



University of New England

**Graduate School of Agricultural and Resource Economics
&
School of Economics**

**Demand for Wine in Australia:
Systems versus Single Equation Approach**

by

Hui-Shung (Christie) Chang and Nicholas Bettington

No. 2001-5 – December 2001

Working Paper Series in

Agricultural and Resource Economics

ISSN 1442 1909

<http://www.une.edu.au/febl/EconStud/wps.htm>

Copyright © 2001 by Hui-Shung (Christie) Chang and Nicholas Bettington. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided this copyright notice appears on all such copies. ISBN 1 86389 7775

Demand for Wine in Australia: Systems versus Single Equation Approach

Hui-Shung (Christie) Chang and Nicholas Bettington**

Abstract

The objective of the study is to estimate demand for wine in Australia, based on both the systems approach and the single equation approach. Both approaches consider demand for three categories of alcoholic drinks (beer, wine and spirits) in a seemingly unrelated regression framework to take account of cross-equation correlations. Time series data on retail price indexes and apparent per capita consumption of alcoholic beverages for Australia for the period 1975/76 to 1998/99 are used for econometric estimation. The results show that over the short run, beer and wine are necessities; however, over the long run, wine becomes a luxury good. Beer and wine are complements. Demand for all three beverages is price inelastic. The study also found that the behaviour of wine consumers reflect past consumption patterns, indicating that wine is more addictive than either beer or spirits. A structural change in consumer preferences away from cheaper cask wines to more expensive bottled table wines has a significant impact on the volume of wine consumption. Finally, wine consumption has increased over time. The study re-confirms the importance of developing a model that considers the impacts of both economic and non-economic variables on wine consumption.

Key Words: wine demand, demand analysis, almost ideal demand system

**Hui-Shung (Christie) Chang is a Senior Lecturer in the School of Economics at the University of New England, and a Member of the Graduate School of Agricultural and Resource Economics at the University of New England. Nicholas Bebbington is a former Agricultural Economics student in the School of Economics at the University of New England.
Contact information: School of Economics, University of New England, Armidale, NSW 2351, Australia.
Email: hchang@metz.une.edu.au.

Demand for Wine in Australia: Systems versus Single Equation Approach

Introduction

The Australian wine industry has experienced rapid expansion over the last 10 to 15 years, due to increasing demand for wines in Australia and overseas. The Australian wine industry represents one of the few success stories of Australian agriculture. Increasing demand, coupled by technological advances and the industry's capacity to innovate, has seen plantings almost double and exports multiply 100-fold in the last 15 years. In fact, 15 years ago Australia's total exports were less than \$10 million per year compared to the present export earnings of almost \$20 million a week. ABARE (1999) predicts that the export earnings will rise even further, to \$1.5 billion in 2000/2001, and within five years to \$2.9 billion. This would put wine ahead of dairy products, sugar and cotton in terms of farm export, and not far behind wool, beef and wheat. It is predictions like these that give the wine industry an unstoppable optimism. A brief overview of the Australian wine industry is presented in Table 1.

Table 1: The Australian Wine Industry in brief

	1996/97	1997/98	1998/99
Wineries (number)	990	1104	1115
Area under vine (hectares) ¹	89 797	98 612	122 915
Wine grape production (tonnes) ²	797 992	975 669	1 100 644
Wine production (million litres) ³	567	680	793
Wine consumption (million litres) ⁴	347	364	371
Wine exports (million litres)	155	194	216
Wine imports (million litres)	14	26	24

Source: Jones, 2000.

Notes: 1. Vines yielding grapes for all purposes, 2. Preliminary ABS crush number, 3. Beverage wine, 4. Domestic and imported wine estimated for 1998/99.

However, the real test is about to come. Adelaide-based wine writer White (2000) has been covering the industry for more than 25 years. He is one of the few people who sound a note of extreme caution. In February 2000, the National Wine Growers Council reported that the ratio of stocks to sales in

Australia was well past its comfort zone and there is too much wine in stock and not enough being sold. One of the first signs of a glut is the fall in grape prices in the largest grape growing areas in Australia. In Riverina, the grape prices in some cases have fallen to half of what they were a year ago. The worst sign is that some contracts with wineries are not being renewed. This is a sure sign of a plentiful winegrape supply.

Although the domestic market has showed strong growth in the last ten years, and can be expected to continue to grow, it is unrealistic to expect it to take up all of the increased production because it is limited in size and does not have the same potential as the international market. The increase in grape supplies will mean that wineries and growers concentrating on the domestic market will come under greater pressure as wine supplies increase. Higher cost wineries and grape growers and those without strong brand loyalty and good distribution chains will be forced to reduce prices and margins in order to compete. The export market looks to be the future for the Australian wine industry. However, it is not clear how easily this can be done in a climate of global overproduction and intense international competition.

The preceding discussion demonstrates that there are worrying signs that there will be a massive increase in the supply of wine in the near future with uncertain demand. To counteract this projected increase in supply the factors influencing the demand for wine need to be known, both in Australia and overseas. The industry is experiencing changes in consumer preferences. There has been a large increase in the value of wine consumed per person because of an increased consumption of bottled table wine. Whereas demand for basic wine is in decline, consumption of quality wine continues to increase. Demand for white wine is also in decline, while red wine consumption is increasing. In addition, there is a shift in consumer preference toward red wine has resulted in a steep increase in the sales of Australian red wine (Sheperd, 1999). There are a number of reasons behind this shift. Perceived health benefits from moderate consumption, higher incomes and an increased knowledge of wines. Domestically, red table wine sales make up about 34 per cent of table wine sales, up from 24 per cent in 1992/93.

The overall objective of this paper is to estimate demand for wine in Australia. The specific objectives are (1) to estimate own-price, cross-price and expenditure elasticities for wine, beer and spirits, and (2) to determine whether there are any structural breaks in the demand for alcoholic beverages in Australia. Demand for three categories of alcoholic drinks (beer, wine and spirits) is estimated based on both the AIDS model and the single equation model using time series data from 1975/76 to 1998/99. The estimated demand equation can potentially be used to forecast demand for wine in Australia. Given that projected supply is readily available, the difference between the projected supply and projected domestic demand will provide an estimate for the amount of wine that needs to be disposed of in overseas markets and the marketing effort required to avoid a glut of Australian wine.

Empirical model

Several papers have been written in the area of applied demand analysis which analyse the demand for wine, beer and spirits. Many of these studies were based on a single-equation estimation of demand for aggregate or disaggregate alcoholic beverages, for example, Hogarty and Elzinga (1972), Johnson and Oksanen (1974, 1977), Labys (1976), McGuinness (1980 and 1983), Duffy (1983), Ornstein and Hanssens (1985), Ahtola et al. (1986), Adrian and Ferguson (1987), Godfrey (1988), Atkinson et al. (1990), Johnson et al. (1992), Lee and Tremblay (1992), and Blaylock and Blisard (1993). Another set of studies involves estimation of demand systems for alcoholic beverages. These include Clements and Johnson (1983), Thom (1984), Uri (1986), Clements and Selvanathan (1987, 1991), Duffy (1987), Penm (1988), Selvanathan (1988, 1989, 1991), Heien and Pompelli (1989), Jones (1989), Tegene (1990), Yen (1994), Nelson and Moran (1995), Blake and Nied (1997), and Andrikopoulos, Brox and Carvalho (1997). The majority of the studies reviewed applied the AIDS model to demand estimation (Heien and Pompelli, 1989; Blake and Nied, 1997; Jones, 1989; Andrikopoulos, Brox and Carvalho, 1997). Other models included the Rotterdam model by Clements and Johnson (1983) and CBS and NBR by Nelson and Moran (1995).

There is a huge variation between the estimates of the key elasticities across the different studies; both time-series and cross-section. The differing results reflect the differences in model specification, data types and estimation procedures. However, they provide guidance for the specification of the empirical

model used in this study. In particular, this study will consider both the systems approach and the single-equation approach, taking into consideration the possible effect of habits and taste change on alcoholic consumption. The reason for this is the advantages of the demand systems for their theoretical consistency over single demand equations and the flexibility afforded by single equations. Both estimations were carried out for comparison purposes.

The analysis presented here adds to a long line of empirical studies of alcohol consumption in various countries. It is of particular interest to compare and update the studies previously conducted in Australia by Clements and Johnson (1983), Clements and Selvanathan (1987) and Selvanathan (1991).

There are various systems of demand equations. Translog Model, Rotterdam, Linear Expenditure Systems, Armington and Almost Ideal Demand System (AIDS). The AIDS model was used in this study because of its many desirable properties relative to other models (Deaton and Muellbauer, 1980a). First, the functional form is general, allowing beverages to be either substitutes or complements. Second, the system is linear in the parameters and hence simple to estimate. Third, this model is the most satisfactory in terms of being able to test the restrictions of adding up, homogeneity and symmetry through linear restrictions on fixed parameters. Since Deaton and Muellbauer (1980) proposed the AIDS model, it has been widely applied in many empirical studies of consumer behaviour using both cross-sectional and time series data. Hence, part of the reason for the popularity of this demand system is due to the considerable contentment with which it can be estimated and used for testing the predictions of consumer demand theory (Chambers and Nowman, 1997).

- **The AIDS model**

This system of AIDS demand functions, in budget share form, is expressed as follows:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln (x/P), \quad (1)$$

where P is defined as:

$$\ln P = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2} \sum_j \sum_k \gamma_{kj} \ln p_k \ln p_j, \quad (2)$$

and w is the budget share, p is the price and x is total expenditure.

The theoretical restrictions on equation (1) are:

$$\text{Homogeneity restriction:} \quad \Sigma \gamma_{ij} = 0, \quad i = 1, 2, \dots, n; \quad (3)$$

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

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

Because equation (1) is non-linear in parameters, the Stone price index is commonly used to replace the price index P , resulting in the linearised version of the AIDS model (LA/AIDS). The Stone price index P^* is defined as:

$$\ln (P^*) = \Sigma w_k \ln p_k \quad (6)$$

According to Buse (1994) elasticities of the LA/AIDS model are calculated using the following formulae:

$$\text{Expenditure elasticities: } n_i = 1 + \beta_i / w_i; \quad (7)$$

$$\text{Own-price elasticities: } e_{ii} = \gamma_{ii} / w_i - (1 + \beta_i); \text{ and} \quad (8)$$

$$\text{Cross-price elasticities: } e_{ij} = \gamma_{ij} / w_i - \beta_i w_j / w_i. \quad (9)$$

Applying the LA/AIDS model to the demand for alcoholic beverages, we have

$$W_{\text{beer}} = \alpha_1 + \gamma_{11} \ln (P_{\text{beer}}) + \gamma_{12} \ln (P_{\text{wine}}) + \gamma_{13} \ln (P_{\text{spirits}}) + \beta_1 \ln (X/P^*) + e_1,$$

$$W_{\text{wine}} = \alpha_2 + \gamma_{21} \ln (P_{\text{beer}}) + \gamma_{22} \ln (P_{\text{wine}}) + \gamma_{23} \ln (P_{\text{spirits}}) + \beta_2 \ln (X/P^*) + e_2, \text{ and}$$

$$W_{\text{spirits}} = \alpha_3 + \gamma_{31} \ln (P_{\text{beer}}) + \gamma_{32} \ln (P_{\text{wine}}) + \gamma_{33} \ln (P_{\text{spirits}}) + \beta_3 \ln (X/P^*) + e_3, \quad (10)$$

where W_{beer} , W_{wine} , and W_{spirits} are the budget shares of beer, wine and spirits, respectively; P_{beer} , P_{wine} and P_{spirits} are their corresponding price indexes; X is the total expenditure on alcoholic beverages; and the error terms e_1 , e_2 and e_3 are assumed to be normally distributed with constant means and variances and may be contemporaneously correlated.

Because Clements and Johnson (1983), Selvanathan (1988), Jones (1989), and Andrikopoulos, Brox and Carvalho (1997) found that habit formation and taste change have affected alcoholic beverage consumption, they are also considered here. These effects can be incorporated into the basic LA/AIDS by including the lagged dependent variable, a time trend and dummy variables. After the addition of these variables, the final LA/AIDS model for alcoholic beverages in this particular study is defined as follows:

$$\begin{aligned}
 W_{\text{beer}} &= \alpha_1 + \gamma_{11} \ln(P_{\text{beer}}) + \gamma_{12} \ln(P_{\text{wine}}) + \gamma_{13} \ln(P_{\text{spirits}}) + \beta_1 \ln(X/P^*) + \gamma_{14} W_{\text{beer}(t-1)} + \gamma_{15} D_1 + \\
 &\gamma_{16} D_2 + \gamma_{17} \text{time} + e_1, \\
 W_{\text{wine}} &= \alpha_2 + \gamma_{21} \ln(P_{\text{beer}}) + \gamma_{22} \ln(P_{\text{wine}}) + \gamma_{23} \ln(P_{\text{spirits}}) + \beta_2 \ln(X/P^*) + \gamma_{24} W_{\text{wine}(t-1)} + \gamma_{25} D_1 + \\
 &\gamma_{26} D_2 + \gamma_{27} \text{time} + e_2, \text{ and} \\
 W_{\text{spirits}} &= \alpha_3 + \gamma_{31} \ln(P_{\text{beer}}) + \gamma_{32} \ln(P_{\text{wine}}) + \gamma_{33} \ln(P_{\text{spirits}}) + \beta_3 \ln(X/P^*) + \gamma_{34} W_{\text{spirits}(t-1)} + \gamma_{35} D_1 + \\
 &\gamma_{36} D_2 + \gamma_{37} \text{time} + e_3.
 \end{aligned} \tag{11}$$

where $W_{\text{beer}(t-1)}$, $W_{\text{wine}(t-1)}$ and $W_{\text{spirits}(t-1)}$ are the lagged budget shares, representing the impact of habit formation because of the addictive nature of alcoholic beverages. These lagged budget shares enable the study to show the tolerance effects of alcohol. Tolerance means that the body becomes less responsive to alcohol, so that a larger dose is required to gain an effect of the original magnitude. As such, we would expect the adjustment coefficients to be positive and lie between zero and one.

D_1 in equation (11) is a dummy variable representing the introduction of lower blood alcohol content for drink driving in the fiscal year 1979/80. In 1979/80, random breath testing became highly stringent and much more regular. The legal limit of blood alcohol reading was reduced from 0.08 percent to 0.05 percent. Therefore, $D_1 = 1$ for the years 1979/80-1998/99 and zero, otherwise. D_2 , represents the swing in the consumption preferences of consumers towards bottled table wine away from the cheaper

cask wines and consumer preferences towards red wine for health reasons, as well as a swing away from full strength beer towards low alcohol beer. Both these changes in consumer preferences began in the mid 1980's. The choice of 1988/89 as a turning point was chosen based on Chow tests, which clearly identified 1988/89 to be the year of structural break for both beer and wine. Therefore, $D_2 = 1$ for the period 1988/89-1998/99 and zero, otherwise. The time trend variable is used to capture other gradual changes in consumer preferences that have not yet specifically been accounted for, such as changing preferences toward wine and away from beer as the population ages and as the economy moves from manufacturing to service industries.

- **The Single Equation Model**

The alternative model used to estimate alcoholic beverage demand was the single equation model. The main difference is that the AIDS model employs budget share as the dependent variable, while the single equation model utilizes quantity consumed as the dependent variable. Moreover, the AIDS are constrained by the choice of functional form and restrictions implied by the theory while the single equation model is not.

In this particular study, the single equation model for the three alcoholic beverages, after the addition of lagged dependent variables, the dummy variables and a time trend is defined:

$$Q_{beer} = \beta_{11} + \beta_{12} \ln P_{beer} + \beta_{13} \ln P_{wine} + \beta_{14} \ln P_{spirits} + \beta_{15} \ln Y + \gamma_{11} Q_{beer(t-1)} + \gamma_{12} D_1 + \gamma_{13} D_2 + \gamma_{14} \text{time} + e_1,$$

$$Q_{wine} = \beta_{21} + \beta_{22} \ln P_{beer} + \beta_{23} \ln P_{wine} + \beta_{24} \ln P_{spirits} + \beta_{25} \ln Y + \gamma_{21} Q_{wine(t-1)} + \gamma_{22} D_1 + \gamma_{23} D_2 + \gamma_{24} \text{time} + e_2, \text{ and}$$

$$Q_{spirits} = \beta_{31} + \beta_{32} \ln P_{beer} + \beta_{33} \ln P_{wine} + \beta_{34} \ln P_{spirits} + \beta_{35} \ln Y + \gamma_{31} W_{spirits(t-1)} + \gamma_{32} D_1 + \gamma_{33} D_2 + \gamma_{34} \text{time} + e_3. \quad (12)$$

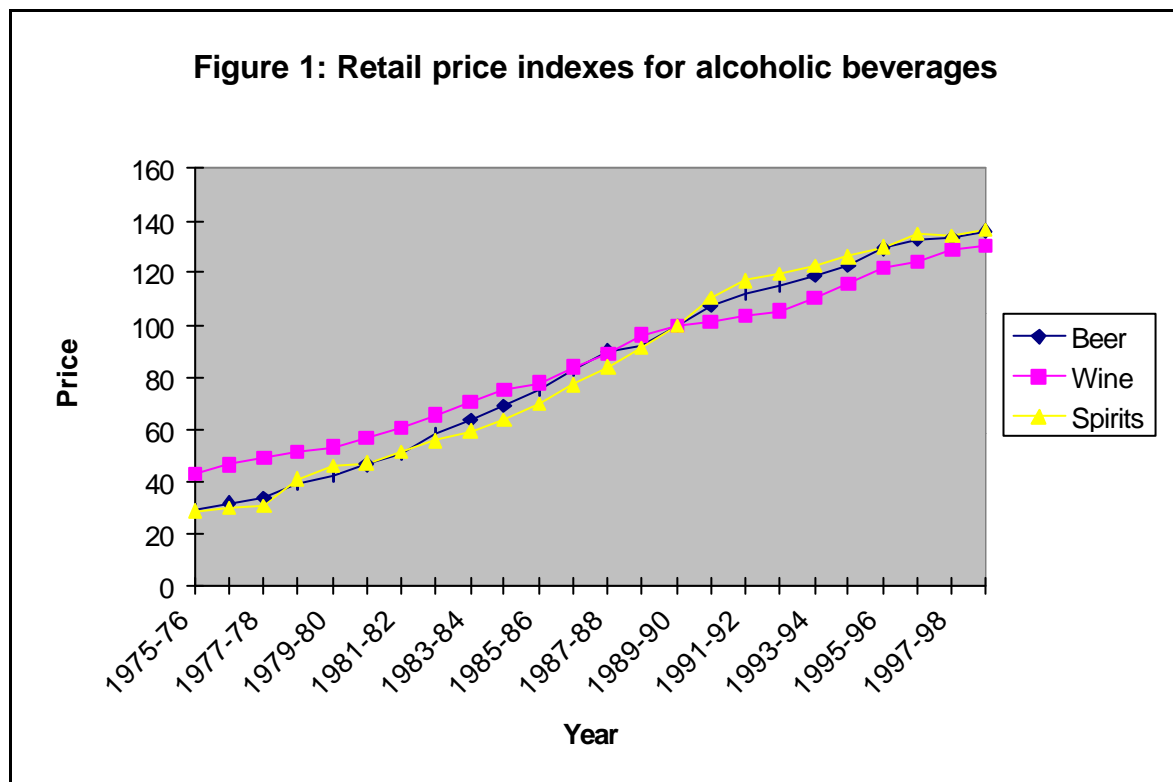
where the Q_{beer} , Q_{wine} and $Q_{spirits}$ are the quantities demanded of beer, wine and spirits, respectively. P_{beer} , P_{wine} and $P_{spirits}$ are corresponding retail price indices deflated by CPI. Y is income per capita, deflated by CPI. The β_k 's are the unknown parameters to be estimated. The error terms e_{1t} , e_{2t} and e_{3t}

are assumed to be normally distributed with constant means and variances and may be contemporaneously correlated. All other variables are as previously defined.

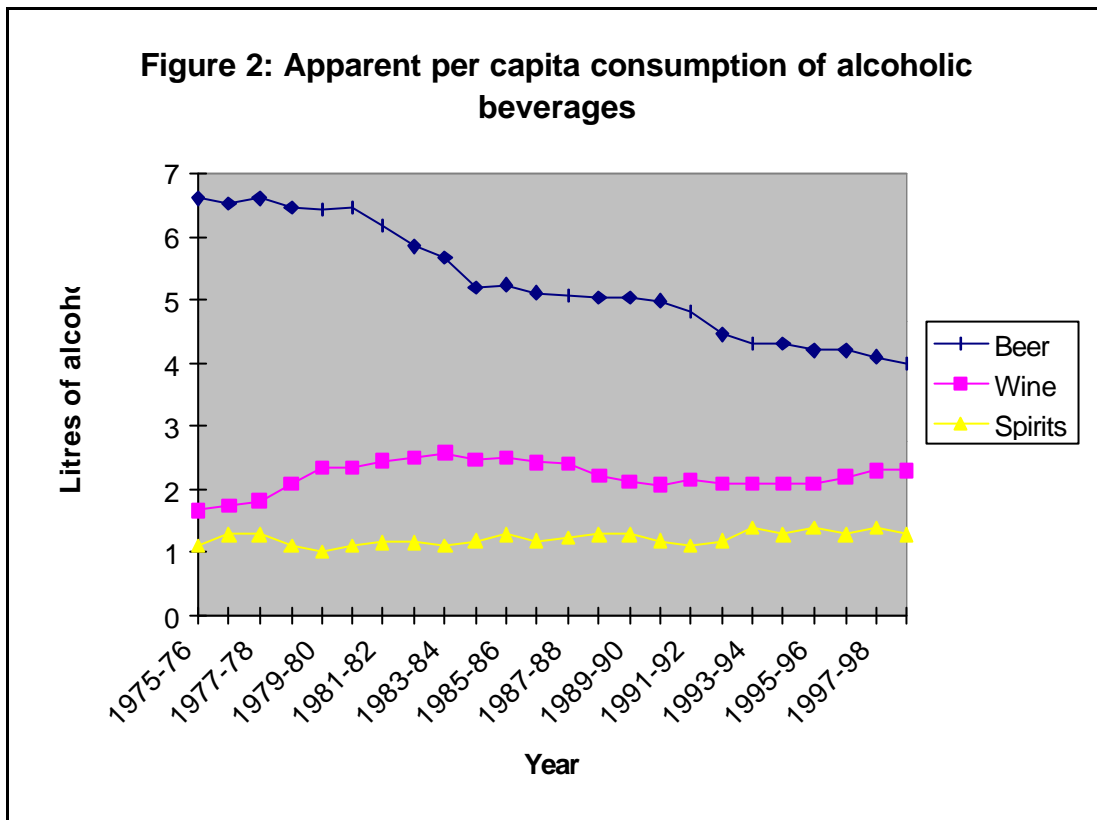
Because demand for alcoholic beverages is likely to be influenced by similar random events and the error terms in equations (11) and (12) are assumed to be contemporaneously correlated, both the LA/AIDS and the single equation models will be estimated using seemingly unrelated regression.

Data Requirements and Data Sources

For estimation the required data are the retail price indexes and per capita consumption of beer, wine and spirits within Australia. The study used annual data from 1975-76 through to 1998-99. Retail price indexes, per capita income and CPI were collected from Australian Commodity Statistics (ABARE, 1999). Apparent per capita consumption of alcohol was collected from the Australian Bureau of Statistics (ABS) publication, Apparent Consumption of Selected Foodstuffs, Australia. Prices and consumption of alcoholic beverages in Australia between 1975/76 and 1998/99 are presented in Figures 1 and 2.



Although the wine curve in Figure 1 above is slightly flatter than the curves for beer and spirits, the three alcoholic beverage retail price indexes tend to move together. This makes it difficult for the model to show the individual effects of a change in price leading to the multicollinearity problems common to empirical demand analysis. Interestingly enough, Deaton and Muellbauer (1980) use highly collinear prices to justify the use of the Stone price index in the LA/AIDS model.



As can be seen in Figure 2 above, the gap between beer and wine consumption has been gradually closing in the past two decades. Beer consumption has declined markedly from 6.59 litres of alcohol per capita (137.4 litres in volume) in 1975/76 down to 4 litres of alcohol per capita (92.8 litres in volume) in 1998/99.

Wine consumption has increased from 1.66 litres of alcohol per capita (13.0 litres in volume) in 1975/76 to 2.3 litres of alcohol (20.4 litres in volume) in 1998/99. The consumption of wine within Australia rose steadily up until the mid 1980's. Around this time, consumption of wine began to decline due to changing consumer preferences. There was a change in the consumption patterns of wine, away

from the cheaper cask wines towards the consumption of more expensive and better quality bottled wine. As a result, the quantity of wine consumed decreased, but the expenditure on wine actually increased. Volumes of wine consumption in Australia began to rise again in 1994/95 and have been increasing ever since. The spirits have shown a slight increase in the level of consumption over the whole sample period.

Estimated results

The modeling strategy was to estimate both the LA/AIDS model and the single equation model for the demand of the three main alcoholic beverages, wine, beer and spirits. These results are presented and compared in terms of their general statistical properties and their economic plausibility.

▪ The LA/AIDS model

In general the estimated results are quite reasonable in terms of goodness-of-fit and precision of the estimates. Estimated price coefficients are mostly statistically significant at the 5 percent level or better. However, estimated expenditure coefficients are all statistically insignificant at the 10 percent level. These results are contrary to other demand studies where expenditure coefficients can be more easily estimated than price coefficients (Deaton and Muellbauer 1980b). The estimated coefficients and their corresponding t-values for the sample period are displayed in Table 2. D1 represents increased random breathalysing and lowering of the blood alcohol content level for drink driving since 1979/80. The result indicates that random breath testing has very little effect on consumption of all three beverages. D2 represents changes in consumer preferences towards bottled table wine and red wine, as well as a swing away from full strength beer towards lower alcohol beer. The t-ratios for this variable were highly statistically significant for beer (3.94) and wine (-4.08), there is a change in consumption patterns of beer and wine in Australia. There appears to have no significant changes over time in alcoholic consumption, other than those identified by D1 and D2, since coefficients associated with the trend variable are statistically insignificant for all three beverages. Coefficients associated with the lagged dependent variable indicate that habit formation has a significant and positive effect on wine consumption but not on beer or spirits.

Table 2: Estimated coefficients for the LA/AIDS model

	BEER	WINE	SPIRITS
Constant	0.83 (1.55) ^a	-0.09 (-0.24)	-- ^b
W _{t-1}	0.17 (0.94)	0.42 (2.62)	--
LNP _{beer}	0.29 (5.07)	-0.19 (-4.66)	-0.10 ^c
LNP _{wine}	-0.30 (-3.63)	0.15 (2.28)	0.15
LNP _{spirits}	-0.10 (-1.66)	0.10 (2.35)	0
TEXP	0.09 (0.51)	-0.01 (-0.07)	-0.08
D1	-0.02 (-1.26)	0.01 (0.91)	0.01
D2	0.04 (3.94)	-0.04 (-4.08)	0
TIME	-0.002 (-0.34)	0.0002 (0.07)	0.0002
R-Square	0.95	0.90	-

^a Figures in parentheses are t-ratios. ^b These figures are not calculated because of identification problem.

^c The t-ratios are not reported because the coefficients are derived from the adding-up conditions.

Because elasticities for LA/AIDS model are calculated based on non-linear functions of variables and parameters, it is sometimes the case that the elasticity estimates are consistent with expectation although the associated price coefficients are not. Therefore, the price and income effects on alcohol consumption will be examined based on elasticity formulae provided in equations (7) to (9). Estimated short-run and long-run demand elasticity values for the LA/AIDS model are presented in Tables 3 and 4, respectively.

The results show that beer, wine and spirits are all price inelastic in both the short run. In the short run, the own-price elasticities for beer, wine and spirits are -0.60, -0.43 and -0.91, respectively. However, alcohol consumers do not respond to changes in the price of wine as much as they do to changes in the price of beer and spirits, indicating that demand for wine is less price sensitive than that of demand for beer and spirits, given the same fluctuation in alcohol prices over the short run. Over the long run the

own-price elasticities for beer and wine are -0.72 and -0.74, respectively, implying that over the long run demand for beer and wine are not sensitive to price changes, as the case in the short run.

The results also show that wine and spirits are substitutes for each other. This is reflected in their positive cross-price elasticities. In both the short run and long run, spirits is a stronger substitute for wine than the other way around. In the short run, the cross-price elasticity of spirits with respect to wine is 1.20. That means that a one percent increase in the price of wine will increase the quantity of spirits demanded by 1.20 percent. In contrast, a one percent increase in the price of spirits will increase the quantity of wine demanded by 0.37 percent. Beer and wine were found to be complements. The estimated expenditure elasticities indicate that beer is a luxury both in the short run and the long run. However, wine and spirits are necessities in the short run but luxuries in the long run.

Table 3: Estimated short-run elasticities for the LA/AIDS model

	PRICE ELASTICITIES			EXPENDITURE ELASTICITIES
	Beer	Wine	Spirits	
BEER	-0.60*	-0.55*	-0.19	1.15
WINE	-0.68*	-0.43*	0.37*	0.96
SPIRITS	-0.35	1.20	-0.91	0.44

* indicates that the price or total expenditure coefficients associated with the estimated elasticities are statistically significant at the 5% level.

Table 4: Estimated long-run elasticities for the LA/AIDS model

	PRICE ELASTICITIES			EXPENDITURE ELASTICITIES
	Beer	Wine	Spirits	
BEER	-0.72*	-0.66*	-0.23	1.38
WINE	-1.17*	-0.74*	0.64*	1.65
SPIRITS	-- ^a	--	--	--

^a Long-run elasticities for spirits are not calculated because the adjustment coefficient cannot be recovered from the adding-up restrictions.

* indicates that the price or total expenditure coefficients associated with the estimated elasticities are statistically significant at the 5% level.

▪ **The Single Equation Model**

The estimated coefficients for the single equation model are displayed in Table 5. Firstly, the lagged dependent variable, which was included in the model to capture the tolerance effects of alcohol, indicates that habit formation has a significant impact on wine consumption. This is, however, not true for beer and spirits. This means that the tolerance effect of alcohol is much lower for wine than beer or spirits and as such may be more addictive. Secondly, the results show that random breath testing has little effect on beer, wine, or spirits consumption. Structural change has a significant negative effect on wine consumption, but has little effect on beer or spirits consumption. Finally, the results show that there is an upward trend in wine consumption but not in spirits consumption.

Table 5: Estimated coefficients for the single equation model

REGRESSORS	BEER	WINE	SPIRITS
Constant	5.22 (4.60) ^a	0.38 (1.48)	0.92 (3.37)
Q _{t-1}	0.08 (0.45)	0.76 (7.24)	0.03 (0.16)
LnP _{beer}	-0.67 (-1.48)	-0.33 (-1.36)	-0.12 (-0.43)
LnP _{wine}	-5.96 (-3.38)	-1.87 (-2.21)	1.29 (1.28)
LnP _{spirits}	-0.44 (-0.67)	0.59 (1.71)	-1.07 (-2.59)
LnY	2.78 (3.85)	0.75 (2.33)	-0.30 (-0.80)
D1	-0.23 (-1.53)	-0.14 (-1.44)	0.04 (0.37)
D2	0.18 (1.72)	-0.25 (-3.70)	0.07 (1.10)
TIME	-0.04 (-1.39)	0.03 (2.35)	0.01 (0.96)
R-Square	0.99	0.96	0.76

^a Figures in parentheses are t-ratios.

Estimated short-run and long-run price and income elasticities are presented in Tables 6 and 7. The estimated short-run own-price elasticities for beer, wine and spirits are -0.13, -0.84 and -0.88, respectively (Table 6). This means that demand for beer, wine and spirits are own-price inelastic in the short run. The own-price elasticity of beer, however, is statistically insignificant. These results imply that consumers are not overly concerned about the price of alcohol in the short term. However, over the long run, consumers may be very responsive to changes in the price; the long-run own-price elasticity of -3.50 for wine indicates just that (Table 7), that is, a one percent increase in the price of wine will decrease wine consumption by 3.5 percent in the long run.

Table 6: Estimated short-run elasticities for the single equation model

	PRICE ELASTICITIES			INCOME ELASTICITIES
	Beer	Wine	Spirits	Income
BEER	-0.13	-1.14*	-0.08	0.53*
WINE	-0.15	-0.84*	0.26	0.34*
SPIRITS	-0.10	1.06	-0.88*	-0.25

* indicates that the price or total expenditure coefficients associated with the estimated elasticities are statistically significant at the 5% level.

Table 7: Estimated long-run elasticities for the single equation model

	PRICE ELASTICITIES			INCOME ELASTICITIES
	Beer	Wine	Spirits	Income
BEER	-0.14	-1.24*	-0.09	0.58*
WINE	-0.63	-3.50*	1.08	1.42*
SPIRITS	-0.10	1.09	-0.91*	-0.26

* indicates that the price or total expenditure coefficients associated with the estimated elasticities are statistically significant at the 5% level.

The results from the single equation model indicate that wine and spirits are substitutes while beer and wine are complements. However, it must be realised that the relationships spirits has with beer and wine are statistically insignificant. Further, the short-run income elasticities for beer, wine and spirits were estimated to be 0.53, 0.34 and -0.25, respectively. The income elasticity for spirits is however statistically insignificant. These results indicate that beer and wine are considered necessary goods and the consumption of either is not affected significantly by income changes, at least in the short run. That is, if consumers income increases by one percent, beer consumption will rise by 0.53 percent and wine consumption will rise by 0.34 percent. However, in the long run wine, with an income elasticity of 1.42,

is considered a luxury good and a one percent increase in consumer income will see wine consumption increase by 1.42 percent.

▪ **Comparison of results**

In general, the results from both models are quite similar and are summarised below. Firstly, in the short run, demand for the three alcoholic beverages is own-price inelastic; wine and spirits are substitutes but wine and beer are complements. Further, wine is a necessary good in the short run, but a luxury good in the long run. Secondly, the effect of habit formation is strong on wine consumption. This means that not only is the tolerance effect lower for wine than for beer or spirits, but the responses to price and income changes are much greater in the long run than in the short run. Thirdly, the drink driving campaign through random breathalysing and lower legal blood alcohol limit has very little effect on alcoholic consumption. Fourthly, there seems a structural change which increases beer consumption but lowers wine consumption. Finally, there seems to be an upward trend in wine and spirits consumption while a downward trend for beer. One significant difference between the two models is that total expenditure has no effect at all on alcoholic beverages in the LA/AIDS model while income is quite significant in affecting demand for beer and wine in the single equation model. Further, estimated price coefficients are mostly statistically significant at the 5 percent level or better in the LA/AIDS model but most of them are statistically insignificant at the 10 percent level in the single equation model. This suggests that further research is necessary to explain the differences particularly when most demand studies reported that expenditure coefficients are much more easily to estimate than price coefficients, for discussion see Deaton and Muellbauer (1980b).

The results obtained here also share some commonality with previous analysis. For example, we found that demand for the three alcoholic beverages is price inelastic. This agrees with the findings of Selvanathan (1988), Heien and Pompelli (1989), Jones (1989) and Selvanathan (1991). Our finding that beer and wine are necessities in the short run was also found by Clements and Johnson (1983) while the finding that wine is a luxury in the long run is consistent with the results by Selvanathan (1988) and Jones (1989). In this study, we found that wine and spirits are substitutes while wine and beer are complements. However, Clements and Johnson (1983) and Selvanathan (1988) found all three beverages (beer, wine and spirits) to be substitutes and Heien and Pompelli (1989) found all three to be

complements. Our results also support the findings of Jones (1989) and Andrikopoulos, Brox and Carvalho (1997) that the behaviour of wine consumers certainly reflect past consumption patterns.

That wine consumption has increased over time means that opportunities exist for wineries to expand the domestic market. The upward trend is possibly due to a number of factors. They include: the presumed health benefits of moderate red wine consumption; Australian society is becoming increasingly health conscious; changing social attitudes and consumer preferences away from beer; the growing trend of wine tourism; the ageing population who tend to prefer wine over beer; and finally improved advertising and marketing by the wine industry as a whole.

Conclusions

Over the past decade there has been a huge increase in volume of wine grapes being produced within Australia in response to high prices. However, increases in the supply of winegrapes will predictably lead to lower prices if demand is not kept up. Knowing if and when prices will fall depends on the consumer demand for wine, as well as other beverages. With increased competition from non-alcoholic beverages, spurred on by the growing awareness of the dangers of alcohol abuse, competition between beverages can be expected to intensify. The purpose of this paper has been to estimate the demand for alcoholic beverages (beer, wine and spirits) based on a systems approach (the LA/AIDS) and a single equation approach. The paper analysed the consumption of wine, beer and spirits in an attempt to understand the factors influencing demand for wine within Australia. The demand model has the potential to be used to forecast the growth of wine consumption.

The main findings are:

- That the income elasticity for wine is elastic in the long run implies that as income is increased, wine consumption will also increase. Generation of wealth within Australian society, therefore, will benefit the wine producers.
- That demand for the three alcoholic beverages is price inelastic suggests that policies that attempt to deter alcohol consumption by, for example, increases in wine consumption taxes may not be effective. This is so because consumers are not very sensitive to changes in price.

- That the behaviour of wine consumers reflect past consumption patterns suggests that wine is more addictive than beer or spirits.

References

- ABARE (Australian Bureau of Agricultural and Resource Economics) 1999, *Australian Commodity Statistics* 1999.
- ABS (Australian Bureau of Statistics) 1999, *Apparent Consumption of Foodstuffs and Nutrients*. Catalogue No. 4306.
- ABS (Australian Bureau of Statistics) 1999, *Australian Wine and Grape Industry*. Catalogue No. 1329.0
- Adrian, M., Fergusson, B. 1987, 'Demand for Domestic and Imported Alcohol in Canada', *Applied Economics*, v19, pp. 531-540.
- Alston, J., Carter, C., Green, R., Pick, D. 1990, 'Whither Armington Trade Models?' *American Journal of Agricultural Economics*, v 70 n2, pp. 456-467.
- Anderson, K., Berger, N., Spahni, P. 1999, *Bilateral Trade Patterns in the World Wine Market, 1988 to 1997*.
- Anderson, K., Berger, N., Stringer, R. 1998, *Trends in the World Wine Market, 1961 to 1996*.
- Anderson, K., Osmond, R. 2000, *Trends and Cycles in the Australian Wine Industry, 1850 to 2000*.
- Andrikopoulos, A., Brox, J., Carvalho, E. 1997, 'The Demand for Domestic and Imported Alcoholic Beverages in Ontario, Canada: a Dynamic Simultaneous Equation Approach', *Applied Economics*, v29 n7, pp. 945-954.
- Attfield, C. 1985, 'Homogeneity and Endogeneity in Systems of Demand Equations', *The Journal of Econometrics*, v27, pp. 197-210.
- Austin, P. 2000, *The Land*, 9th March 2000. 'Sobering Outlook for Wine', p. 13.
- Australian Wine and Brandy Corporation 1998, *Annual Report 1997-98*.
- Australian Wine and Brandy Corporation 1999, *Annual Report 1998-99*.
- Bayles, F. 2000, *The Land*, 23rd March 2000. 'Washout for 2000 Vintage', p. 3.
- Blake, D., Nied, A. 1997, 'The Demand for Alcohol in the United Kingdom', *Applied Economics*, v29 n12, pp. 1655-1673.
- Buse, A. 1998, 'Evaluating the Linearised Almost Ideal Demand System', *American Journal of Agricultural Economics* v80 n1, pp. 208-217.

- Chalfant, J., Lariviere, E., Larue, B. 2000, 'Modeling the Demand for Alcoholic Beverages and Advertising Specifications', *Agricultural Economics*, v22, pp.147-162.
- Chaloupka, F. 1993, 'Effects of Price on Alcohol-related Problems', *Alcohol Health and Research World*, v17 n1, pp. 46-54.
- Chambers, M., Nowman, K. 1997, 'Forecasting with the Almost Ideal Demand System: evidence from some alternative dynamic specifications', *Applied Economics* v29 n7, pp. 935-947.
- Clements, K., Johnson, L. 1983, 'The Demand for Beer, Wine, and Spirits: a systemwide analysis', *Journal of Business*, v56 n3, pp. 273-306.
- Clements, K., Selvanathan, E., Selvanathan, S. 1996, 'Applied Demand Analysis: a Survey', *Economic Record*, v72 n216, pp. 63-82.
- Clingeffer, P. 2000, 'New Grape Varieties', <http://www.abc.net.au/rural/news/stories/s98945.htm>
- Committee of Inquiry into the Wine Grape and Wine Industry 1995, *Wine Grape and Wine Industry in Australia*.
- Coombe, D. 1999, 'Southcorp Most Successful Global Wine Company', <http://www.abc.net.au/rural/news/stories/s70589.htm>
- Deaton, A., Muellbauer, J. 1980a, 'An Almost Ideal Demand System', *The American Economic Review*, v70 n3, pp. 312-325.
- Deaton, A., Muellbauer, J. 1980b, *Economics and Consumer Behaviour*, Vail Ballou Press, New York, pp. 64-163.
- Delforce, J. 1989, 'Using the Almost Ideal Demand System to Model Household Expenditure', South Pacific Smallholder Project, University of New England.
- Elsley, K. 2000, *The Land*, 2nd March 2000. 'Push for Quality. Vineyards Facing Cuts in Prices', p. 34.
- Forde, K., Terry, C. 1992, *Microeconomics: an Introduction for Australian Students*, Prentice Hall, Sydney, pp. 71-134
- Griffiths, W., Hill, C. and Judge, G. 1997, *Undergraduate Econometrics*, John Wiley & Sons Inc., New York, pp.129-256.
- Hahn, W. 1994, 'Elasticities in the AIDS Model: Comment', *American Journal of Agricultural Economics*, v76, pp. 972-977.

- Heien, D., Pompelli, G. 1989, 'The Demand for Alcoholic Beverages: Economic and Demographic Effects' *Southern Economic Journal*, v55 n3, pp. 759- 771.
- Henschke, I. 2000, *Landline*, ABC Television.
- Jones, A. 1989, 'A Systems Approach to the Demand for Alcohol and Tobacco', *Bulletin of Economic Research*, v41 n2, 85-101.
- Jones, J. 2000, *Australian Farm Journal*, March 2000. 'Wine at the Crossroads', pp.8-18.
- Koop, G. 2000, *Analysis of Economic Data*, John Wiley & Sons, Ltd, Chichester, England.
- Kyte-Powell, R. 2000, *The Sun Herald*, 19th March 2000. 'Up the Creek, by 26pc', p.15
- Labys, W. 1976, 'An International Comparison of Price and Income Elasticities for Wine Consumption', *Australian Journal of Agricultural Economics*, v20 n1, pp. 33-36.
- Lando, S. 1999, 'Government Agrees to Tax Rebate for Small Wineries',
<http://www.abc.net.au/rural/news/stories.s48687.htm>
- Moran, J., Nelson, J. 1995, 'Advertising and United States Alcohol Beverage Demand: systemwide estimates', *Applied Economics*, v27 n12, pp1225- 1237.
- Oczkowski, E. 1994, 'A Hedonic Price Function for Australian Premium Table Wine', *Australian Journal of Agricultural Economics*, v 38 n1, pp. 93-110.
- Robinson, K., Tomek, W. 1995, *Agricultural Product Prices*, Cornell University Press, Ithaca, New York, pp. 7-54.
- Selvanathan E. 1988, 'Alcohol Consumption in the United Kingdom, 1955-85: a Systemwide Analysis', *Applied Economics*, v20 n8, pp.1071-1086.
- Selvanathan, E. 1991, 'Cross-country Alcohol Consumption Comparison: an Application of the Rotterdam Demand System', *Applied Economics*, v23 n10, pp. 1613-1623.
- Sheperd, A. 1998, 'Wine Grapes - Projections of Wine Grape Production and Winery Intake 2000-01', ABARE Research Report 98.9.
- Sutton, I. 1999, 'Major Initiative to Address Alcohol Abuse',
<http://www.abc.net.au/rural/news/stories/s72784.htm>
- Taylor, G. 1999, 'The Australian Wine Industry: is the Glass Half Full or Half Empty?' Global Strategy Centre, Monash Mt Eliza Business School.
- Thompson, S. 2000, <http://www.abc.net.au/rural/news/stories/s115484.htm>

White, K. 1993, *Shazam: the Econometrics Computer Program*, McGraw- Hill Book Company, Vancouver, Canada.

Yen, S. 1994, 'Cross-section Estimation of United States Demand for Alcoholic Beverages', *Applied Economics*, v26 n4, pp.381-393.