) spirits, especially among young women (Ramful and Zhao, 2008).

Alcohol policies aimed at addressing harmful and excessive drinking have long been in the forefront of the national agenda of the Australian Government. A range of policy tools have been introduced over the years including regulations limiting place and time to sell alcohol, restrictions on underage drinking, enforcement of drink driving laws, restrictions on advertising, anti-alcohol campaigns and the highly contentious alcohol pricing and taxation policy. As an important policy tool, alcohol taxes have been debated on various fronts (Anderson 2010; Freebairn 2010; Srivastava and Zhao 2010; Clarke 2008; Zhao and Wittwer 2007). The total alcohol tax revenue was estimated at around \$7 billion in 2008-09, which is considerably lower than Collins and Lapsley’s estimate of the cost of alcohol harm (VAADA, 2010). However, it is the details of any proposed changes to the

alcohol taxation system that spark the most discussion.

The proposed tax increase for the RTDs in 2008 by the Labor government reopened the ‘can of worms’ of the long-standing issue of the ‘anomalies’ of alcohol tax in Australia and caused intense responses from grape growers, beer, wine and spirit producers, health professionals and welfare bodies (Zhao and Wittwer 2007). Australia has a very complex alcohol tax system, with beer and spirits being taxed by alcohol content with differentiated volumetric excise (VT) rates according to alcohol strength while wine is levied an ad valorem wine equalization tax (WET) based on wholesale value. The spirit industry has long pushed for the ‘equal alcohol, equal tax’ argument while the wine industry lobbies its contribution to the vitality and employment of the Australian agricultural industry and externalities such as tourism. However, there has been consensus for the need of a comprehensive review of alcohol taxation by differentiated products. In 2009, a major review of the Australian taxation system undertaken by the Federal Department of Treasury called for an urgent introduction of a volumetric tax on wine products given the anomalous nature of the WET (Henry et al., 2010) and for the restructuring of taxes for certain forms of alcoholic beverages most open to excessive consumption. Both policy changes were specially targeted towards cheap cask wine, which pays the lowest effective tax on per litre of alcohol (LAL) basis. Alcohol tax reform was also high on the agenda of the 2011 Tax Summit with important lobbyists such as the Australian Medical Association (AMA) and the National Alliance for Action against Alcohol (NAAA)¹ advocating the urgent need for alcohol tax reforms.

However, essential and urgent to effective alcohol tax policy is empirical evidence of consumer price responsiveness by differentiated alcohol types. For instance, whilst an increase in ‘alcopops’ tax is aimed at shifting consumers to non-alcohol drinks, how much will the

¹ The NAAA is a newly established national coalition of more than 50 major health and community organisations from across Australia such as VicHealth, Cancer Council Victoria, Heart Foundation Victoria and Turning Point Alcohol and Drug Centre, with the goal of reducing alcohol-related harm. It considers alcohol pricing and taxation as one of the three key priority areas (NAAA, 2011).

preference be shifted from premixed RTDs to straight spirits as a consequence, thus encouraging potentially even riskier drinking behaviour when young people are less informed about the quantity of alcohol consumed when mixing drinks themselves? What would happen to the market equilibrium prices and consumptions of all beverages, such as cask wine and RTDs, if a revenue neutral across-the-board flat volumetric tax rate is to be in place as suggested by the Henry tax review? Surprisingly, little up-to-date empirical evidence is available in Australia to answer a range of such questions to inform alcohol policy formulation. There is an urgent need for exploring available data sources for estimating demand elasticities, so that proposed alcohol tax policies can be based on sound empirical knowledge (see for example, Collins and Lapsley 2008b, Parliament of Australia 2008). Availability of consumption and price data by differentiated beverage types and the need for an econometric model that is consistent with economic theory and accommodates specific data features are two main challenges.

There is a large body of economic literature internationally that examined alcohol consumption over the last few decades. These studies have generally found evidence of a decline in alcohol consumption in response to demand restriction policies. Chaloupka (1993) carried out a survey of studies which assessed the sensitivity of alcohol use to price changes in particular. He found considerable evidence that an increase in the price of alcohol beverages could effectively reduce drinking. Pacula and Chaloupka (2001) reviewed studies which examined the impact of price and public policies on alcohol abuse. They concluded that addictive behaviour is sensitive to changes in the full price of drugs, where the full price of a drug reflects not only its monetary cost, but also health, legal and time costs involved in obtaining and using the drugs. Cook and Moore (2002) reviewed some studies which examined the impact of prices on alcohol use and abuse and alcohol-related problems. They also concluded that excise taxes on alcohol beverages are effective at controlling alcohol consumption and therefore can be effectively used to promote public

health. Chaloupka et al. (2002) drew similar conclusions from a survey of studies that examined the impact of alcohol prices on drinking and heavy drinking by teenagers and young adults.

Whilst taxes on alcohol products are widely recognised as one of the most effective ways to reduce alcohol-related harm (Chaloupka, 1993; Pacula and Chaloupka, 2001; Cook and Moore, 2002). The effectiveness of such policy hinges primarily on individuals' responsiveness to changes in the relative prices of different alcohol products. From an extensive review of the economic literature on the relationship between price and the demand for the three beverages, Leung and Phelps (1993) concluded that the demand for beer was significantly price inelastic while those for wine and spirits were elastic. Similar evidence was found from an earlier survey by Ornstein and Hanssens (1985), but no reliable estimates were obtained for wine price elasticity. In contrast, a few studies have found all three types of alcohol beverages to be price inelastic (Clements and Selvanathan, 1987; Heien and Pompelli, 1989; Nelson, 1997) of which some have used Australian data (for example, Clements, 1983; Clements and Selvanathan, 1991; Selvanathan, 1991). Fogarty (2006) and Gallet (2007) shed light on this disparate and conflicting literature by showing that most of the variations in the own price elasticity of demand estimates for alcohol could be related to demand specifications, data issues, estimation methods, the level of alcohol consumption, and the ethanol share in the beverages. The results on cross price responses have been equally conflicting in the literature. As a result, there is mixed evidence on the economic relationships across the three types of alcohol drinks.

Existing estimates for alcohol demand elasticities in Australia are few, outdated and lack the level of disaggregation for the purpose of analysing any alcohol tax policy changes that involve detailed types of alcohol drinks. The study by Clements and Johnson (1983) was the first to use Australian data to analyse separately the demand for beer, wine and spirits.

Selvanathan and Selvanathan (2005) provide another set of demand elasticity estimates for beer, wine and spirits, using aggregated consumption data up to 1998 and a conditional Rotterdam demand model with a Preference Independence assumption. In particular, it is important to determine the economic relationships not only across the broad groups of beer, wine and spirits but also across the various product types within each broad group. For instance, the tax increase on ‘alcopops’ in 2008 was aimed at shifting consumers to non-alcohol drinks which can be potentially harmful in their own rights if they are sugar-sweetened. But there has also been concern of demand being shifted from premixed RTDs to straight spirits. The dearth of price elasticities’ estimates and the importance of ongoing data collection and analysis has time and again been underlined in alcohol policy discussions (VAADA, 2010; Henry et al., 2010; NDRI, 2008; Parliament of Australia, 2008; VicHealth, 2008; Collins and Lapsley, 2008). There is clearly a need to estimate own and cross-price elasticities of alcohol consumption by differentiated product types in order to evaluate the impact of any tax related policy and the flow-on effects in other areas. In fact, a recent study by Doran et al. (2013) estimated impacts of alternative Australian alcohol taxation structures on consumption, public health and government revenues; they used price elasticities estimated using UK data to simulate the policy changes which they recognised as an important limitation of their study.

The aim of this paper is to estimate a flexible Almost Ideal demand system model proposed by Moschini (1998) for 12 alcohol beverage types, allowing for consumer within-group substitution across different alcohol drinks. We use data obtained from AC Nielson Australia for state level monthly consumption for 14 alcohol beverage types between 2004 and 2010. We also correct for seasonality and serial correlation by estimating the system with a first order autoregressive scheme. Own and cross price and income elasticities, together with their standard errors, are then estimated. Morishma elasticities of substitution are also estimated across different product types, which are more appropriate measures for the

ease of substitution along an indifference curve. These results provide the much needed consumer response information in terms of differentiated types of alcohol products that is crucial for policy formulation. The Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980) is one of the most widely used demand system models. However, for the sake of simplicity, most previous studies using AIDS models have firstly, adopted a simple linear approximation of the highly non-linear model and secondly, ignored the violation of semi-definiteness of the Slutsky matrix resulting in a model that does not satisfy the curvature property of concavity.

2 Econometric Framework

The AIDS model is defined as

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \left(\frac{y}{P} \right); \quad i, j = 1, \dots, n \quad (1)$$

where w_i represents commodity i 's share of the total budget allocated to the set of n goods and y is the total expenditure. P is the translog price index defined as

$$\ln P = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j. \quad i, j = 1, \dots, n. \quad (2)$$

The regularity properties of demand theory can be summarised by the following regularity properties of the underlying cost function: positivity; monotonicity; homogeneity and concavity. In terms of the corresponding Marshallian demands, monotonicity implies nonnegativity of demands; homogeneity implies adding up and homogeneity of degree zero in prices and expenditure; and concavity implies that the Slutsky matrix is negative semidefinite. Continuous differentiability alone of the cost function implies that the Slutsky matrix is symmetric. The restrictions of adding-up, homogeneity and symmetry can be imposed by the following equality restrictions on parameters (Deaton and Muellbauer, 1980):

$$\text{Adding - up : } \quad \sum_{i=1}^n \alpha_i = 1 \quad \sum_{i=1}^n \gamma_{ij} = 0 \quad \sum_{i=1}^n \beta_i = 0;$$

$$\text{Homogeneity : } \quad \sum_{j=1}^n \gamma_{ij} = 0, \text{ for } i = 1, \dots, n; \text{ and}$$

$$\text{Symmetry : } \quad \gamma_{ij} = \gamma_{ji}, \text{ for all } i \neq j.$$

While the theoretical properties of adding up, homogeneity and symmetry can be imposed by parameter restrictions, the properties of nonnegativity of demand and negative semidefiniteness of the Slutsky matrix cannot be imposed globally by simple parameter restrictions. The negativity conditions are satisfied if the matrix of (scaled) Slutsky substitution terms, S_{ij} defined as

$$S_{ij} = \gamma_{ij} + \beta_i \beta_j \ln \left(\frac{y}{P} \right) - \delta_{ij} w_i + w_i w_j \quad (3)$$

is negative semidefinite, where δ_{ij} is the Kronecker delta such that $\delta_{ij} = 1$ if $i = j$ and $\delta_{ij} = 0$ if $i \neq j$ and the share functions are given by (1). Many empirical applications of the AIDS violate this curvature property (Moschini, 1998), resulting in an estimated Slutsky matrix which is not necessarily negative semidefinite.

Building on the concept of semiflexible functional form in (Diewert, 1987), Moschini (1998) proposes a semiflexible AIDS that not only maintains the curvature property in the AIDS at a point but also reduces the risk of losing degrees of freedom with increasing number of goods, an inherent problem in standard flexible demand systems². Assuming that concavity is maintained at the point where $P = y = 1$ (i.e. when $p_i = 1$ for all i), the data can be scaled appropriately so that the desired concavity property can be imposed at any point. We choose the sample geometric mean in this application. At this data point, the Slutsky substitution

²Note that in flexible models such as the AIDS, the number of parameters to be estimated increases quadratically as the dimension of the demand system increases. This is circumvented by restricting the rank of the $(n-1)$ substitution matrix for a n -good demand system to any rank K where $1 < K < (n-1)$.

matrix is a function only of parameters and can be written as:

$$\theta_{ij} = \gamma_{ij} + \alpha_i \alpha_j - \delta_{ij} \alpha_i. \quad (4)$$

Concavity at this point is satisfied if the matrix $\Theta \equiv [\theta_{ij}]$ is negative semidefinite. A necessary and sufficient condition for the matrix Θ to be negative semidefinite is that the upper $(n-1) \times (n-1)$ submatrix of Θ be set to equal to $-T'T$; where T is an $(n-1) \times (n-1)$ upper triangular matrix such that $\tau_{ij} = 0$ for $i > j$. The T matrix has the following structure:

$$T = \begin{bmatrix} \tau_{11} & \tau_{12} & \tau_{13} & \dots & \tau_{1n-1} \\ 0 & \tau_{22} & \tau_{23} & \dots & \tau_{2n-1} \\ 0 & 0 & \tau_{33} & \dots & \tau_{3n-1} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & 0 & \tau_{n-1n-1} \end{bmatrix}. \quad (5)$$

Our approach to imposing negative semi-definiteness on the AIDS model at the geometric means follows Moschini's (1998) approach. The approach involves expressing not only the parameters in terms of the τ_{ij} 's, but also expressing the model as a function of price indexes which are, in turn, functions of the τ_{ij} 's. The advantage of this approach, as discussed by Moschini (1998), is that it simplifies estimation through simple deletion of price indexes as the rank of the Slutsky substitution matrix is reduced.

Reparametrising γ_{ij} firstly in terms of θ_{ij} and the α 's from equation (4) and subsequently in terms of τ_{ij} from equation (5) allows us to write the AIDS model as:

$$w_i = \alpha_i + \alpha_i \ln \left(\frac{P_i}{P^\alpha} \right) - \sum_{s=1}^i \tau_{si} \ln P_s^\tau + \beta_i \ln \left(\frac{y}{P} \right), \quad i = 1, \dots, n-1 \quad (6)$$

where P_s^τ is an aggregation function, homogeneous of degree zero in prices, given by:

$$\ln P_s^\tau = \sum_{j=s}^{n-1} \tau_{sj} \ln \left(\frac{P_j}{P_n} \right), \quad s = 1, \dots, n-1; \quad (7)$$

and P^α is a price function, homogeneous of degree plus one, given as:

$$\ln P^\alpha = \sum_{i=1}^n \alpha_i \ln p_i; \quad (8)$$

and the translog price index is written as:

$$\ln P = \ln P^\alpha + \frac{1}{2} (P^\alpha)^2 + \frac{1}{2} \sum_{i=1}^n \alpha_i (\ln p_i)^2 - \frac{1}{2} \sum_{s=1}^{n-1} (\ln P_s^\tau)^2. \quad (9)$$

Equation (6) results in a locally concave AIDS model. However, the estimation of this model can present convergence issues if the estimation of the unrestricted AIDS model (equation (1)) violates local concavity. This can potentially result in a substitution matrix of less than full rank. Thus, if concavity is violated when estimating an unrestricted AIDS model, estimating a model with substitution matrix of rank $K < (n-1)$ can be useful to achieve convergence. Along with maintaining curvature properties, this semi-flexible AIDS model has the added advantage of reducing the number of parameters to be estimated. A detailed illustration of the semi-flexible AIDS model can be obtained in Diewert (1987). Essentially, by setting $\tau_{ij} = 0$ for all $i > K$, we can estimate a restricted model of rank $K < (n-1)$. According to Diewert (1987), the rule of thumb for setting the rank of the restricted model is that K should not exceed the number of negative eigenvalues of the unrestricted model.

The presence of serial correlation is a common feature in time series. While serial correlation will not affect the unbiasedness or consistency of the estimators, it does affect their efficiency. We therefore estimate the system of demand equations (6) with a first-order autoregressive scheme which greatly complicates the model specification. However, a simple way of illustrating the estimation procedure is as follow. Writing the right-hand side component of (6) as $W(\cdot)$ results in

$$w_{it} = W(\mu, Z_{it}) + e_{it}, \quad i = 1, 2, \dots, n-1; \quad t = 2, \dots, T \quad (10)$$

where w_{it} is the observed commodity i 's share at time t , μ is the vector of unknown

parameters, Z_{it} is the vector of the corresponding exogenous variables at time t and e_{it} is a vector of error terms. To allow for serial correlation, a first-order autoregressive scheme is specified as follows:

$$e_{it} = \rho e_{i,t-1} + \epsilon_{it}, \quad i = 1, 2, \dots, n-1; \quad t = 2, \dots, T \quad (11)$$

where ρ is the autocorrelation coefficient, and ϵ_{it} is a vector of independently and identically error terms with $E[\epsilon_{it}] = 0$ and $E[\epsilon_{it}\epsilon_{it}'] = \Omega$. Transforming the dependent variable to $w_{it} - \rho w_{i,t-1}$ results in:

$$w_{it} - \rho w_{i,t-1} = W(\mu, Z_{it}) - \rho W(\mu, Z_{i,t-1}) + \epsilon_{it}, \quad i = 1, 2, \dots, n-1; \quad t = 2, \dots, T. \quad (12)$$

This results in a system of equations with a first order autoregressive scheme but with an additional parameter ρ which is the same across all equations because of the adding up restriction (Berndt and Savin, 1975). Assuming the ϵ_{it} 's follow a multivariate normal distribution, we estimate the system of $n-1$ nonlinear equations by iterated feasible generalized nonlinear least squares (FGNLS). As noted by Kmenta and Gilbert (1970) and Poi (2008), for the AIDS class of models iterated feasible generalized least squares is equivalent to maximum likelihood estimation.

The non-linear form of the AIDS model prevents the direct interpretation of its coefficients as elasticities. However, the signs of these coefficients still give an indication of the response of the dependent variable to a change in its determinants. For instance, the coefficients of the price variables (γ_{ij} 's) represent the change in expenditure share allocated to commodity i in response to a proportionate change in prices, everything else held constant. Coefficients β_i s represent the change in the i^{th} expenditure share for a proportional change in real expenditure.³ The demand elasticities are calculated using the model's estimates as

³Total expenditure allocated to the group of n alcohol commodities, deflated by price index P .

follows⁴:

Expenditure elasticities:

$$\eta_i = 1 + \frac{\beta_i}{\hat{w}_i};$$

Marshallian or uncompensated elasticities:

$$\varepsilon_i = -\delta_{ij} + \frac{\gamma_{ij}}{\hat{w}_i} - \hat{\beta}_i \frac{\hat{w}_j}{\hat{w}_i};$$

Hicksian or compensated elasticities:

$$\varepsilon_i^* = \varepsilon_i + \hat{w}_i \eta_i = -\delta_{ij} + \frac{\gamma_{ij}}{\hat{w}_i} + \hat{w}_j$$

where δ_{ij} is the Kronecker delta that takes value one if $i = j$ and zero otherwise (Green and Alston, 1990, 1991); \hat{w}_i represents the predicted share of commodity i ($i = 1, \dots, n$).

3 Data

Data in this study are obtained from AC Nielsen, Australia. Information is collected using the ScanTrack Liquor service that tracks value and volume of sales for off-premise consumption of liquor from supermarkets, grocery/convenience stores liquor chains⁵. Monthly values and volume of sales of 14 alcohol beverage types for the period January 2004 through August 2010 at state level⁶ are used in this study resulting in 400 observations for each series. These include four beer types (premium, full strength, low alcohol and mid strength); five wine types (red bottled, white bottled, fortified, sparkling, and cask); three Ready to Drink (RTD) types (dark, light, cider/cooler); and two spirits types (dark and light).

Table 1 presents the market shares of these alcohol beverages based on value of sales.

⁴ Uncompensated price elasticities take account of total effect of price changes. However, compensated elasticities compensate for the effects of changes in real income which result from price changes.

⁵ The only on-premise component resulting from consumption at integrated hotels, i.e., hotels that have bottle shops and bars.

⁶ Note that ACT and NT information are rolled into NSW and SA, respectively. Liquor data is not audited for TAS. We thus have five data points in terms of states.

Looking at the four broad types of alcohol products, beer has the largest market share of 42.7% which is almost double the size of its immediate competitor wine (22.6%) (Column 3). Due to its increasing popularity the budget share of RTD is not far from that of wine (18.7%) while spirits has the lowest share of 16%. Column 4 presents the budget shares of the 14 alcohol types within each broad category of products. Within beer, full strength beer dominates the market with a high budget share of 62.4%. Within the wine broad type, bottled wine largely dominates the market, with a slightly larger share for white wine (33.8%) relative to red wine (25.8%). Within both RTD and spirits, dark liquor budget shares exceed those of light liquor. Finally, column 5 presents budget shares of the 14 alcohol types out of total expenditure. Full strength beer dominates the market with a high share of 26.8% followed by dark RTD (13.5%) and dark spirits (11.1%).

As noted earlier, traditionally, studies have split alcohol into three broad types of beverage: beer, wine and spirits. Here, we conduct the analysis on 12 alcohol types, grouping fortified wine and cider/cooler with sparkling wine and light RTD, respectively, due to their small expenditure shares. Implicit prices per litre of beverage are then constructed by dividing value of sales measured in dollars by respective volume of sales measured in litres of beverage. Per capita expenditure is derived using the states and territories population estimates obtained from the Australian Bureau of Statistics (ABS, 2012). Before estimation, prices and per-capita income are converted into logs and then normalised by subtracting their respective arithmetic mean, which is equivalent to dividing the original series by the respective geometric mean. Given the high frequency of our data, seasonality can potentially affect our results. We thus allow for seasonal intercept shifts in the demand system using a set of monthly dummy variables.

4 Results

Traditionally, empirical studies that have estimated an AIDS model have used the Stone Price Index instead of the nonlinear price index, Equation (2), in order to circum-

convergence issues. With the advent of powerful computers, improved modelling algorithms and faster computational techniques, the estimation of nonlinear AIDS does not necessarily pose any computational difficulty. Here, to avoid any specification bias, we estimate a nonlinear AIDS with translog prices. We start by estimating the unrestricted AIDS which shows that at the mean point, the Slutsky matrix does not satisfy the curvature property. In particular, we find that 4 eigenvalues are positive and 8 are negative. We thus estimate a semiflexible model of order $K = 7$. In other words, for $i > K$, we set $\tau_{ij} = 0$.

Estimates of the constant terms, α_i 's, and budget coefficients, β_j 's, and the τ_{ij} 's from the 11 equations are reported in Table 2 in the appendix. Of the 11 budget coefficients that are estimated, six are statistically significant at the 5% level and one at the 10% level. Of the 56 τ_{ij} 's, 28 are significant at the 5% level and five at the 10% level. Table 3 presents price coefficients derived from the τ_{ij} in Table 2 along with their standard errors. Of the 144 price coefficients, 61 are significant at the 5% level and 7 at the 10% level. In Table 4 we present our estimated budget and compensated price elasticities calculated at the mean. Note that our results do not compare readily with previous studies. Our results are estimated conditional elasticities since the total expenditure on alcohol is the expenditure variable. The estimation of unconditional elasticities for each alcohol type requires that we estimate the overall price elasticity for alcohol using a multi-stage budgeting approach. Capentier and Guyomord (2001) provide formulas in the case of approximate two-stage budgeting.

The positive signs on the expenditure elasticities indicate that all 12 alcohol types are normal goods or luxury goods⁷. Our estimates of own-price elasticity for the beer types are in the range 1.0-5.4, higher than those of the wine types which ranged between 1.2-3.0, RTD

⁷ The unconditional expenditure elasticities are products of the conditional elasticities and elasticity of total expenditure with respect to expenditures on alcoholic beverages. Thus, if the product of the two is less than one it is a normal good; conversely, if the product is larger than one it is a luxury good. See Carpentier and Guyomord (2001) for details.

types which ranged between 1.2-1.9 and spirits types, 1.3-1.6. Among the 12 alcohol types premium beer and mid strength beer have the highest own-price elasticities of 5.4 and 3.4, respectively.

As far as we know there are hardly any studies that have looked at differentiated alcohol products. However, a study by Hausman et al. (1994) which focuses on brand competition in the US, estimates a multi-stage demand system for brands in the beer market. They estimated conditional own-price elasticities of premium and light beer to be around 2.4 and 2.7, respectively. These conditional elasticities, however, are estimated holding expenditures on beer constant so they are not strictly comparable to our estimates. The compensated cross-price elasticities shown in Table 4 indicate how price responsive demand for each of the alcohol beverages is to changes in prices of other alcohol beverages. However, these cross-elasticities and the Allen elasticities of substitution that can be derived from them do not measure the ease of substitution along an indifference curve (Blackorby and Russell 1989). Blackorby and Russell (1989) show that the Morishma elasticity of substitution (MES) is (i) a measure of ease of substitution and (ii) is a sufficient statistic for measuring effects of changes in prices or quantity ratios on relative factor shares. It is defined as the logarithmic derivative of a quantity ratio with respect to a marginal rate of substitution or price ratio. For computational purposes, it can be calculated with the formula (Blackorby and Russell 1989)

$$MES_{ij} = \varepsilon_{ji}^* - \varepsilon_{ii}^* .$$

Morishma elasticities of substitution between the 12 alcohol beverages are shown in Table 5. A striking feature of the elasticities is how large the values are. With only a few exceptions, all the MES's are much larger than one. The largest substitutions occur with respect to premium beer (PRB), mid strength beer (MSB), and cask wine (CW). For example, a one percent increase in the price of CW leads to a 3.2 percent increase in consumption of premium beer (PRB) relative to CW. The lowest substitution rates are with respect to low alcohol beer (LAB), light RTD beverages (LR), and light spirits (LS). Substitutions of other

beverages with respect to a price change in a given beverage appear quite uniform for all beverages. For example, with respect to cask wine (CW), substitution rates range from 2.9 to 3.2 across all eleven alcohol beverages.

5 An Illustration of Importance of Demand Interrelationships in Taxation Policies

There has been considerable discussion and debate in Australia about the appropriate mix of taxes for alcohol beverages. One particular proposal has been to replace the current ad valorem wine equalisation tax (WET) with a revenue volumetric tax (VT) based on alcohol content of all wine products. There are also health concerns expressing themselves in desires to change taxes in favour of wine and beer compared to spirits and ready to drink beverages. There are a myriad of policies one could analyse and such analyses would of necessity require the complete set of demand elasticities estimated in this study. The purpose of this section is to simply illustrate the importance of the system of demand elasticities through evaluation of the effect of a change in the tax system that would move wine toward equalisation of taxation based on alcohol content.

In the tax illustration, assume that taxes on all wines are increased 10% from their current ad valorem levels and that beer and spirits taxes are decreased proportionately (in equivalent ad valorem levels) to keep tax revenue neutral. Taxes on Ready to Drink (RTD) beverages are not assumed to change in light of April 2008 increases by the Australian government (The Age, 2008). To model the economic effects of this tax change scheme, it is useful to place the model in matrix form. Let $d \ln Q$ denote the $n \times 1$ vector of relative changes in quantities of the different alcohol beverages consumed, $d \ln P = d \ln P^* + \hat{W} d \ln T$, is the vector of relative changes in retail prices of the alcohol beverages, $d \ln P^*$ is the vector of relative changes in retail price net of the equivalent ad valorem tax changes (both alcohol and GST), \hat{W} is an $n \times n$ diagonal matrix of expenditure

shares of taxes in total revenue, and $d \ln T$ is the vector of relative tax changes.⁸

The relative change in quantities demanded from the tax scheme is

$$d \ln Q = E d \ln P = E \left(d \ln P^* + \hat{W} d \ln T \right) \quad (13)$$

where E is the $n \times n$ matrix of price elasticities of demand given in Table 5. If we assume, for sake of simplicity, that there is complete pass-through of the taxes to consumers, then $d \ln P^* = 0$, and

$$d \ln Q = E \hat{W} d \ln T. \quad (14)$$

Finally, if the tax scheme is revenue neutral, then the relative change in tax revenue,

$$d \ln TR = \sum_{i=1}^n w_i s_i d \ln T_i + \sum_{i=1}^n w_i s_i d \ln q_i \text{ implies that}$$

$$\sum_{i=1}^n w_i s_i d \ln T_i = - \sum_{i=1}^n w_i s_i d \ln q_i \quad (15)$$

when $d \ln TR = 0$. In the above notation, s_i is the expenditure share of good i in total tax revenue of all alcohol beverages, i.e., $s_i = \frac{p_i q_i}{TR}$.

Table 6 shows the effects on changes in quantities demanded from a 10% increase in equivalent ad valorem taxes on all wines with no change in total tax revenue. Of all the wine types, cask wine (CW) declines the most because it is the most own-price elastic.

Demand for all beer types and dark and light spirits increase when taxes on these alcohol beverages are decreased uniformly by 2.85 percent in order to keep total tax revenue constant. The largest increases in consumption occur where demands are more elastic: PRB, DS, MSB, and FSB. While neither RTD beverage's tax is changed we find

⁸ The price relationship is based on the basic price relationship between price with and price without taxes, $P_i = P_i^* (1 + t_i)$ where t_i is the ad valorem tax rate (James and Alston, 2002). Totally differentiating this expression yields $d \ln P_i = d \ln P_i^* + \left(\frac{P_i^* q_i}{P_i q_i} \right) d \ln (p_i^* t_i) = d \ln P_i^* + w_i d \ln T_i$ where $d \ln T_i = d \ln (p_i^* t_i)$ represents the relative change in equivalent *ad valorem* tax rate

DR consumption declines by about 1% and LR consumption declines by about 0.5%. This reflects the fact that the RTD beverages are closer substitutes with spirits, especially dark spirits.

This policy illustration ignores the fact that the elasticities estimated are conditional on real alcohol expenditures being fixed. However, in this instance, we find that total real alcohol expenditures would change by only about 0.16 percent. Therefore, the estimated effects of the tax illustration given here would be accurate in this instance. In general, one would also want to have the first-stage elasticity of demand for all alcohol beverages in order to compute unconditional elasticities. Estimates of first-stage demand parameters are left as an exercise for future research. The present illustration points out the importance of having the entire matrix of own-price and cross-price elasticities to evaluate the impact of tax changes.

6 Conclusion

This paper presents estimates of price elasticities of demand for twelve disaggregated alcohol beverages in Australia. The beverages include four types of beer: premium beer, full strength, low alcohol and mid strength; four types of wine: red bottled wine, white bottled wine, sparkling wine cask wine; two ready-to-drink alcohol beverages (RTD): dark and light; and two types of spirits dark and light. These disaggregated categories correspond closely to the commodities of interest to public policymakers regarding taxation and health policies. Data were obtained from AC Nielsen, Australia and cover the time period January 2004 through August 2010, a total of 400 observations. The system of demand functions was estimated using the semiflexible AIDS model of Moschini (1998) in order to impose negative semidefiniteness on the parameters. The error terms were also corrected for first-order autocorrelation following the methodology of Berndt and Savin (1975). The results seem reasonable and indicate elastic own- price elasticities for virtually all the commodities. Individual beer types overall appear more elastic than wine, followed by spirits and RTD commodities.

Morishma elasticities of substitution were also computed. These elasticities indicate the ease with which other beverages can be substituted for the beverage in question. Premium beer (PRB), Mid strength beer (MSB), and cask wine (CW) exhibit the largest elasticities of substitution. Low alcohol beer (LAB), light RTD (LR), and light spirits (LS) show the lowest rates of substitution. Overall, the rates of substitutability are quite large and uniform with respect to each beverage.

To illustrate the importance of a matrix of price elasticity of demand satisfying all the restrictions of consumer behaviour, we have used the elasticities to estimate the effect of a change in the current tax system that would move wine toward taxation equalization based on alcohol content. In particular, using the elasticities, we assumed a 10% increase in taxes on wine from their current ad valorem levels and a commensurate decrease in taxes on beer and spirits in order to keep tax revenue equal. Demand for each wine type decreases with the largest decrease in percentage terms occurring for cask wine. Demand for all beer and dark and light spirits increase with the largest increases occurring among the different beer types. The policy simulation shows the importance of having a set of demand elasticities because the mix of consumption of alcohol beverages will change in different ways depending upon the type of taxation policy implemented.

The results obtained in this study should be useful for a variety of applications. In applying these results, however, the researcher may want to supplement them with an econometric estimate of the first-stage elasticity of demand for alcohol, conditional on total expenditures being fixed because the estimates reported here are conditional demand elasticities conditional on alcohol expenditures being fixed.

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Table 1: Budget Shares of Alcohol Off-Premise Expenditure

	%	Budget	Share	Within	Budget	Share
	Alcohol	by		Group	by	
		Broad	Groups	Share	Alcohol	Type
Beer	4.3%	42.7%				
Premium Beer	5.0%			16.5%	7.1%	
Full Strength	4.7%			62.4%	26.8%	
Low Alcohol	2.6%			11.0%	4.8%	
Mid Strength	3.4%			10.1%	4.3%	
				100.0%		
Wine		22.6%				
Red Bottle Wine	12.6%			28.5%	6.5%	
White Bottle	12.6%			33.8%	7.6%	
Fortified Wine				2.0%	0.5%	
Sparkling Wine				16.8%	3.8%	
Cask Wine	12.6%			19.0%	4.3%	
				100.0%		
RTD	5.2%	18.7%				
Dark RTD/Cider				73.4%	13.5%	
Light RTD/Cider				24.0%	4.4%	
Cider/Cooler				2.5%	0.5%	
				100.0%		
Spirits	36.0%	16.0%				
Dark Spirits				68.9%	11.1%	
Light Spirits				31.1%	5.0%	
				100.0%		
		100.0%			100.0%	

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Table 2: Semiflexible AIDS Estimates

α_i	0.291 (0.137)**	0.072 (0.137)	0.000 (0.000)	0.129 (0.066)*	0.046 (0.013)**	0.094 (0.037)**	0.040 (0.006)**	0.080 (0.047)*	0.130 (0.035)**	0.017 (0.008)**	0.092 (0.038)**
β_i	0.036 (0.006)**	-0.001 (0.012)	0.007 (0.002)**	0.007 (0.005)	-0.018 (0.007)**	0.012 (0.006)*	0.022 (0.005)**	-0.016 (0.004)**	-0.046 (0.008)**	-0.003 (0.004)	-0.007 (0.007)
τ_{1i}	-0.571 (0.047)**	0.148 (0.033)**	0.001 (0.001)*	0.074 (0.027)**	0.049 (0.012)**	0.057 (0.016)**	0.034 (0.012)**	0.020 (0.022)	0.058 (0.019)**	0.025 (0.009)**	0.075 (0.023)**
τ_{2i}		0.320 (0.053)**	0.002 (0.001)	-0.206 (0.050)**	0.009 (0.031)	-0.021 (0.038)	-0.041 (0.025)*	-0.137 (0.042)**	-0.062 (0.044)	0.018 (0.022)	0.109 (0.046)**
τ_{3i}			-0.001 (0.001)*	0.026 (0.036)	-0.038 (0.032)	0.054 (0.054)	-0.044 (0.025)*	0.039 (0.062)	-0.025 (0.025)	-0.042 (0.027)	0.141 (0.065)**
τ_{4i}				0.316 (0.061)**	-0.032 (0.026)	-0.060 (0.039)	0.003 (0.017)	-0.130 (0.050)**	-0.099 (0.042)**	0.002 (0.018)	0.015 (0.042)
τ_{5i}					-0.132 (0.039)**	0.097 (0.033)**	-0.052 (0.026)**	0.060 (0.047)	0.055 (0.044)	0.097 (0.028)**	-0.152 (0.062)**
τ_{6i}						0.245 (0.046)**	-0.034 (0.018)*	-0.132 (0.041)**	-0.115 (0.038)**	0.014 (0.022)	0.013 (0.059)
τ_{7i}							-0.003 (0.015)	0.173 (0.052)**	-0.314 (0.032)**	0.005 (0.018)	0.099 (0.045)**

Table 3: Semiflexible AIDS Derived Price Coefficients

	θ_{i1}	θ_{i2}	θ_{i3}	θ_{i4}	θ_{i5}	θ_{i6}	θ_{i7}	θ_{i8}	θ_{i9}	θ_{i10}	θ_{i11}	θ_{i12}
θ_{1j}	-0.32776 (0.05399)**	0.08438 (0.02089)**	0.00079 (0.00052)	0.04235 (0.01593)**	0.02811 (0.00793)**	0.03241 (0.01017)**	0.01982 (0.00833)**	0.01143 (0.01268)	0.03376 (0.01238)**	0.01445 (0.00586)**	0.04327 (0.01473)**	0.01699 (0.00618)**
θ_{2j}	0.08438 (0.02089)**	-0.12814 (0.04053)**	-0.00066 (0.00024)**	0.05496 (0.01635)**	-0.00956 (0.00930)	-0.00097 (0.01114)	0.00868 (0.00870)	0.04053 (0.01247)**	0.01182 (0.01439)	-0.00945 (0.00744)	-0.04508 (0.01430)**	-0.00652 (0.00930)
θ_{3j}	0.00079 (0.00052)	-0.00066 (0.00024)**	-0.00001 (0.00000)*	0.00027 (0.00026)	-0.00014 (0.00007)**	0.00001 (0.00014)	-0.00006 (0.00005)	0.00024 (0.00019)	-0.00003 (0.00012)	-0.00012 (0.00005)**	-0.00011 (0.00016)	-0.00018 (0.00006)**
θ_{4j}	0.04235 (0.01593)**	0.05496 (0.01635)**	0.00027 (0.00026)	-0.15697 (0.05174)**	0.00980 (0.00603)	0.01102 (0.01054)	-0.01036 (0.00599)*	0.01088 (0.01265)	0.01668 (0.01385)	0.00264 (0.00621)	0.01147 (0.01278)	0.00725 (0.00682)
θ_{5j}	0.02811 (0.00793)**	-0.00956 (0.00930)	-0.00014 (0.00007)**	0.00980 (0.00603)	-0.02656 (0.01222)**	0.01121 (0.00542)**	-0.00981 (0.00379)**	0.00712 (0.00548)	0.00143 (0.00597)	0.00947 (0.00369)**	-0.01848 (0.00684)**	-0.00258 (0.00354)
θ_{6j}	0.03241 (0.01017)**	-0.00097 (0.01114)	0.00001 (0.00014)	0.01102 (0.01054)	0.01121 (0.00542)**	-0.08900 (0.03156)**	0.01375 (0.00447)**	0.01592 (0.00834)*	0.01450 (0.00872)*	-0.01199 (0.00370)**	0.00432 (0.00963)	-0.00119 (0.00415)
θ_{7j}	0.01982 (0.00833)**	0.00868 (0.00870)	-0.00006 (0.00005)	-0.01036 (0.00599)*	-0.00981 (0.00379)**	0.01375 (0.00447)**	-0.01150 (0.00459)**	-0.00517 (0.00495)	-0.00740 (0.00528)	0.00397 (0.00328)	0.00164 (0.00617)	-0.00357 (0.00299)
θ_{8j}	0.01143 (0.01268)	0.04053 (0.01247)**	0.00024 (0.00019)	0.01088 (0.01265)	0.00712 (0.00548)	0.01592 (0.00834)*	-0.00517 (0.00495)	-0.10367 (0.04232)**	0.01483 (0.01009)	0.00054 (0.00587)	0.00977 (0.01209)	-0.00242 (0.00660)
θ_{9j}	0.03376 (0.01238)**	0.01182 (0.01439)	-0.00003 (0.00012)	0.01668 (0.01385)	0.00143 (0.00597)	0.01450 (0.00872)*	-0.00740 (0.00528)	0.01483 (0.01009)	-0.14174 (0.03056)**	-0.00237 (0.00598)	0.05051 (0.01104)**	0.00801 (0.00599)
θ_{10j}	0.01445 (0.00586)**	-0.00945 (0.00744)	-0.00012 (0.00005)**	0.00264 (0.00621)	0.00947 (0.00369)**	-0.01199 (0.00370)**	0.00397 (0.00328)	0.00054 (0.00587)	-0.00237 (0.00598)	-0.01560 (0.00574)**	0.01801 (0.00800)**	-0.00955 (0.00482)**
θ_{11j}	0.04327 (0.01473)**	-0.04508 (0.01430)**	-0.00011 (0.00016)	0.01147 (0.01278)	-0.01848 (0.00684)**	0.00432 (0.00963)	0.00164 (0.00617)	0.00977 (0.01209)	0.05051 (0.01104)**	0.01801 (0.00800)**	-0.08879 (0.02854)**	0.01347 (0.00902)
θ_{12j}	0.01699 (0.00618)**	-0.00652 (0.00930)	-0.00018 (0.00006)**	0.00725 (0.00682)	-0.00258 (0.00354)	-0.00119 (0.00415)	-0.00357 (0.00299)	-0.00242 (0.00660)	0.00801 (0.00599)	-0.00955 (0.00482)**	0.01347 (0.00902)	-0.01971 (0.00929)**

Table 4: Price and Expenditure Elasticities

	Compensated Own and Cross Price Elasticities:												Expenditure Elasticity
	PRB	FSB	LAB	MSB	RBW	WBW	SW	CW	DR	LR	DS	LS	
PRB	-5.257 (0.718)**	1.383 (0.278)**	0.037 (0.007)**	0.621 (0.212)**	0.436 (0.105)**	0.501 (0.135)**	0.301 (0.111)**	0.194 (0.169)**	0.580 (0.165)**	0.246 (0.078)**	0.685 (0.196)**	0.274 (0.082)**	1.476 (0.082)**
FSB	0.398 (0.080)**	-1.215 (0.155)**	0.024 (0.001)**	0.272 (0.063)**	0.025 (0.036)	0.065 (0.043)	0.073 (0.033)**	0.200 (0.048)**	0.180 (0.055)**	0.020 (0.028)	-0.064 (0.055)	0.023 (0.036)	0.997 (0.046)**
LAB	0.104 (0.019)**	0.235 (0.009)**	-0.974 (0.000)**	0.070 (0.010)**	0.059 (0.003)**	0.072 (0.005)**	0.041 (0.002)**	0.052 (0.007)**	0.136 (0.004)**	0.052 (0.002)**	0.109 (0.006)**	0.043 (0.002)**	1.246 (0.078)**
MSB	0.767 (0.262)**	1.168 (0.269)**	0.031 (0.004)**	-3.374 (0.850)**	0.218 (0.099)**	0.222 (0.173)	-0.136 (0.098)	0.215 (0.208)	0.382 (0.228)*	0.094 (0.102)	0.254 (0.210)	0.159 (0.112)	1.109 (0.082)**
RBW	0.511 (0.124)**	0.102 (0.145)	0.025 (0.001)**	0.207 (0.094)**	-1.283 (0.191)**	0.232 (0.085)**	-0.109 (0.059)*	0.128 (0.086)	0.150 (0.093)	0.208 (0.058)**	-0.182 (0.107)*	0.010 (0.055)	0.724 (0.107)**
WBW	0.526 (0.142)**	0.239 (0.156)	0.027 (0.002)**	0.189 (0.147)	0.209 (0.076)**	-2.045 (0.441)**	0.227 (0.063)**	0.219 (0.117)*	0.326 (0.122)**	-0.104 (0.052)**	0.151 (0.135)	0.036 (0.058)	1.163 (0.086)**
SW	0.538 (0.198)**	0.452 (0.207)**	0.026 (0.001)**	-0.197 (0.143)	-0.166 (0.090)*	0.386 (0.106)**	-1.163 (0.109)**	-0.076 (0.118)	-0.036 (0.126)	0.140 (0.078)*	0.133 (0.147)	-0.036 (0.071)	1.525 (0.112)**
CW	0.334 (0.290)	1.198 (0.285)**	0.032 (0.004)**	0.299 (0.289)	0.188 (0.125)	0.358 (0.191)*	-0.073 (0.113)	-2.977 (0.968)**	0.465 (0.231)**	0.037 (0.134)	0.194 (0.277)	-0.055 (0.151)	0.628 (0.086)**
DR	0.318 (0.090)**	0.343 (0.105)**	0.026 (0.001)**	0.170 (0.101)*	0.070 (0.044)	0.170 (0.064)**	-0.011 (0.039)	0.148 (0.074)**	-1.831 (0.223)**	0.031 (0.044)	0.466 (0.081)**	0.099 (0.044)**	0.665 (0.058)**
LR	0.331 (0.105)**	0.092 (0.133)	0.025 (0.001)**	0.102 (0.111)	0.239 (0.066)**	-0.133 (0.066)**	0.105 (0.059)*	0.029 (0.105)	0.076 (0.107)	-1.164 (0.102)**	0.399 (0.143)**	-0.100 (0.086)	0.951 (0.067)**
DS	0.459 (0.131)**	-0.150 (0.128)	0.026 (0.001)**	0.138 (0.114)	-0.104 (0.061)*	0.096 (0.086)	0.050 (0.055)	0.076 (0.108)	0.569 (0.098)**	0.199 (0.071)**	-1.519 (0.254)**	0.160 (0.080)**	0.938 (0.066)**
LS	0.415 (0.125)**	0.120 (0.187)	0.023 (0.001)**	0.195 (0.137)	0.013 (0.071)	0.052 (0.084)	-0.031 (0.060)	-0.048 (0.133)	0.272 (0.121)**	-0.113 (0.097)	0.362 (0.182)**	-1.260 (0.187)**	1.155 (0.073)**

PRB: Premium beer; FSB: Full Strength beer; LAB: Low alcohol beer; MSB: Mid strength beer; RBW: Red bottled wine; WBW: White bottled wine; SW: Sparkling wine; CW: Cask wine; DR: Dark RTD; LR: Light RTD; DS: Dark spirits; LS: Light spirits

Table 5: Morishma Elasticities of Substitution

		Elasticity of Quantity of:											Budget Share
With Respect to Price of:	PRB	FSB	LAB	MSB	RBW	WBW	SW	CW	DR	LR	DS	LS	
PRB		5.655	5.361	6.024	5.768	5.783	5.795	5.591	5.575	5.588	5.716	5.672	0.071
FSB	2.598		1.45	2.383	1.317	1.454	1.667	0.017	1.558	1.307	1.065	1.335	0.268
LAB	1.011	0.998		1.005	0.999	1.001	1	1.006	1	0.999	1	0.997	0.048
MSB	3.995	3.646	3.444		3.581	3.563	3.177	3.673	3.544	3.476	3.512	3.569	0.043
RBW	1.719	1.308	1.342	1.501		1.492	1.117	1.471	1.353	1.522	1.179	1.296	0.065
WBW	2.546	2.07	2.117	2.267	2.277		2.431	2.403	2.215	1.912	2.141	2.097	0.076
SW	1.464	1.236	1.204	1.027	1.054	1.39		1.09	.152	1.268	1.213	1.132	0.043
CW	3.171	3.177	3.029	3.192	3.105	3.196	2.901		3.125	3.006	3.053	2.929	0.043
DR	2.411	2.011	1.967	2.213	1.981	2.157	1.795	2.296		1.907	2.4	2.103	0.135
LR	1.41	1.184	1.216	1.258	1.372	1.06	1.304	1.201	1.195		1.363	1.051	0.049
DS	2.204	1.455	1.628	1.773	1.337	1.67	1.652	1.713	1.985	1.918		1.881	0.111
LS	1.534	1.283	1.303	1.419	1.27	1.296	1.224	1.205	1.359	1.16	1.42		0.05

PRB: Premium beer; FSB: Full Strength beer; LAB: Low alcohol beer; MSB: Mid strength beer; RBW: Red bottled wine; WBW: White bottled wine; SW: Sparkling wine; CW: Cask wine; DR: Dark RTD; LR: Light RTD; DS: Dark spirits; LS: Light spirits

Table 6: Effects of 10% Increase in Equivalent Ad Valorem Taxes of Wine on Quantities Consumed of 12 Different Alcoholic Beverages - Tax Revenue held Constant

Alcoholic Beverage	Tax as Proportion of Retail Price	Percent Change in Equivalent Ad Valorem Tax	Percentage Change in Quantity Demanded
PRB	0.3322	-2.85	4.4085
FSB	0.4252	-2.85	1.6788
LAB	0.2443	-2.85	0.4877
MSB	0.3636	-2.85	1.8026
RBW	0.2462	10	-3.1340
WBW	0.2462	10	-4.8412
SW	0.2462	10	-3.5172
CW	0.2047	10	-7.2700
DR	0.3442	0	-1.0278
LR	0.3534	0	-0.4897
DS	0.6108	-2.85	2.2107
LS	0.6108	-2.85	0.7923

Source: Tax shares from Zhao and Wittwer (2007)