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Oversupply has posed a number of problems for the Australian wine industry in recent times. When disaggregated from the industry level, however, the problem can be better described as a range of attribute-specific disequilibria. To date, solutions to this problem have predominantly revolved around reducing output through crop thinning or vine pulling. This paper proposes a different approach by suggesting that disequilibria may be reduced by gaining a better understanding of the demand for Australian wine. A discrete choice model of product differentiation is used to estimate the demand for wine in the United States, Australia's second largest export market. Implications of the analysis are explored.

Key words: oversupply, demand for wine, product differentiation, nested logit.

1. Introduction

Oversupply has emerged as a central problem facing the Australian wine industry in recent times. Increases in area under vine and a number of record grape yields have caused grape and wine output to exceed levels required to satisfy domestic and export markets. This has had a significant negative impact on wine producers and the industry as a whole. Some of Australia's largest wine companies have reported considerable financial losses, which have been largely attributed to oversupply (Freed 2005). However, very little research has been conducted on how Australian producers can best address the problem. This study attempts to bridge the gap.

Industry analysts use the stock-to-sales ratio to gauge the size and nature of supply-demand imbalances in the market. McGrath-Kerr (2003) defines the ratio's "comfort zone", or equilibrium range, to be between 1.5 and 1.75. As can be seen in Figure 1, the industry, at an aggregate level, is currently in a state of oversupply.

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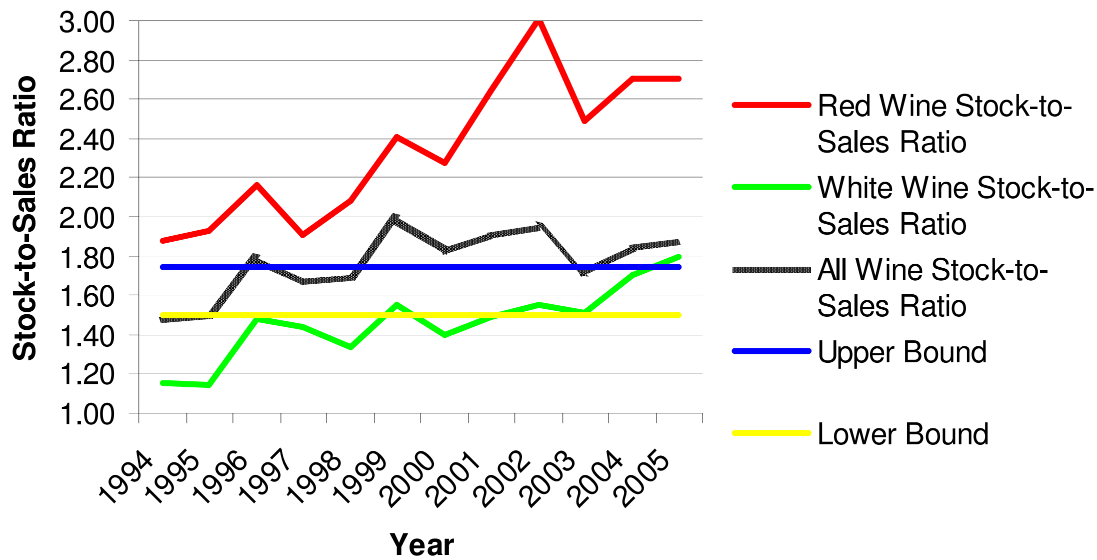

Figure 1 Stock-to-Sales Ratio, 1994-2005

Source: McGrath-Kerr (2003; 2005), ABS (1998; 2005)

Wine is a highly differentiated product. There arguably exist no two wines in any one market that are identical. Therefore, it is probable that when the aggregate problem of oversupply is broken down to a more attribute-specific level, the complexity of the problem will increase considerably. Figure 1 supports this observation, with red and white wine exhibiting different natures of disequilibrium. Over the past 10 years white wine has often experienced excess demand, while red wine has been clearly in oversupply. Davis (2005) found that when the industry was disaggregated further, the level and nature of disequilibrium became increasingly diverse.

Many reasons appear to be responsible for the recent trend toward industry-wide oversupply. The most significant of these include Federal Government taxation incentives available to new grape growers, lucrative supply contracts targeting prospective growers and a mismatching of research and development to the issues that are most important to the industry's health.

It is argued that solving this oversupply problem may be best achieved through a better understanding the demand for Australian wine. In contrast to this approach, supply-side policies, including crop thinning and reduction in grape vine area are inherently contractionary in nature. However, better matching Australia's production regime to consumer preferences using demand analysis may lead to the reduction of disequilibrium, while simultaneously promoting industry growth. Given wine's highly heterogeneous nature, a model of product differentiation has been chosen to analyse consumer preferences in one of Australia's largest export markets, the United States.

Section 2 will provide an overview of the literature. The theoretical model is detailed in Section 3, with the corresponding empirical model being outlined in Section 4. Results are presented in Section 5, followed by policy implications and concluding comments in Sections 6 and 7.

2. Previous studies

The vast majority of the empirical wine demand literature has employed hedonic pricing methods. One reason for this is likely to be the less stringent data requirements and the method's focus on product attributes rather then the final good. Another method that has been employed to study wine demand is the Almost Ideal Demand System (AIDS). No previous application of product differentiation theory appears to have been made to wine markets.

Hedonic price analysis involves the regression of price on product attributes, in order to estimate implicit attribute-level prices. The theory underlying the method is derived from Lancaster (1971)'s "new approach" to demand theory, and was later formalised as the hedonic method by Rosen (1974). Schamel and Anderson's (2003) estimation of a hedonic price function provides a good example of the method's application to wine. The model provides price premiums and discounts for the major attributes that are known to the consumer at the time of purchase, including variety, region and vintage. Other literature adopting a similar modelling specification include Oczkowski (1994), Combris *et al.* (1997), Schamel (2000), Oczkowski (2001), Steiner (2004) and Noev (2005).

Unwin (1999) provides a comprehensive critique of hedonic pricing applications to wine. One of the most significant limitations of the hedonic approach is its inability to be used as a demand model. Hedonic models estimate equilibrium implicit prices for product attributes, which are inherently determined jointly by supply and demand factors.

Coefficients cannot, therefore, be interpreted solely as indicators of consumer preferences. Applications of the Almost Ideal Demand System (AIDS) to wine include such analyses as Moosa and Baxter (2002), Eakins and Gallagher (2003) and Seale *et al.* (2003). Seale *et al.* (2003) attempted to explain the disproportionate growth of imported red wine sales in the US market, relative to the domestically produced product. Unlike hedonic price analysis, however, these analyses were not conducted at an attribute level.

Other demand models used to study wine have predominantly included simple linear demand equation estimation, nearly all of which have been conducted at an "overall product" level. For example, Owen (1979) used a log-linear consumption function to estimate the demand for wine in Australia between 1955 and 1977. The results showed that Australia's income elasticity of demand for wine was much greater than many Old World wine producing countries (including France, Italy, Portugal, Spain, and West Germany), most likely reflecting wine's emerging nature in Australia at the time. Other analyses of wine demand, including Clements and Johnson (1983), Tegene (1990) and Selvanathan and Selvanathan (2004), provided similar results, with varying research objectives. The results obtained from these analyses provide some interesting insight into the way in which the consumer base as a whole approaches the product. However, like the AIDS studies, the applicability of the results to industry disequilibrium problems is hampered by both their "aggregate" product-level nature, and restrictive market structure assumptions.

Discrete choice analysis provides a popular means of studying product differentiation. Pompelli and Heien (1991) use a discrete choice model in their analysis of white wine demand in the United States. The analysis was an application of Heckman's (1976) two-step method. Despite the model having a discrete choice element, the demand modelling component (the second stage) is a simple product level analysis similar to those discussed above. Therefore, it does not capture product differentiation due to its aggregated nature.

Overall, many of the models used in the previous literature, such as hedonic price analysis and the AIDS model, appear inadequate in analysing consumer preferences for a heterogeneous good such as wine. James and Alston (2002) make this point by noting that the majority of economic policy analysis is conducted using models of homogenous products, and that policy effects estimated using such models are likely to be significantly different from those derived from product differentiation models. However, it appears that the empirical literature has virtually ignored this important observation. Therefore, in order for plausible policy recommendations to be derived, it is desirable that future studies of the demand for Australian wine be based on the theory of product differentiation.

3. Demand under product differentiation

The theoretical framework is based on Berry's (1994) nested logit discrete choice model. This model is identical in effect to the traditional nested logit, but differs in estimation method used. In general terms, the use of market share data, which is more aggregated than the individual data required for the traditional estimation, allows for the model's functional form to be linear.

A nesting structure is constructed to reflect the grouping of like product attributes. The nesting structure used for one of the models in this paper is shown in Figure 2.

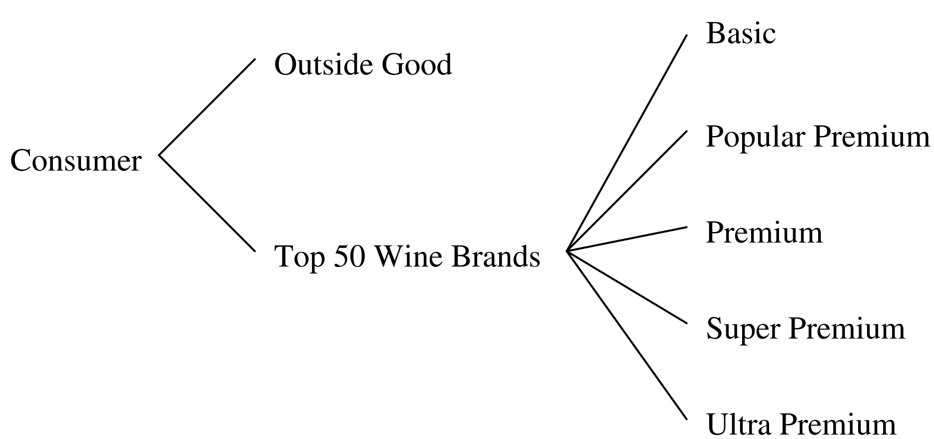

Figure 2 Nested logit structure for the US wine market

An efficient grouping exists where the correlation of preferences is high within nests but low between nests. The econometric rationale for this grouping relates to the independence from irrelevant alternatives (IIA) assumption, which must hold in the basic multinomial logit model. The IIA assumption states that any alternative not included in the choice set is considered to have no impact on the consumer decision. The nested logit model allows this restrictive assumption to be relaxed within nests but requires it to hold among them. Therefore, the restriction can effectively be "assumed away" if the tree structure is efficient. The choice between an outside good and inside good makes up the first tier of the tree structure. Given that the consumer chooses the inside good, a choice is made between attribute "groups", which constitute the second tier of the tree structure.

Following the model outlined in detail by Deng (2003), consumer i at time t chooses among $J+1$ alternatives, where J = the number of specific wines in the market. In the case of the tree structure in Figure 2, the product groupings are quality segments. Let the respective groups be denoted as g = 1,…,5. The set of wines in group g is denoted M_g. $g \in G$, where $G = \{0,1,…,5)$. The outside good, $j = 0$, is the only component of group 0. The utility for alternative $j \in M_g$ obtained by consumer i is

(1) $$u_{ij} = x_j\beta - \alpha p_j + \xi_j + \gamma_{ig}(\sigma_g) + (1-\sigma_g)\varepsilon_{ij}$$

where x_j, ξ_j and p_j are observed product attributes, unobserved product attributes, and price, respectively. β and α are demand parameters, that will be estimated by the model. ε_{ij} is assumed to be the identically and independently distributed extreme value error term over each of the product variants, J, and γ_{ig} follows a unique distribution such that $\gamma_{ig}(\sigma_g) + (1-\sigma_g)\varepsilon_{ij}$ is an extreme value random variable conditional on ε_{ij} also being an extreme value random variable (Deng 2003, p.6; Cardell 1997). σ_g is a correlation coefficient of consumer tastes within group g. Therefore, this coefficient explains consumer heterogeneity within a specified group of products. As σ_g approaches unity, consumers tend toward homogeneity. A value closer to zero indicates that consumers are highly diverse in their tastes within the corresponding group.

Equation 1 can be written as

(2) $$u_{ij} = \delta_j + \gamma_{ig}(\sigma_g) + (1-\sigma_g)\varepsilon_{ij}$$

where δ_j is the mean utility level of variant j, and is equal to $x_j\beta - \alpha p_j + \xi_j$.

Following Berry (1994), the logit model, when estimated with market share data, can be expressed as

(3) $$s_j(\delta) = \frac{e^{\delta_j}}{\sum_{k=0}^{N} e^{\delta_k}},$$

with the mean utility of the outside good normalised to zero, the model can be simplified as

(4) $$\ln(s_j) - \ln(s_0) = \delta_j \equiv x_j\beta - \alpha p_j + \xi_j$$

Casting the above logit model into a nested form allows the estimation of correlation terms for products that lie within the groups defined in the nested structure of the model. In the estimated function (Equation 11), this is the coefficient on the $s_{j/g}$ variable defined as

(5) $$s_{j/g}(\delta, \sigma_g) = \frac{e^{\delta_j/(1-\sigma_g)}}{D_g},$$

where $D_g = \sum_{j \in M_g} e^{\delta_j/(1-\sigma_g)}$.

The term D_g is known as the "inclusive value" as it captures the utility of all products within group g (Deng 2003). The market share of group g can then be written as

(6) $$s_g(\delta, \sigma_g) = \frac{D_g^{(1-\sigma_g)}}{\sum_g D_g^{(1-\sigma_g)}}.$$

Multiplying the within group share, $s_{j/g}$, and the group share, s_g, yields the market share of product j:

(7) $$s_j(\delta, \sigma_g) = s_{j/g}(\delta, \sigma_g) * s_g(\delta, \sigma_g) = \frac{e^{\delta_j/(1-\sigma_g)}}{D_g^{\sigma}\left[\sum_g D_g^{(1-\sigma_g)}\right]}.$$

Berry (1994) identifies the outside good as the only product in group *0*, with $\delta_0 \equiv 0$ and $D_0 = 1$ such that

$$s_0(\delta, \sigma_g) = \frac{1}{\sum_g D_g^{(1-\sigma_g)}}.$$

An expression for mean utility levels can then be derived by taking logs of market shares

(8) $$\ln(s_j) - \ln(s_0) = \frac{\delta_j}{(1-\sigma) - \sigma \ln(D_g)}.$$

Solving for D_g is achieved by taking the log of the group share (Equation 6), that is

(9) $$\ln(D_g) = \frac{\left[\ln(\dot{s}_g) - \ln(s_0)\right]}{(1-\sigma)},$$

where $\dot{s}_g$ is the observed group share. Substituting (9) into (8) yields the expression for s_j^{-1}

(10) $$\delta_j = \ln(s_j) - \sigma \ln(s_{j/g}) - \ln(s_0).$$

Rearranging (10) provides a linear equation, equivalent to the logit model in (4)

(11) $$\ln(s_j) - \ln(s_0) = x_j\beta - \alpha p_j + \sigma_g \ln(s_{j/g}) + \xi_j.$$

Estimates of β, α and σ can be obtained through a linear instrumental variable regression, using an estimator such as two stage least squares.

Having estimated equation (11), the coefficients can be used to calculate own and cross price elasticities at the attribute level. Deng (2003) defines these elasticities as follows

(12) $$\varepsilon_{j,j} = \frac{\partial s_j}{\partial p_j}\frac{p_j}{s_j} = \frac{\partial s_j}{\partial \delta_j}\frac{\partial \delta_j}{\partial p_j}\frac{p_j}{s_j}, \quad j \in M_g, g \in G, \text{ and}$$

(13) $$\varepsilon_{j,k} = \frac{\partial s_j}{\partial p_k}\frac{p_k}{s_j} = \frac{\partial s_j}{\partial \delta_k}\frac{\partial \delta_k}{\partial p_k}\frac{p_k}{s_j}, \quad j \neq k, j \in M_g, k \in M_h, g, h \in G.$$

Solving for $\frac{\partial s_j}{\partial p_k}$ and $\frac{\partial s_j}{\partial p_j}$ leads (12) and (13) to become

(14) $$\varepsilon_{j,j} = \frac{\partial s_j}{\partial p_j}\frac{p_j}{s_j} = \alpha p_j \left(\frac{\sigma_g}{1-\sigma_g} s_{j/g} + s_j - \frac{1}{1-\sigma_g} \right), \quad j \in M_g, g \in G, \text{ and}$$

(15) $$\varepsilon_{j,k} = \frac{\partial s_j}{\partial p_k}\frac{p_k}{s_j} = \alpha p_k \left(\frac{\sigma_h}{1-\sigma_h} s_{k/g} + s_k \right), \quad j \neq k, j \in M_g, k \in M_h, g, h \in G.$$

Deng (2003) suggests that group g and group h can be the same or different, and if $g \neq h$, the cross price elasticity across groups is equal to $\alpha p_k s_k$.

4. Data and estimation procedures

Two models are estimated, differing primarily in terms of nesting structure. Steven Berry (pers. comm., 2006) suggests that a nesting structure defined by price may be problematic, as price is not a "fundamental component of the good". Therefore, both a "quality" nesting structure (based on price as shown in Figure 2) and a "region of origin" nesting structure have been used in the analysis.

Scanner data have been sourced from ACNielsen and comprise US wine sales occurring in grocery and drug stores for the years 2003, 2004 and 2005. The grocery store sector represents 44% of the total US market sales, while the drug store sector makes up 8%. In total, these sectors cover 52% of the total US wine sales. The data cover only off-premise sales which constitute 79% of total sales (ACNielsen 2004). Therefore the total market coverage of the data is equal to 41%.

Initial estimation of the model using all available data yielded underestimated price coefficients, according to various industry and academic opinions (Clements 2006; John Asker, pers. comm., 2006). Following a cluster analysis of the data, it was found that there existed a large number of observations with low prices and low sales, most likely a result of distribution inefficiencies and loyalty to established brands. To account for this, the model was estimated using data on the top 50 brands (according to total brand sales) only, thereby omitting observations with both low sales and low prices. The omitted observations accounted for 24% of sales in the original dataset. This may present an illusion of sample selection bias, given that the largest brands only are retained in the dataset. However, this is simply a truncated sample, as used by Nevo (2001), and is not of concern from a selection bias perspective. This is supported further by Nevo (2000), stating that since the majority of activity occurs within these brands, it is logical that they be the focus of a study of market behaviour. For this exercise, the market has been defined as the total US market for wine. The outside good is, therefore, the proportion of the total wine market not represented by the dataset outlined above.

The data are at a wine-specific level. That is, each specific branded wine is a separate observation in the dataset (not including wines that have repeated sales across the three years in the sample). Aggregate sales per nine litre case of wine are available, as well as the average 750ml bottle (or equivalent) price. The data also include container size, value and description of product attributes such as grape variety and region of origin.

The nesting structures used consist of either quality segments or regions of origin. Wine quality is defined by price segments outlined by Heijbroek (2003) (Table 1). These categories have been converted from Euros to US Dollars using the 2003 Purchasing Power Parity (PPP) adjusted exchange rate sourced from the World Bank Development Indicators database (WBDI 2006). Upon preliminary estimation using this quality specification, it was found that the nesting was more robust if the “Icon” segment was aggregated with the “Ultra Premium” segment. Therefore, in the quality nesting, segments are as outlined in Table 1, with the exception of “Ultra Premium” consisting of all wines with a price exceeding \$12.60.

Table 1 Quality segments, defined by price

Quality Segment	US Dollars per 750ml Bottle
Basic	< \$2.70
Popular Premium	\$2.70 to \$4.50
Premium	\$4.50 to \$6.30
Super Premium	\$6.30 to \$12.60
Ultra Premium	\$12.60 to \$135
Icon	> \$135

Source: Heijbroek (2003)

The regional nesting structure is based on the country from which the wine is imported into the United States. To simplify the estimation process, European wine producers (including France, Germany and Italy) have been aggregated into a single category named “Europe”, and similarly, South American wine producers (including Argentina and Chile) have been aggregated into a category named “South America”. The remaining regions in the nesting structure are Australia and the United States.

The Hausman test was used to show that price and group share variables were endogenous. Therefore, Equation 16 below was estimated using two stage least squares (2SLS)

(16) $$\ln(s_j) - \ln(s_0) = \gamma + x_j\beta + \alpha p_j + \sigma_g \ln[s_{j/g}] + \xi_j$$

where *x* is a vector of product characteristics including grape variety and region of origin, *j* represents a particular branded wine, and *g* represents a market segment, being defined by either quality or region of origin, depending on the nesting structure of the respective model.

Instrumental variables (IVs) obtained for estimation include exchange rates, crop and food production indices, container size (bottle/cask) and distance to market for each of the exporting countries in the sample. In the case of domestically produced wine an exchange rate of “1” and a distance to market of “0” were used. Exchange rate data were obtained from the International Monetary Fund (IMF 2006), crop and food indexes were obtained from the World Bank Development Indicators database (WBDI 2005) and distance to market data were obtained from (Mapcrow 2006).

Auxiliary regressions for all combinations of IVs were estimated for both model specifications outlined above (both quality and regional nesting structures). Key statistics from these regressions were examined, including F statistics, R^2 values and individual significance levels of each IV. It was found that the most efficient IV combination for the quality nesting was exchange rates, crop production index, container size and distance to market. For the regional nesting, it was found that container size and distance to market were the most appropriate IVs. In both models, instruments were interacted with nesting dummies to enable two-stage estimation.

5. Results

Both the quality and region models were run using a two-stage least squares estimator to account for endogeneity of both price and group share variables. The group share variables describe the nesting structure of the model. The estimated coefficients associated with these variables explain the correlation of consumer preferences in each market segment defined by the nesting structure of the respective model. The results are presented in Table 2.

Table 2 Demand parameters

Quality nesting			Region nesting		
Dep var: lnSj-lnSo	Coefficient	Standard error	Dep var: lnSj-lnSo	Coefficient	Standard error
Constant	-4.85***	0.82	Constant	-5.35***	0.31
Year 2004	-0.04	0.03	Year 2004	-0.03	0.06
Year 2005	-0.04	0.03	Year 2005	-0.10*	0.06
Price	-0.11***	0.02	Price	-0.27***	0.03
Merlot	0.16*	0.09	Merlot	0.60***	0.12
Burgundy	0.14	0.10	Burgundy	-0.35*	0.19
Cabernet Sauvignon	0.25***	0.07	Cabernet Sauvignon	0.88***	0.15
Cabernet Sauvignon Merlot	0.08	0.09	Cabernet Sauvignon Merlot	0.33	0.26
Paisano	0.76***	0.25	Paisano	0.90***	0.21
Zinfandel	-0.18***	0.06	Zinfandel	-0.24	0.15
Pinot Noir	0.08	0.08	Pinot Noir	0.66***	0.16
Chianti	0.08	0.10	Chianti	-0.35*	0.20
Generic Red Wine	-0.11	0.16	Generic Red Wine	-0.86**	0.35
White Grenache	-0.42***	0.16	White Grenache	-1.70***	0.32
Rose	-0.20*	0.12	Rose	-1.07***	0.26
Blush	0.28*	0.15	Blush	-0.11	0.26
White Zinfandel	0.09	0.08	White Zinfandel	-0.20	0.14
Generic White Wine	-0.32*	0.19	Generic White Wine	-1.01**	0.43
Rhine	0.15	0.11	Rhine	-0.37*	0.22
Pinot Grigio	0.03	0.06	Pinot Grigio	-0.11	0.13
Sauvignon Blanc	-0.01	0.05	Sauvignon Blanc	-0.12	0.13
Chablis	0.22*	0.12	Chablis	-0.17	0.20
Chardonnay	0.10	0.07	Chardonnay	0.43***	0.11
Other Wine	-0.18***	0.07	Other Wine	-0.46***	0.13
Australia	0.59**	0.25			
Chile	0.44*	0.24			
France	0.40*	0.23			
Germany	0.60**	0.27			
Italy	0.43*	0.23			
United States	0.55**	0.25			
$\ln S_{j/g}$ (Basic)	0.74***	0.07	$\ln S_{j/g}$ (Australia)	0.57***	0.06
$\ln S_{j/g}$ (Popular Premium)	0.80***	0.07	$\ln S_{j/g}$ (South America)	0.89***	0.07
$\ln S_{j/g}$ (Premium)	0.79***	0.07	$\ln S_{j/g}$ (Europe)	0.64***	0.06
$\ln S_{j/g}$ (Super Premium)	0.76***	0.07	$\ln S_{j/g}$ (United States)	0.46***	0.05
$\ln S_{j/g}$ (Ultra Premium)	0.94***	0.08			
R^2=0.93 R^2adj=0.93 DW=2.04			R^2=0.69 R^2adj=0.69 DW=1.99		
F statistic = 2244.01			F statistic = 493.16		

***, ** and * signify 1%, 5% and 10% levels of significance, respectively.

The group share correlation coefficients in the quality model indicate that consumer preferences are relatively heterogeneous for the lowest four quality segments, with preferences being notably more similar in the Ultra Premium segment. Within the lowest four quality segments, the Popular Premium and Premium groups have relatively high levels of consumer homogeneity, particularly when compared to the Basic segment. This may be explained by the level of wine knowledge that consumers possess at different quality levels in the market. Wine knowledge is likely to increase with quality, leading to a corresponding increase in the homogeneity of consumer tastes. With increased wine knowledge often comes a convergence to a common idea of what specific characteristics create a "good wine". However, at lower quality segments consumers have less wine knowledge, but in many cases they have a greater number of product variants to choose from. These two factors combined lead to preferences being more "sporadic" in lower quality segments, hence increasing the level of observed consumer heterogeneity.

The results from the region model suggest that Australian and US wine consumers are the most heterogeneous. Consumers of South American wine appear, however, to be the most homogenous. This result may be explained by the perceived low level of product diversity in South American wines. One may expect a similar outcome for Australian wine, which anecdotally has a reputation as a generic "value-for-money" wine style (AWBC 2007). However, despite this being the case for many Australian wines, there also exist a large number of boutique variants in the US market. This, in combination with the high degree of product differentiation among Australian wines in the United States, at all quality levels, has led to increased heterogeneity of consumer tastes. It is not surprising that consumers of the domestic US product are relatively heterogeneous. It is in this category that the number of product variants is likely to be highest. Furthermore, US consumers will have greater access to boutique products from domestic producers than foreign producers who may be prohibited from providing such products due to the transaction costs of foreign trade.

The coefficients of the product attributes, shown in Table 2, provide some insight into the types of wine that US consumers have the greatest preferences for. It should be noted that in each of the models estimated, a base variable was used to avoid the dummy variable trap. In the quality model, the base variable is "Argentinean Shiraz" sold in

2003. In the region model the base variable is "Shiraz" sold in 2003. Therefore, in each case the attributes in the base variables do not exist in the regression output, and all coefficients in Table 2 must be interpreted relative to the base variable in the respective model.

Both models suggest that US consumers have a preference for Cabernet Sauvignon and Merlot grape varieties. These varieties are among those overproduced in Australia. Despite Rosé and White Grenache not being preferred by US consumers, it appears that Blush, a very similar product technically, is a popular variety among these consumers. This may indicate that US consumers are "brand conscious" and that Australian producers should be open to modifying their product's branding, regardless of any modification of the product itself. The negative coefficients of Generic Red and Generic White wine support this claim. Branding is clearly important if increased market share is sought by Australian exporters.

The estimated coefficients of regional dummy variables, included in the quality model, help to explain the US preferences for wine produced in various countries. With the exception of Germany, Australia is the most preferred producer of wine in the United States, implying that the United States may be a promising market through which Australia could eradicate excess wine stocks. However, wines must be clearly branded as "Australian" to take advantage of the preferences revealed in this market.

Table 3 provides attribute level own price elasticities for each of the product attributes presented in the regression output (Table 2), across each year in the sample. Table 4 reports price elasticities for each group in the quality model, and similarly, Table 5 includes elasticities for the region model. These elasticities are presented for each year in the sample, as well as an average for each market segment and year. An average elasticity for the entire market, across all time periods, is reported in Tables 4 and 5. The elasticities are sales weighted averages of individual brand-specific elasticities that were calculated for every specific wine in the model. Therefore, they are not market elasticities, but rather represent the elasticity of the "average specific wine" in each respective category. Due to a higher degree of competition and larger number of substitutes at such a disaggregated level, the magnitude of the elasticities is naturally greater than would be the case with aggregate market elasticities.

Table 3 Weighted average attribute level own price elasticities

Quality Nesting					Region Nesting				
	2003	2004	2005	Average		2003	2004	2005	Average
Burgundy	-0.81	-0.82	-0.93	-0.85	Burgundy	-0.90	-0.91	-0.98	-0.93
Cabernet Sauvignon	-3.67	-3.54	-4.01	-3.74	Cabernet Sauvignon	-2.95	-2.99	-3.10	-3.02
Cabernet Sauvignon Merlot	-2.51	-2.57	-2.63	-2.57	Cabernet Sauvignon Merlot	-6.35	-6.40	-6.13	-6.28
Chianti	-1.00	-1.05	-1.29	-1.11	Chianti	-1.20	-1.30	-1.53	-1.34
Merlot	-3.32	-3.30	-3.38	-3.33	Merlot	-3.09	-3.09	-3.06	-3.08
Paisano	-0.78	-0.80	-0.91	-0.83	Paisano	-0.89	-0.92	-0.99	-0.93
Pinot Noir	-5.01	-5.07	-7.16	-6.05	Pinot Noir	-4.32	-4.36	-4.54	-4.44
Shiraz	-3.32	-3.32	-3.33	-3.33	Shiraz	-4.15	-4.14	-4.11	-4.13
Zinfandel	-3.45	-3.52	-3.89	-3.62	Zinfandel	-2.87	-2.94	-3.18	-3.00
Generic Red Wine	-0.55	-0.56	-0.63	-0.58	Generic Red Wine	-0.64	-0.65	-0.73	-0.67
Blush	-0.59	-0.60	-0.68	-0.62	Rose	-1.05	-1.07	-1.14	-1.09
Rose	-0.93	-0.95	-1.09	-0.99	Blush	-0.68	-0.70	-0.78	-0.72
White Grenache	-0.61	-0.60	-0.65	-0.62	White Grenache	-0.70	-0.69	-0.74	-0.71
White Zinfandel	-1.49	-1.51	-1.70	-1.56	White Zinfandel	-1.46	-1.48	-1.62	-1.51
Chablis	-0.77	-0.77	-0.89	-0.81	Chablis	-0.87	-0.88	-0.96	-0.90
Chardonnay	-2.78	-2.75	-2.95	-2.83	Chardonnay	-2.83	-2.82	-2.86	-2.84
Pinot Grigio	-3.11	-3.16	-3.15	-3.14	Pinot Grigio	-4.09	-4.07	-3.92	-4.01
Rhine	-0.70	-0.70	-0.80	-0.73	Rhine	-0.80	-0.80	-0.88	-0.83
Sauvignon Blanc	-2.61	-2.64	-2.78	-2.68	Sauvignon Blanc	-2.59	-2.63	-2.76	-2.66
Generic White Wine	-0.57	-0.59	-0.68	-0.61	Generic White Wine	-0.65	-0.66	-0.77	-0.69
Other Wine	-2.43	-2.45	-2.58	-2.49	Other Wine	-2.78	-2.80	-2.88	-2.82
All Red Wine	-2.63	-2.65	-3.01	-2.77	All Red Wine	-2.52	-2.60	-2.72	-2.62
All White Wine	-2.14	-2.17	-2.39	-2.24	All White Wine	-2.28	-2.32	-2.44	-2.35
All Rose	-1.19	-1.21	-1.35	-1.25	All Rose	-1.21	-1.22	-1.33	-1.25
Argentina	-2.45	-2.46	-2.46	-2.46					
Australia	-3.25	-3.24	-3.24	-3.25					
Chile	-2.21	-2.22	-2.24	-2.23					
France	-3.67	-3.58	N/A	-3.64					
Germany	-3.11	-3.27	-3.77	-3.40					
Italy	-2.83	-2.87	-3.10	-2.93					
USA	-1.97	-2.00	-2.29	-2.09					

Table 4 Own price elasticities for quality nesting

	Basic	Popular Premium	Premium	Super Premium	Ultra Premium	Average
2003	-0.74	-1.91	-2.86	-3.71	-25.56	-2.12
2004	-0.75	-1.90	-2.90	-3.76	-25.63	-2.15
2005	-0.77	-1.88	-2.94	-3.82	-25.63	-2.42
Average	-0.75	-1.90	-2.90	-3.76	-25.61	-2.23

Table 5 Own price elasticities for region nesting

	Australia	South America	Europe	United States	Average
2003	-4.05	-8.21	-4.19	-1.80	-2.16
2004	-4.00	-8.36	-4.24	-1.83	-2.22
2005	-3.94	-8.48	-4.46	-1.98	-2.36
Average	-3.99	-8.36	-4.29	-1.87	-2.25

6. Policy implications

Several policy implications for Australian wine producers emerge from the analysis. These implications relate to ways in which Australian producers can induce sales in the US market, with the goal of reducing disequilibrium in the Australian wine industry. Price elasticities presented in Section 5 provide insight into how price can be used to achieve this end. However, price has been shown to be an ineffective tool in some circumstances. Alternate non-price policies, such as promotion and bundling, must be developed for these situations. The competitive situation in the United States is also discussed, with recommendations on how Australian producers can their competitiveness. It becomes evident in this discussion, that there are no "blanket" policies that can address the problem of disequilibrium in the Australian wine industry. Australian producers may need to employ a range of policies to address this problem.

From Table 2 it can be seen that US consumers have a preference for Cabernet Sauvignon and Merlot grape varieties. These varieties have also been found to exhibit relatively elastic demand (Table 3). Being some of the greatest culprits of the aggregate-level oversupply that exists in the Australian wine industry (Davis 2005), the US market may provide a viable means of reducing excess stocks. The findings of this analysis suggest that sales of Cabernet Sauvignon and Merlot could be increased significantly, if price discounting is employed by Australian exporters.

White Grenache, a Rosé-style wine, is relatively price inelastic in the US market. Like Cabernet Sauvignon and Merlot, Grenache is a variety that has contributed to oversupply in Australia. However, the inelastic demand of White Grenache indicates that price discounting would be an inefficient method of surplus disposal. Australian producers may be more successful producing Rosé-style wine with Grenache grapes, and exporting it to the United States branded as Blush. The popularity of Blush with US consumers (see Table 2) may provide Australian producers with an opportunity to reduce excess Grenache stocks, while its inelastic demand may enable prices to be increased with little effect on sales. Therefore, despite price discounting being an inferior surplus disposal policy in the case of Grenache, non-price alternatives such as a change in branding, may be used to achieve the same objective.

Table 4 shows group share price elasticities for the quality model over the three years in the sample. As expected the demand for higher quality wine is more responsive to price changes. This implies that price discounting is more effective when implemented on high quality wines. Relatively little reward is attainable from reducing the price of low quality wine, and will most likely lead to a fall in profitability. In this segment non-price strategies, such as promotion, bundling and tying wine, are likely to provide a more effective way of increasing sales. Such a strategy was recently implemented in Australia where a small wine rack was bundled with the purchase of a particular wine. The effect on the consumer was two-fold. Initially, bundling was used to create a perception of greater “value for money”. From then onwards, “tying” was used to induce repeat sales, as the wine rack encouraged the storage of wine. Promotional strategies such as this appear more effective in driving sales in lower quality segments of the market.

The results also provide some insight into competition in the US market. This is an important issue for Australian producers to consider if they wish to enhance their market share. Australia must consider all other producers in the market as legitimate competitors, however, these producers may be competitive in varying capacities. From the perspective of price competition, Table 5 indicates that South American producers have the most ability to induce sales, potentially as Australia’s expense, via price discounting. However, the findings of this analysis suggest that US consumers of South American wines have highly homogenous tastes. The opposite appears to be the case for

Australian wine. This implies that if Australia were to continually innovate and differentiate its products, it might be able to distance itself South America's competitive advantage on price.

In contrast, consumers of domestically produced wine appear to be the most heterogeneous of all regions in the US market. For this reason, increasing product diversity would have the effect of drawing Australia into direct competition with the United States. Tables 3 and 5 suggest that the price elasticity for Australian wine in the US market is significantly higher than that of domestically produced wine. A one percent decrease in price will yield approximately a four percent increase in sales. This is in contrast to US producers who can expect around a two percent rise in sales. This implies that Australia may become more successful in competing with US produced wine by competing on price.

The results also provide some information on the outlook of the US market. Analysing the past trends in elasticities over time, it may be possible to gain an idea of the path the market may take in the future. In general, across the three years in the sample price elasticities for wine in the United States have steadily increased. This suggests that US consumers have become more price conscious over time. Given that elasticities of individual product attributes (Table 3) are also showing an upward trend, it appears that price has become an increasingly powerful tool in influencing the behaviour of US consumers. However, from the perspective of Australia, the opposite appears to be the case, with a gradual fall in price elasticity over time. The effectiveness of price discounting, therefore, has fallen for Australian wine, while it has increased for its competitors. Therefore, Australian producers need to be aware that "following" the actions and marketing strategies of their competitors, particularly those that are price-orientated, may not provide a favourable outcome. It is important for Australian producers to combine pricing policies with an emphasis on promotion and market exposure, in order to enhance market share.

7. Concluding comments

The present study has used a product differentiation model of demand to provide some insight into the consumer preferences for wine in the United States, one of Australia's largest export markets. It was proposed that this information might identify strategies by which Australian producers could enhance market share in the US market, which would in turn help to reduce the disequilibrium that exists in the Australian wine industry. It has been found that the wine types that US consumers prefer are generally those that have experienced excess production in Australia. This implies that the US market may be a viable means of surplus disposal for Australian producers. However, the tools with which Australian producers induce increased sales differ depending on the wine type in question. Pricing has been shown not to always be the best tool of competition, particularly in the lower quality segments of the market. In these situations non-price strategies, such as promotion, bundling and tying, may be used more effectively. It has also been found that of all wine producing countries in the sample, Australia is the only one where price discounting has become increasingly ineffective over time. This indicates that Australia must differentiate away from its competition, and adopt more innovative marketing strategies in order to increase market share.

Areas of further work include the derivation of cross-price elasticities for market segments and product attributes. Equation 15 can be used to achieve this end. It is important to understand the demand for individual products in the US wine market, but it is also vital to gauge the interaction of various products. For example, if Australian wines are close substitutes (high cross-price elasticity within Australian wines), price discounting to cause an increase in sales may simply lead to the cannibalisation of sales from other Australian wines, thereby having little positive effect on Australian industry-level disequilibrium problems. It is important to ensure that such a policy leads to increases in market share at the expense of Australia's competitors, rather than other Australian producers, if the aim is to reduce disequilibrium in the entire industry.

References

ABS (1998). 'Australian Wine and Grape Industry', Australian Bureau of Statistics, Catalogue no. 1329.0.

ABS (2005). 'Australian Wine and Grape Industry', Australian Bureau of Statistics, Catalogue no. 1329.0.

ABS (2006). 'Sales of Australian Wine and Brandy by Winemakers', Australian Bureau of Statistics, Catalogue no. 8504

ACNielsen (2004). 'ACNielsen Wine Coverage', ACNielsen Beverage Alcohol.

AWBC (2007). Wine Australia, Australian Wine and Brandy Corporation, Australian Government, Available: http://www.wineaustralia.com/AUSTRALIA/Default.aspx?tabid=1721

Berry, S.T. (1994). 'Estimating Discrete-Choice Models of Product Differentiation', *RAND Journal of Economics*, 25, 242-262.

Cardell, N.S. (1997). 'Variance Components Structures for the Extreme-Value and Logistic Distributions with Application to Models with Heterogeneity', *Econometric Theory*, 13, 185-213.

Clements, K.W. and Johnson, L.W. (1983), 'The Demand for Beer, Wine, and Spirits: A Systemwide Analysis', *Journal of Business*, 56, 273-304.

Clements, K.W. (2006). 'Comments on Tim Davis "Demand Under Product Differentiation: An Empirical Analysis of the US Wine Market"', Prepared for the PhD Conference in Economics and Business, ANU, November 2006, Business School, University of Western Australia.

Combris, P., Lecocq, S. and Visser, M. (1997). 'Estimation for a Hedonic Price Equation for Bordeaux Wine: Does Quality Matter?' *Economic Journal*, 107, 390-402.

Davis, T. (2005). 'Using the Bulk Wine Market to Explain Oversupply in the Australian Wine Industry', *Journal of Wine Research*, 16, 249-258.

Deng, H. (2003). 'Market Structure and Pricing Strategy of China's Automobile Industry', University of California, Davis.

Eakins, J.M. and Gallagher, L.A. (2003). 'Dynamic Almost Ideal Demand Systems: An Empirical Analysis of Alcohol Expenditure in Ireland', *Applied Economics*, 35, 1025-1036.

Freed, J. (2005). 'Flood of Plonk Hits McGuigan Earnings', *Sydney Morning Herald*, April 9, 2005. Available: http://smh.com.au/articles/2005/04/08/1112815727724.html

Heckman, J.J. (1976). 'The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models', *Annals of Economic and Social Measurement*, 5, 475-492.

Heijbroek, A. (2003). 'Wine is Business - Shifting Demand and Distribution: Major Drivers Reshaping the Wine Industry', Rabobank International. Available: http://www.rabobank.com/Images/rabobank_publication_wine_is_business_2002_tcm25-156.pdf

IMF (2006). International Financial Statistics, International Monetary Fund, Available: http://ifs.apdi.net/imf/ifsbrowser.aspx?branch=ROOT

James, J., S. and Alston, J.M. (2002). 'Taxes and Quality: A Market-Level Analysis', *Australian Journal of Agricultural and Resource Economics*, 46, 417-445.

Lancaster, K. (1971). *Consumer demand : a new approach*, Columbia University Press, New York.

Mapcrow (2006). Travel Distance Calculator Between Countries, Available: http://www.mapcrow.info/

McGrath-Kerr, S. (2003). 'Australian Winegrape Conference Report', Australian Winegrape Conference, Mildura. Available: http://www.awbc.com.au/winefacts/data/free.asp?subcatid=109

McGrath-Kerr, S. (2005). 'Australian Winegrape Conference - Beyond 2005 "The Outlook for Supply and Demand"', Australian Winegrape Conference, Mildura. Available: http://www.gwrdc.com.au/downloads/ResearchTopics/SMK%2005-01.pdf

Moosa, I.A. and Baxter, J.L. (2002). 'Modelling the Trend and Seasonals within an AIDS Model of the Demand for Alcoholic Beverages in the United Kingdom', *Journal of Applied Econometrics*, 17, 95-106.

Nevo, A. (2000). 'Mergers with Differentiated Products: The Case of the Ready-to-Eat Cereal Industry', *RAND Journal of Economics*, 31, 395-421.

Nevo, A. (2001). 'Measuring Market Power in the Ready-to-Eat Cereral Industry', *Econometrica*, 69, 307-342.

Noev, N. (2005). 'Wine Quality and Regional Reputation: Hedonic Analysis of the Bulgarian Wine Market', *Eastern European Economics*, 43, 5-30.

Oczkowski, E. (1994). 'A Hedonic Price Function for Australian Premium Table Wine', *Australian Journal of Agricultural Economics*, 38, 93-110.

Oczkowski, E. (2001). 'Hedonic wine price functions and measurement error', *Economic Record*, 77, 374-382.

Owen, A.D. (1979). 'The Demand for Wine in Australia, 1955-1977', *Economic Record*, 55, 230-235.

Pompelli, G.K. and Heien, D. (1991). 'Discrete/Continuous Consumer Demand Choices: An Application to the U.S. Domestic and Imported White Wine Markets', *European Review of Agricultural Economics*, 18, 117-130.

Rosen, S. (1974). 'Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition', *Journal of Political Economy*, 82, 34-55.

Schamel, G. (2000). 'Individual and Collective Reputation Indicators of Wine Quality', CIES Discussion Paper 0009, Centre for International Economic Studies, University of Adelaide.

Schamel, G. and Anderson, K. (2003). 'Wine Quality and Varietal, Regional and Winery Reputations: Hedonic Prices for Australia and New Zealand', *Economic Record*, 79, 357-369.

Seale, J.L., Jr., Marchant, M.A. and Basso, A. (2003). 'Imports versus Domestic Production: A Demand System Analysis of the U.S. Red Wine Market', *Review of Agricultural Economics*, 25, 187-202.

Selvanathan, E.A. and Selvanathan, S. (2004). 'Economic and Demographic Factors in Australian Alcohol Demand', *Applied Economics*, 36, 2405-2417.

Steiner, B.E. (2004). 'Australian Wines in the British Wine Market: A Hedonic Price Analysis', *Agribusiness*, 20, 287-307.

Tegene, A. (1990). 'The Kalman Filter Approach for Testing Structural Change in the Demand for Alcoholic Beverages in the U.S', *Applied Economics*, 22, 1407-1416.

Unwin, T. (1999). 'Hedonic Price Indexes and the Qualities of Wines', *Journal of Wine Research*, 10, 95-104.

WBDI (2005). World Bank Development Indicators Database, World Bank, University of Sydney Library Database, Washington DC

WBDI (2006). 'World Bank Development Indicators', Relative Prices and Exchange Rates, World Bank, Washington DC