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Demand under product differentiation: an empirical analysis of the US wine market*

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Oversupply has led to a number of perplexities 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, the solutions to this problem have predominantly revolved around supply-side policies of reducing output through crop thinning or vine pulling. By contrast, this paper focuses on the demand side and argues that the 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 Australia's second largest export market, the United States. Implications of the analysis are explored.

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

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 resulted in excess production of grapes and wine with a 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. We believe that a better understanding of the demand for Australian wine can help solve this issue. To this end, we study the demand for wine in Australia's second largest export market, the United States.

Industry analysts use the stock : 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

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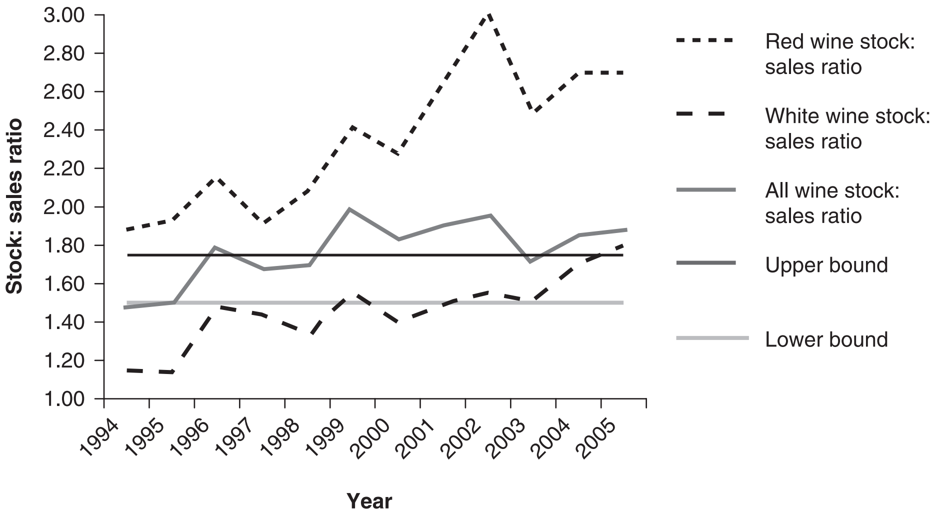

Figure 1 Stock : sales ratio, 1994–2005.
Source: McGrath-Kerr (2003, 2005), ABS (1998, 2005).

can be seen in Figure 1, at an aggregate level the industry is currently in a state of oversupply. However, wine is a highly differentiated product. Arguably, there exist no two wines in any one market that are identical. Therefore, it is probable that when the problem of aggregate oversupply is broken down to a more disaggregated attribute-specific level, the complexity of the problem will become evident. Figure 1 supports this observation, showing that over the past 10 years white wine has often experienced excess demand, while red wine has been in oversupply. Davis (2005) shows that when the industry is disaggregated further, the level and nature of the disequilibrium becomes increasingly diverse.

The problem of oversupply in the Australian wine industry is especially complex due to the interrelation with the upstream market for grapes. As the grape market responds very slowly to changes in the derived demand for wine, sometimes the price behaviour and production decisions in both markets appear to follow different paths. For instance, while recent overproduction has caused grape prices to fall to levels close to, and in some cases below average cost, wine retail prices have remained virtually unchanged (ABS 2005). Such disconnection between the two markets is partly explained by what economists call 'hysteresis'. Due to the necessary capital investments and the uncertainty on the returns, at times grape varieties that have become uneconomical are still being grown while more appealing varieties take time to be adopted.[1]

Disconnection between the grape and wine markets might have been aggravated by the Federal Government taxation incentives available to new grape growers, a policy that has since been abolished following extensive

[1] Richards and Green (2003) document a hysteresis effect in the timing of removals and re-plantings of grape varieties in California.

lobbying by grape growers themselves. Lucrative supply contracts targeting prospective growers have also had a significant expansionary effect on production. Grape production contracts were offered by wine companies not only to current growers, but also to prospective growers if they produced grapes of a particular type. Given that the majority of such contracts had terms of five years, and new plantings take approximately three years to produce a commercial crop, wine companies were attempting to effectively predict demand eight years into the future. These contracts also acted as signals to otherwise unrelated growers who used them as indicators of future prices. Furthermore, Fraser (2005) suggests that supply contracts may have provided wine firms with a way of shifting production risk to grape growers, who in many cases have relatively little access to information on consumer preferences. Such a situation therefore had the effect of further widening the gap between wine production decisions and consumer demand. Finally, research and development in the wine industry has predominantly focused on technological advancement that has largely been production-inducing, thereby contributing further to aggregate-level oversupply in the industry.

Supply-side policies, including crop thinning and reduction in grapevine area, have been used in previous episodes of wine surplus with very limited success. This is mainly due to the lag that exists between the planting of the grapes and the production of a commercial crop. Particularly in the case of growing export demand, reducing the grapevine area to bring the market back into balance would soon lead to a shortage as demand continues to grow. Subsequent increases in plantings to counter this shortage can then result in further surplus production when crops are realised. Enhancing the demand for Australian wine by better understanding consumer preferences, however, may allow current production regimes to be unaltered, thereby reducing output uncertainty. Currently available information on preferences for Australian wine in foreign markets is scarce, potentially leading to ill-conceived marketing and distribution strategies. Therefore, providing more information on preferences may help exporters, as well as growers, to effectively market their products to where they are most highly demanded, thus helping to reduce the market disequilibrium, while simultaneously promoting growth.

During the past 20 years, export sales have become increasingly important to the Australian wine industry. In 2005 Australian export sales were over five times the level they were in 1986, while domestic sales remained virtually unchanged during the same period (ABS 1998, 2005). For this reason, it appears logical that a wine demand study seeking to address the problem of oversupply should focus on export markets. This view is supported by Monke *et al*. (1987), who advocates for the use of foreign markets as a means of surplus disposal. We target one of Australia's largest export markets, the United States. In 2006 Australian exports of wine to the United States totalled 205 million litres, valued at over Aus$864 million. The United Kingdom, Australia's largest wine export market, was only marginally larger, with sales of 262 million litres at a value of A$946 m in 2006 (ABS 2007).

The rest of the article is organised as follows. Section 2 provides an overview of the literature. The demand model is detailed in Section 3, with the corresponding empirical estimation being outlined in Section 4. The results are presented in Section 5, followed by policy implications in Section 6. Finally, Section 7 concludes the analysis.

2. Previous studies

The vast majority of the empirical analyses of wine markets have estimated hedonic pricing equations (see for example, Oczkowski 1994; Combris *et al*. 1997; Schamel 2000; Oczkowski 2001; Schamel and Anderson 2003; Steiner 2004; Noev 2005). One reason for this is the less stringent data requirements and the method's focus on product attributes, which allows for some degree of differentiation among wine brands. Despite these advantages, however, hedonic price analysis is not a demand model as the attribute- level prices it estimates are jointly determined by producer and consumer behaviour. In other words, they do not capture only the demand but the equilibrium points of demand and supply.

Simple demand systems based on homogeneous product models such as the Almost Ideal Demand System (AIDS) have also been estimated. Examples of some applications to wine are Moosa and Baxter (2002), Eakins and Gallagher (2003) and Seale *et al*. (2003) which attempt to explain the disproportionate growth of imported red wine sales in the US market relative to the domestically produced product. Other demand models used to study wine have predominantly included simple linear demand equation estimations, 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 (such as France, Italy, Portugal, Spain, and West Germany), most likely reflecting wine's emerging status 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 findings from these studies offer some interesting insight into the way the consumer base as a whole approaches the product.

However, the AIDS and the other demand models previously reported in the literature have many shortcomings that make them unsuitable to address wine market disequilibria. First, their 'aggregate' product-level nature and restrictive market structure assumptions mean that they cannot adequately capture the varying levels of disequilibria that exist in the market. Second, as they do not take into account the different attributes of wine, they appear inadequate to analyse a market that is by nature inherently differentiated. James and Alston (2002) made this point by noting that the majority of economic policy analysis was conducted using models of homogenous

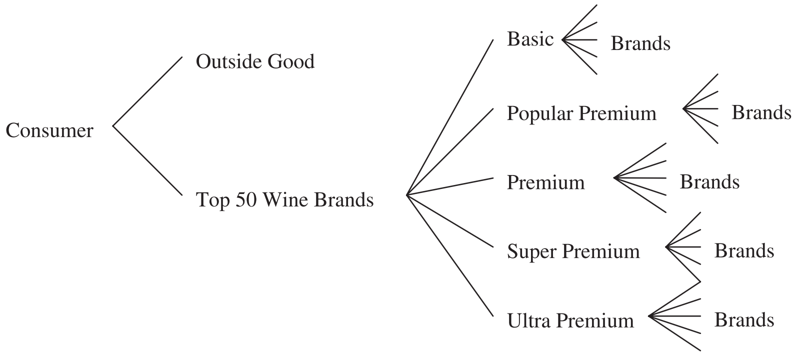

Figure 2 Nested logit structure for the US wine market.

products, and that policy effects estimated using such models were probably significantly different from those derived from product differentiation models. The empirical literature appears to have overlooked this important issue as no models of product differentiation have been applied to the market for wine. We attempt to fill this gap.

3. Demand under product differentiation

The discrete choice model proposed here follows Berry's (1994) theoretical work that set the basis to estimate a nested multinomial logit model using market share data instead of individual consumer-level data. As Berry (1994) derives it, the market share resulting from a nested logit model reduces to a simple linear function that can be estimated using conventional econometric techniques.

The main advantage of the nested logit model is that it relaxes the independence of 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 requires this assumption to hold among groups or nests but this is relaxed within nests. Therefore, the nesting structure essentially breaks up the market into independent groups or segments reflecting the grouping of like product attributes, making it highly suitable for analysing the market for wine. An efficient grouping exists where the correlation of preferences is high within nests but low between nests. Figure 2 shows one of the two nesting structures used in the analysis.

Following Berry (1994) and its detailed application in Deng (2003), at time t consumer i chooses among $J+1$ alternatives, where J denotes the number of specific wines in the market. At the first level of the tree the consumer chooses between an outside good or the top 50 wine brands analysed here. At the second tier of the tree, the consumer chooses from different wine groups. (In the tree structure depicted in Figure 2, the wine groupings consist of quality segments). Finally, the consumer chooses the particular brand of wine in the group. Let the wine groups or segments be denoted as $g = 1, \ldots, 5$. The set of wines in group g is denoted M_g, $g \in G$, where $G = \{0,1, \ldots, 5\}$. 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:

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

where x_j, ξ_j and p_j are observed product attributes, unobserved product attributes, and price, respectively. β and α are demand parameters to be estimated within the model. ε_{ij} is assumed to be an 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 (Cardell 1997). σ_g is a correlation coefficient of consumer tastes within group g. As in Deng (2003), we differ from Berry (1994) by allowing the parameter σ_g to differ across groups, which is more realistic and lends flexibility to the model. Therefore, this coefficient captures consumer heterogeneity within a specified group of products. As σ_g approaches unity, consumers tend towards homogeneity in tastes. A value closer to zero indicates that consumers are highly diverse in their tastes within the corresponding group.

Equation (1) can be re-written as:

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

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

As Berry (1994) derives it, the relative market share of a wine brand j obtained from the nested logit model takes the following linear functional form:

$$\ln(s_j) - \ln(s_0) = x_j\beta - \alpha p_j + \sigma_g \ln(s_{j/g}) + \xi_j. \quad (3)$$

where s_0 is the market share of the outside group. Consistent estimates of β, α and σ can be obtained through a two stage least squares estimator such as the instrumental variable estimator.

Having estimated Equation (3), the coefficients can then be used to calculate the own and cross price elasticities of any given wine brand. Following Deng (2003) derivation, they amount to the following expressions:

$$\varepsilon_{j,j} = \frac{\partial s_j}{\partial p_j}\frac{p_j}{s_j} = \alpha p_j\left(\frac{\sigma_g}{1-\sigma_g}s_{j/g} + s_j - \frac{1}{1-\sigma_g}\right), \quad j \in M_g,\ g \in G, \quad (4)$$

and

$$\varepsilon_{j,k} = \frac{\partial s_j}{\partial p_k}\frac{p_k}{s_j} = \alpha p_k\left(\frac{\sigma_h}{1-\sigma_h}s_{k/g} + s_k\right), \quad j \neq k,\ j \in M_g,\ k \in M_h,\ g, h \in G. \quad (5)$$

It is worth noting that groups g and h can be the same or different, and if $g \neq h$, the cross price elasticity across groups reduces to $\alpha p_k s_k$.

4. Data and estimation procedures

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

We model the choice among the top 50 brands by value in the US grocery and drug store sectors, while the market is defined as the total US wine market and the outside good is defined as the proportion of grocery and drug store wine sales not captured by the top 50 brand wines. One could argue that this would affect the IIA assumption of the nested logit model, given that some wines that US consumers may consider do not lie in the choice set. However, due to the very small volume of sales of the wines that fall into this category (altogether they only make up about six per cent of US wine sales), this is of little concern.

The data are at the wine-brand level. That is, each specific branded wine represents a separate observation (not including wines that have repeated sales across the three years in the sample). Aggregate sales per 9 L case of wine are available, as well as the average 750 mL bottle (or equivalent) price. The data also include container size, value and description of product attributes such as grape variety and region of origin.

Two models are estimated based on alternative nesting structures: wine quality and regions of origin. Wine quality is defined by price segments. Berry (pers. comm., 2006) believes that a nesting structure defined by price may be problematic, as price is not a 'fundamental component of the good'. However, many studies suggest that price is a reasonable proxy for wine quality (see for example, Costanigro *et al*. 2005), which is a fundamental attribute of wine. Thus, in this respect, price can be justified as a basis for market segmentation. We use Heijbroek's (2003) taxonomy of quality groupings to generate the quality nesting structure (Table 1). These categories have been converted from Euros to US Dollars using the 2003 purchasing power parity (PPP) adjusted exchange rate from the World Bank Development Indicators database (WBDI 2006). Upon preliminary estimation using this quality specification, the nesting appeared more robust if the 'Icon' and 'Ultra Premium' segments were aggregated. Therefore, in the quality nesting, the groups are as outlined in Table 1 with the exception of 'Ultra Premium' consisting of all wines with a price exceeding \$12.60.

The regional nesting structure is based on the country from which the wine is imported into the United States. To simplify the estimation process,

Table 1 Quality segments, defined by price

Quality segment	US dollars per 750 ml Bottle
Basic	< $2.70
Popular premium	$2.70–4.50
Premium	$4.50–6.30
Super premium	$6.30–12.60
Ultra premium	$12.60–135
Icon	> $135

Source: Heijbroek (2003).

Table 2 First-stage regressions: quality nesting model

Dependent variable	Price	Within-group share
Constant	9.151***	–5.629***
Exchange rate	0.147	–1.317***
Distance to market	0.00001	0.00006***
Crop index	0.002	–0.023***
Container size	–0.002***	0.0005***
R^2	0.14	0.04
F statistic (*p*-value)	244.3 (0.000)	66.47 (0.000)
Number of observations	5985	5985

***, ** and * denote 1%, 5% and 10% per cent levels of significance, respectively.

European wine producers (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.

As the price and group market shares are clearly endogenous, Equation (3) is estimated using an instrumental variable approach. Appropriate instrumental variables include those related to the underlying production cost (for example, see Deng 2003). We used exchange rates, crop and food production indices, distance to market for each of the exporting countries in the sample and also container size (bottle/cask). 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 production indices were obtained from the World Bank Development Indicators database (WBDI 2005) and distance to market data were obtained from Mapcrow (2006).

5. Results

Tables 2 and 3 present the first-stage regressions of the endogenous variables on the instruments. Preliminary exploration showed that exchange rates, crop

Table 3 First-stage regressions: region nesting model

Dependent variable	Price	Within-group share
Constant	9.502***	–11.288***
Distance to market	0.000008	0.0002***
Container size	–0.002***	0.0008***
R^2	0.14	0.14
F statistic (p-value)	488.67 (0.000)	469.19 (0.000)
Number of observations	5985	5985

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

production index, container size and distance to market provided the best IV combination for the quality nesting model (Table 2), while container size and distance to market were the most appropriate IVs for the region nesting model (Table 3). As shown by the F-test of joint significance, the instruments are overall statistically significant (the F-statistic takes on large values in both Tables 2 and 3) and most of the instruments are individually significant as well. We also tested for the exogeneity of the instruments using the test of over-identifying restrictions as described in Wooldridge (2002). The test statistic for the quality nesting model is 0.748, while the critical value at the 5 per cent significance level is 5.99. Thus we cannot reject the null hypothesis that the instruments are exogenous.[2] The only concern with the instruments is their low explanatory power (that is, low R-squared values) which could lead to weak instrument bias. Yet, the 2SLS estimations (Tables 4 and 5) do not show the typical signs of weak instrument bias, namely large standard errors and imprecise estimates that would make the coefficients statistically not different from zero. On the contrary, the 2SLS estimated coefficients on the price and group correlations are highly significant and also statistically different from the OLS estimates.

Tables 4 and 5 show the 2SLS estimation results for the quality and region nesting models, respectively. The standard errors are corrected to account for heteroskedasticity by imposing a robust variance-covariance matrix on the estimation. To facilitate comparison, Tables 4 and 5 also report the OLS estimates. As observed, the price coefficients estimated using OLS are considerably larger (that is, less negative) than those estimated using 2SLS, which confirms that the OLS estimates suffer from endogeneity bias. Furthermore, many of the within-group share coefficients estimated with OLS are implausible in value (that is, larger than unity). As for the 2SLS estimates, as expected the coefficient on the price is negative and statistically significant given the standard errors, they are also statistically different from the OLS estimated coefficients.

The coefficients on the group market shares capture the correlation of consumer preferences in each market segment as defined by the nesting structure

[2] The test cannot be performed on the region model, as the number of instruments is equal to the number of endogenous variables.

Table 4 Demand parameters: quality nesting model

	OLS		2SLS	
Dependent variable: lnSj–lnSo	Coefficient	Standard error	Coefficient	Standard error
Constant	–3.32***	0.09	–4.85***	0.82
Year 2004	–0.04**	0.02	–0.04	0.03
Year 2005	–0.02	0.02	–0.04	0.03
Price	–0.02***	0.00	–0.11***	0.02
Merlot	–0.03	0.02	0.16*	0.09
Burgundy	0.21***	0.03	0.14	0.10
Cabernet Sauvignon	–0.01	0.02	0.25***	0.07
Cabernet Sauvignon Merlot	0.01	0.03	0.08	0.09
Paisano	0.45***	0.05	0.76***	0.25
Zinfandel	–0.07**	0.03	–0.18***	0.06
Pinot Noir	–0.08**	0.03	0.08	0.08
Chianti	0.15***	0.04	0.08	0.10
Generic red wine	0.16***	0.05	–0.11	0.16
White Grenache	0.05	0.05	–0.42***	0.16
Rosé	0.10***	0.04	–0.20*	0.12
Blush	0.27***	0.05	0.28*	0.15
White Zinfandel	0.07	0.05	0.09	0.08
Generic white wine	0.04	0.07	–0.32*	0.19
Rhine	0.24***	0.04	0.15	0.11
Pinot Grigio	0.01	0.02	0.03	0.06
Sauvignon Blanc	0.02	0.02	–0.01	0.05
Chablis	0.24***	0.04	0.22*	0.12
Chardonnay	–0.02	0.03	0.10	0.07
Other wine	–0.04	0.03	–0.18***	0.07
Australia	0.10**	0.04	0.59**	0.25
Chile	0.12***	0.04	0.44*	0.24
France	–0.001	0.04	0.40*	0.23
Germany	0.10*	0.06	0.60**	0.27
Italy	0.10**	0.04	0.43*	0.23
United States	0.06*	0.03	0.55**	0.25
$\ln S_{j/g}$ (basic)	0.91***	0.01	0.74***	0.07
$\ln S_{j/g}$ (popular premium)	0.97***	0.01	0.80***	0.07
$\ln S_{j/g}$ (premium)	0.97***	0.01	0.79***	0.07
$\ln S_{j/g}$ (super premium)	0.96***	0.01	0.76***	0.07
$\ln S_{j/g}$ (ultra premium)	1.24***	0.01	0.94***	0.08
R^2	0.97		0.93	
R^2 adj	0.96		0.93	
F statistic (*p*-value)	0.000		0.000	
Number of observations	5985		5985	

***, ** and * denote 1%, 5% and 10% levels of significance, respectively.
Reference dummy variable: 'Argentinean 2003 Shiraz'.

of the respective model. In the quality model (Table 4), consumer preferences appear to be relatively heterogeneous for the lowest four quality segments, with preferences being notably more similar in the ultra premium segment. The apparent pattern of increasing preference correlation with quality is partly due to the fact that there are more wine brands available at low quality segments, but it could also be explained by the level of wine knowledge that

Table 5 Demand parameters: region nesting model

Dependent variable: lnSj-lnSo	OLS Coefficient	OLS Standard error	2SLS Coefficient	2SLS Standard error
Constant	−2.53***	0.04	−5.35***	0.31
Year 2004	−0.04***	0.01	−0.03	0.06
Year 2005	−0.10***	0.01	−0.10*	0.06
Price	−0.004***	0.009	−0.27***	0.03
Merlot	0.11***	0.03	0.60***	0.12
Burgundy	0.31***	0.03	−0.35*	0.19
Cabernet Sauvignon	0.13***	0.03	0.88***	0.15
Cabernet Sauvignon Merlot	−0.20*	0.10	0.33	0.26
Paisano	0.50***	0.04	0.90***	0.21
Zinfandel	0.13***	0.03	−0.24	0.15
Pinot Noir	0.14***	0.04	0.66***	0.16
Chianti	0.17***	0.05	−0.35*	0.20
Generic red wine	0.23***	0.06	−0.86**	0.35
White Grenache	0.11**	0.04	−1.70***	0.32
Rosé	0.18***	0.04	−1.07***	0.26
Blush	0.35***	0.04	−0.11	0.26
White Zinfandel	0.27***	0.03	−0.20	0.14
Generic white wine	0.14*	0.07	−1.01**	0.43
Rhine	0.31***	0.04	−0.37*	0.22
Pinot Grigio	0.01	0.04	−0.11	0.13
Sauvignon Blanc	0.18***	0.03	−0.12	0.13
Chablis	0.33***	0.04	−0.17	0.20
Chardonnay	0.14***	0.03	0.43***	0.11
Other wine	0.05**	0.03	−0.46***	0.13
$lnS_{j/g}$ (Australia)	1.15***	0.00	0.57***	0.06
$lnS_{j/g}$ (South America)	1.41***	0.02	0.89***	0.07
$lnS_{j/g}$ (Europe)	1.19***	0.00	0.64***	0.06
$lnS_{j/g}$ (United States)	0.92***	0.00	0.46***	0.05
R^2	0.98		0.69	
R^2adj	0.98		0.69	
F statistic (*p*-value)	0.000		0.000	
Number of observations	5985		5985	

***, ** and * signify 1%, 5% and 10% levels of significance, respectively.
Reference dummy variable: '2003 Shiraz'.

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 characteristics that create a 'good wine'. However, at lower quality segments consumers have less wine knowledge, and there are a greater number of brands to choose from. Equality restrictions on the estimated correlation coefficients were tested, and showed that overall the correlation parameters for ultra premium and popular premium wines were significantly different from those of other quality segments, while taste heterogeneity for Basic, Premium and Super Premium were not significantly different from one another.

Regarding the region model (Table 5), it was found that the degree of heterogeneity of US consumer tastes differed significantly according to the region of origin. While tastes for Australian and US wine are the most heterogeneous, preferences for South American wines appear the most homogeneous. This result may be justified 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 fact, 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 consumer tastes for domestic US wines are relatively heterogeneous. It is in this category that the number of product variants is likely to be the highest. Furthermore, US consumers will have greater access to boutique wines from domestic producers than from foreign producers who may be prohibited from providing such products due to the transaction costs of foreign trade.

The coefficients of the product attributes reported in Tables 4 and 5 provide some insight into the types of wine that US consumers have the greatest preference 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 was 'Argentinean Shiraz' sold in 2003. In the region model the base variable was 'Shiraz' sold in 2003. Therefore, all product attribute coefficients in Tables 4 and 5 must be interpreted relative to the base variable in the quality and region models, respectively. 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 so desired by US consumers, Blush, a very similar product technically, appears to be a popular variety. 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 attest to this observation. Branding becomes 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 preference 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 full advantage of the preferences revealed in this market.

Using the demand parameters reported in Tables 4 and 5, we computed individual own price elasticities as described in Equation (4). Table 6 reports weighted average own price elasticities by wine attribute, for each year in the sample. Similarly, Tables 7 and 8 present weighted average price elasticities

Table 6 Weighted average of own-price elasticities by wine attribute

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

for each group in the quality and region nestings.[3] These elasticities represent the elasticity of the 'average wine' in each respective group. Due to a higher degree of competition and a larger number of substitutes at such a disaggregated level, the magnitudes of the elasticities are greater than would be the case with aggregate market elasticities.

6. Policy implications

Several policy implications for Australian wine producers emerge from the analysis. On the one hand, the estimated degree of heterogeneity of consumers' preferences gives an idea of the possibilities for product differentiation and brand expansion. On the other hand, price elasticities provide insight into

[3] In all cases, these represent sales weighted averages of the individual brand-level elasticities.

Table 7 Own-price elasticities by quality nesting

Year		Basic	Popular premium	Premium	Super premium	Ultra premium	Average
2003	Average	–0.74	–1.91	–2.86	–3.71	–25.56	–2.12
	Standard deviation	0.206	0.255	0.250	0.674	5.04	
2004	Average	–0.75	–1.90	–2.90	–3.76	–25.63	–2.15
	Standard deviation	0.209	0.251	0.263	0.690	5.074	
2005	Average	–0.77	–1.88	–2.94	–3.82	–25.63	–2.42
	Standard deviation	0.165	0.278	0.257	0.710	4.69	
	Average	–0.75	–1.90	–2.90	–3.76	–25.61	–2.23

Table 8 Own-price elasticities by region nesting

Year		Australia	South America	Europe	United States	Average
2003	Average	–4.05	–8.21	–4.19	–1.80	–2.16
	Standard deviation	0.668	1.456	1.319	1.354	
2004	Average	–4.00	–8.36	–4.24	–1.83	–2.22
	Standard deviation	0.639	1.401	1.412	1.369	
2005	Average	–3.94	–8.48	–4.46	–1.98	–2.36
	Standard deviation	0.588	1.421	1.289	1.398	
	Average	–3.99	–8.36	–4.29	–1.87	–2.25

how pricing policies may be used to effectively induce sales, thereby, reducing the excess supply in the Australian wine industry. However, a word of caution is to be applied to price discounting as this has shown to be an ineffective tool in some circumstances, especially given recent declines in the unit value of Australian wine exports (Sheales *et al.* 2006, p. 11). Consequently, alternative non-price policies, such as promotion and bundling, should also be explored. In fact, the competitive situation in the United States implies that a portfolio of price and non-price strategies may be called for.

Merlot and Cabernet Sauvignon, both overproduced varieties in Australia (Davis 2005), face relatively elastic demand in the United States given current sales and prices. There also appears to be an underlying preference for these varieties among US consumers. In this case price discounting may lead to a significant rise in sales, thereby providing a potentially viable surplus disposal policy for Australian producers. However, in the case of Rosé wine, for which the US demand appears highly inelastic, price discounting may be ineffective. Furthermore this appears to be a style that US consumers dislike while Blush, another Rosé style wine, is popular among US consumers. Thus, non-price policies such as a change in branding from 'Rosé' to 'Blush' would be effective. Given that both can be produced using a range of red grape varieties – including Grenache, a variety in oversupply – this change in the branding could boost sales.

Competition in the US market differs significantly depending on the market segment in question. South American wines, for example, are the most price-elastic (see average own-price elasticities in Table 8) and tastes for South American wines are relatively homogenous. Thus, with respect to South American wines, Australian producers could best compete on prices, rather than product diversity. By contrast, US wines are the least price-elastic in the US market and tastes for these wines are highly heterogeneous. In this case, Australian producers should compete by increasing product diversity and producing brands that seem to match American tastes, even if that would lead to stiff price competition.

The results also provide some insight into the direction in which the US market is heading. In general, throughout the three years in the sample, price elasticities of demand have increased. This implies that pricing policies could prove more potent in persuading the behaviour of US consumers. However, Australia is the one exception to this trend. Australian wine exported to the United States tends to indicate a steady fall in price elasticity from 2003 to 2005. This limits the effectiveness of price discounting as a means to boost sales and may force Australian exporters to adopt non-price policies instead. On the other hand, this finding also implies that Australian wine is viewed differently from other wines in the US market. In this sense, Australia could take advantage of this differentiation from other producers in the market to exploit price premiums and other niche market advantages.

The policies outlined above must be viewed and implemented subject to the structure of the US wine market. Price discounting policies that aim at expanding sales are plausible only if wholesalers and retailers cooperate by passing on these price discounts to the consumer. However, given that grape and wine producers supplying the market are considerably greater in number than the wholesale and retail wine firms further down the supply chain, growers and wine producers have relatively little bargaining power. In such a situation, price discounting by grape growers and wine makers might have little effect on the retail final prices which is another reason to be cautious in pursuing price policies. Indeed, the imbalance in bargaining power through the wine supply chain was a key focus of a recent Senate Inquiry into the problem of oversupply in the Australian wine industry (APH 2005). The inquiry made a number of recommendations to address this problem, including the formation of grower-representative groups. Given the Australian wine industry's increasing reliance on export markets, an exporter group made up of smaller individual producers may help to increase the bargaining power of growers and winemakers, thereby increasing the effectiveness of pricing policies in the US wine market.

7. Concluding comments

The present study has estimated 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. This approach sheds some light into the strategies via which Australian producers may be able to enhance market share in the United States, and help reduce the disequilibrium that exists in the Australian wine industry. The findings indicate 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 marketing strategies with which to induce sales differ depending on the wine type in question. Pricing is not always the best tool of competition, particularly in the lower quality segments of the market. Further, of all wine producing countries in the sample, Australia is the only one where price discounting has become increasingly ineffective over time. This implies that Australia should explore non-price strategies, such as promotion, bundling and tying, and especially product differentiation and branding policies, to increase market share.

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