**Disequilibrium in the Australian wine industry: A product diversity approach**

Tim Davis and Fredoun Ahmadi-Esfahani[1]

Stocks of Australian wine, at an industry level, have considerably exceeded sales for many years. However, all varieties and regions are not the culprits of this "oversupply". The mismatching of supply and demand can be attributed to a lack of adequate market information, particularly at the export level. Sub-optimal levels of product diversity in international markets can act as a barrier to entry for new wine exporters, despite that market remaining a promising prospect from a purely "volume" perspective. This paper focuses on product diversity. An empirical model for studying the US wine market is proposed and the implications of the analysis are explored.

*Keywords:* *Wine exports, Discrete choice analysis, Optimal product diversity*

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## 1. Introduction

The Australian wine industry has recently experienced the problem of oversupply. Growth in the volume of winegrapes produced has caused prices to adjust to levels that are, in many cases, below the cost of production.

The purpose of this paper is to present a model by which this problem can be addressed. Approaching the problem of oversupply by focusing solely on wine quantities may be insufficient. That is, a market could be under-utilised in terms of quantity, but saturated in terms of product diversity. In such a situation consumers would be willing to drink more wine, but would not desire greater levels of variety above the current level. The "crowding out" effect of over-provided levels of product diversity acts as a barrier to entry in the market, regardless of any existing excess demand for quantity. For the Australian wine industry, which has an opportunity to exhaust excess stock levels through entering new markets abroad, such a situation would be of considerable concern. Analysis that involves a focus on both wine quantity and product diversity, such as that proposed in this paper, is necessary in order to fully address the problem that is currently faced by the Australian wine industry.

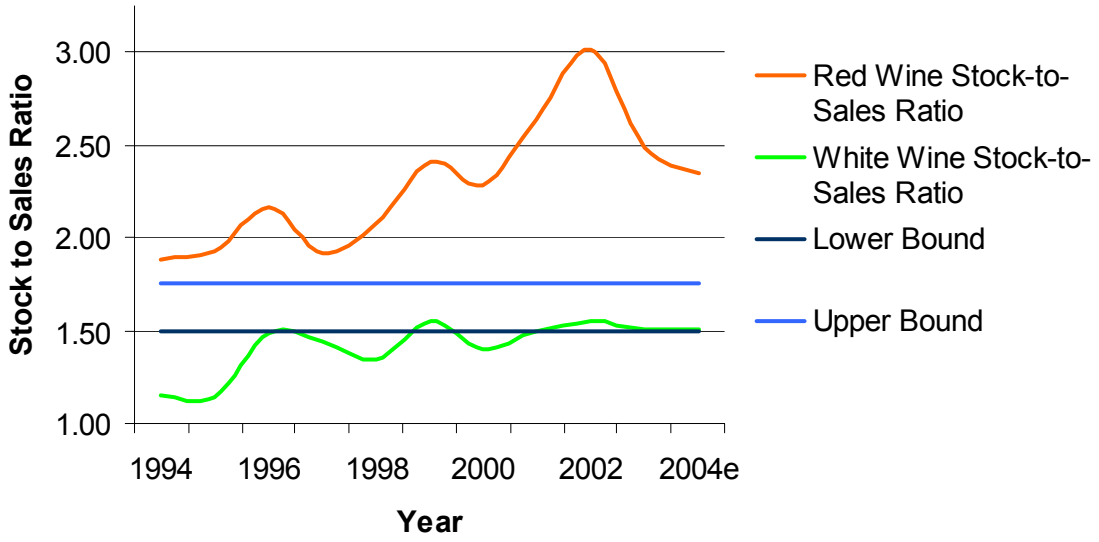
This paper's approach focuses on product diversity: the number of brands that exist in the market. The model can be broken down into two broad components. Firstly, demand analysis must be conducted to estimate consumer preferences for wine and the desire for product diversity. Then a welfare analysis is undertaken to determine the marginal benefit/cost of introducing a new brand to the market.

The industry uses a "stock-to-sales" ratio to measure the degree of any supply-demand imbalance. McGrath-Kerr (2003) has identified the industry's equilibrium range, or "comfort zone", to be between 1.5 and 1.75. The Australian wine industry, at an aggregate level, has been in a state of oversupply since the late 1990s. In 2004 the stock to sales ratio for all wine was 1.85 (ABS 2004). However, when broken down to a more attribute-specific level, it becomes evident that not all Australian grape varieties are contributing to the aggregate oversupply condition. Figure 1 shows that red grape varieties have been the greatest contributors to oversupply over the past decade. Davis (2005) showed that when the analysis was conducted at a variety-specific level, the culprits of oversupply become more diverse again, with some varieties even exhibiting

excess demand. Any attempts to address this problem must, therefore, be conducted at an attribute level. It is clear that the solution will differ according to the wine type in question.

The reasons underlying the recent expansion in production lie mainly on the supply side, and include technological advancements and government incentives to new producers, among other factors. However, given the relatively inflexible nature of wine grape production, the most appropriate solution to the problem lies on the demand side. Indeed, the enhancement of demand in current markets or the identification of new markets would serve to both exhaust current excess wine stocks, and also promoting further industry growth.

Figure 1. Stock-to-Sales Ratio for Australian Red and White Wine, 1994-2004e




Source: McGrath-Kerr (2003)

Empirical results will not be presented, with the paper acting predominantly as a precursor to a planned future application to the US wine market. Section 2 will review the past literature in the area of attribute level demand analyses of wine markets. Section 3 will cover the analytical framework of the proposed empirical model. Information on the available data is discussed in Section 4, with the interpretation and implications of the expected results being explored in Section 5.

## 2. Review of Empirical Literature

The vast majority of empirical studies of product diversity have been in response to suspected anti-competitive strategic firm behaviour. As outlined in Lancaster (1990), the use of product diversity by incumbent firms as a barrier to new entrants is one of three broad reasons for observed levels of diversity to be suboptimal from a social welfare perspective. In the case of the Australian wine industry, no such allegation is being made; however, the crowding out effect of over-provided product diversity exists regardless of whether any anti-competitive intent is evident or not. This situation could adversely affect efforts to extinguish excess wine stocks through the movement into export markets.

Much of the empirical work in the area of optimal product diversity has been focused on breakfast cereal markets. For instance an investigation by the US Federal Trade Commission in 1972, which alleged incumbent firms were acting in an anticompetitive fashion through strategically launching new brands to the market (Church and Ware 2000, p.367). In a simple contextual example, if a finite amount of shelf space is available to a product category, such as breakfast cereal, the introduction of more brands by incumbent firms almost literally has the effect of crowding out new entrants. In more economic terms, once the optimal number of brands has been exceeded, the consumer desire for a new product variant is insufficient to justify the launch cost, thereby making it infeasible for a new brand to enter. That is, total societal benefit would fall upon the introduction of that new product.

Scherer (1979) studied the welfare implications of product diversity in the US breakfast cereal industry, following the antitrust investigation mentioned above. It was argued that a great number of new brands had entered the market prior to this investigation, with little effect on previous brand-specific market shares. It was hypothesised that this might indicate a situation where the optimal level of product diversity had been exceeded. The term “welfare”, as it is used in Scherer (1979), refers to consumer surplus, as opposed to the model used here which defines social welfare as total surplus. The condition that the paper presents is that consumer surplus must be greater than or equal to the cost of launching a new brand into the market, for the overall level of product diversity not to exceed the optimal level. The paper found that 29 breakfast cereal brands did not satisfy this condition, indicating that new products were

launched into the market well beyond the point at which welfare is maximised, and added justification to the investigation that preceded the study.

The findings of Hausman (1994) indicated that the state of the market in 1989, compared to the time of the antitrust investigations, had changed substantially. The analysis showed that consumer surplus increased by 25%, following the launch of a new breakfast cereal brand. This initial analysis was conducted under the assumption of perfect competition. When conducted under imperfect competition, the consumer surplus gain associated with the introduction of a new brand was estimated to be 20%.

Breakfast cereals, however, have not been the only focus of empirical applications of product diversity theory. Hortacsu and Syverson (2003) attempted to determine whether or not too many mutual funds exist in the United States. From a strategic firm behaviour viewpoint, it could be hypothesised that consumers of financial products would be more likely to choose a large reputable firm's product in a market that is over-provided with product diversity. Potential exists, therefore, for these larger firms to introduce more products, in an effort to achieve greater sales. The analysis conducted by Hortacsu and Syverson (2003) used structural estimates of demand parameters and search costs to determine the effect of a change in diversity on a number of welfare components. It was found that reducing the number of funds in the market would lead to a reduction in search costs, but also remarked that search costs could continually be reduced until a monopolist fund remained. Furthermore, it is stated that the reduction in funds could reduce welfare associated with product variety and the deadweight loss associated with the increased market power of the remaining funds. From an overall welfare perspective, the authors suggested that a monopolised mutual fund industry might be socially beneficial, but argued that many simplifying assumptions were imposed in the calculation of that outcome.

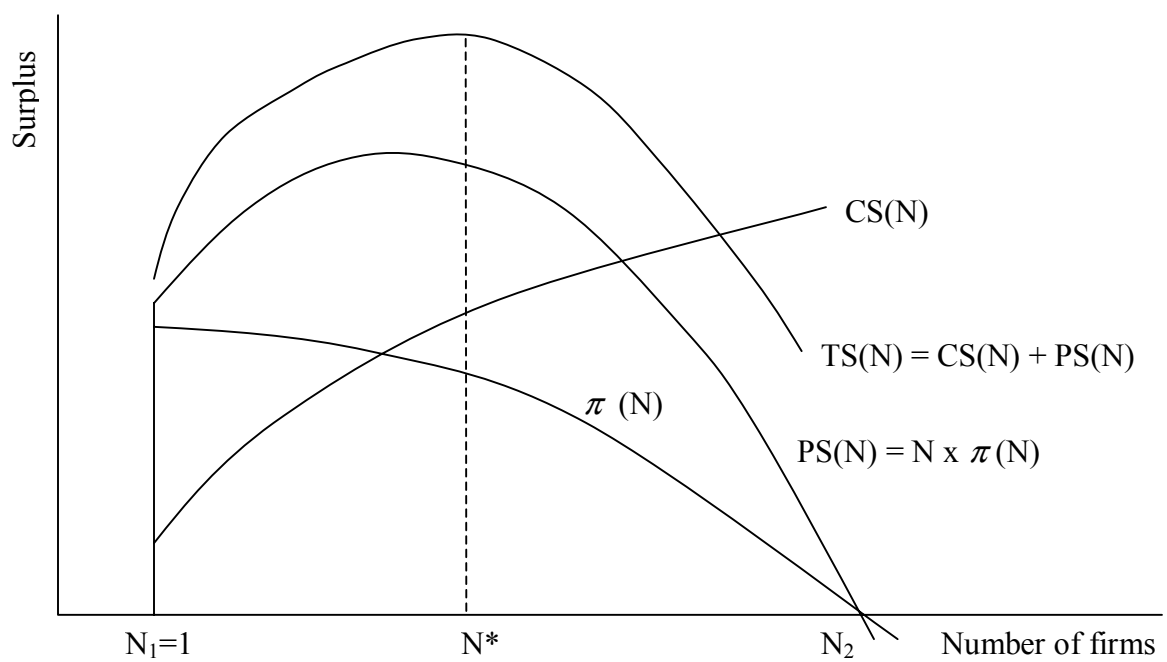
No analyses of product diversity appear to have been conducted on wine markets. Accordingly, the Australian wine industry would appear to benefit greatly from such a study. Growth in export sales is a key method by which the industry can reduce excess wine stocks. The insight that a study of product diversity in export markets would provide on the viability of those markets would considerably improve the industry's chances of rectifying the problem of oversupply.

## 3. Analytical Framework

The product diversity framework can be broken down into two broad models. The first model involves attribute level demand analysis, using discrete choice modelling. A brief comparison of discrete choice models is provided in the appendix. The results of the analysis are then used, along with some quantification of the supply side, in a welfare model to determine the impact that product diversity has on social benefit.

The theory underlying optimal levels of product diversity relates to the maximisation of a welfare function. Welfare is defined as total surplus (TS), where TS is the sum of consumer surplus (CS) and Producer surplus (PS). Welfare is maximised with respect to the number of firms (N), yielding the level of product diversity that benefits society in the greatest way. Lipczynski *et al.* (2005) presents a graphical depiction of the theory (Figure 2), providing some theoretical insight into the ways in which both consumers and producers view product diversity.

Figure 2. Welfare Effects of Product Diversity




Source: Lipczynski *et al.* (2005, p.421)

From Figure 2, it can be seen that theory suggests profit is decreasing in product diversity, while consumers will always demand more variety, albeit at a decreasing rate. These two relationships, when combined, yield a theoretical total surplus curve with a clear maximum.

*Discrete Choice Model of Wine Demand*

A comparative overview of the various discrete choice models that are available, with particular reference to the wine market, can be found in the appendix. Based on this overview, the mixed logit model appears best suited to studying consumer preferences for wine attributes. The working empirical model seeks to estimate the probability that a consumer chooses a given variant of wine, given the attributes that make up that variant. In this context the words "brand" and "variant" are synonymous and represent the number of differentiated wines that exist in a given grape variety / quality segment combination (defined as $d \in J$ in the welfare model presented later in this section).

In general form the discrete choice demand model can be outlined as follows:

$$\Pr(choice) = f(grape\ variety, region\ of\ origin, container\ type, quality\ segment, number\ of\ brands, price)$$

Using the mixed logit functional form, the model can, therefore be presented as:

$$\Pr_{qi} = \int L_{qi}(\beta_j) f(\beta_j) d\beta_j$$

where,

$$L_{qi}(\beta_j) = \frac{e^{(\beta_1 x_1, \beta_2 x_2, \beta_3 x_3, \beta_4 x_4, \beta_5 x_5, \beta_6 x_6)}}{\sum_{j=1}^{6} e^{(\beta_1 x_1, \beta_2 x_2, \beta_3 x_3, \beta_4 x_4, \beta_5 x_5, \beta_6 x_6)}}$$

The formal mixed logit model can, therefore, be represented as:

$$\Pr_{qi} = \int \frac{e^{(\beta_1 x_1, \beta_2 x_2, \beta_3 x_3, \beta_4 x_4, \beta_5 x_5, \beta_6 x_6)}}{\sum_{j=1}^{6} e^{(\beta_1 x_1, \beta_2 x_2, \beta_3 x_3, \beta_4 x_4, \beta_5 x_5, \beta_6 x_6)}} f(\beta_j) d\beta_j$$

where, $x_2$ represents a vector of grape variety characteristics,

$x_2$ represents a vector of region of origin characteristics,

$x_3$ represents a vector of container type characteristics,

$x_4$ represents a quality segment vector, defined by price categories,

$x_5$ represents a vector of the number of brands ($N_j$) existing in the corresponding category, defined by variety and quality segment, and

$x_6$ represents a vector of the price of alternative $i$.

*The Supply Side*

Modelling the supply side of the Australian wine industry requires detailed output and cost data, preferably of a cross-sectional nature. Such data are very difficult to obtain, perhaps explaining why much of the past literature in the area of product diversity has focused only on consumer benefit, instead of total societal welfare. In order to capture the supply side of the Australian wine industry, simulation is a preferable option. This process will draw on a combination of theory and broad-level industry data. Industry-level financial statistics, including cost information according to firm size, are available from Deloitte (2005). These data will provide insight into the scale economies that the industry exhibits, and may also be used to estimate parameters of an industry profit function. Theory suggests that profit is decreasing in product diversity. This assumes that the costs associated with a loss of economies of scale outweigh any potential economies of scope gains. In this way, the development of a wine industry profit function requires both an adherence to theory, but also a realistic representation of the conduct of the industry itself. Factors such as scale and or scope economies must be accurately incorporated into the profit function.

Details of the simulation process used to capture the supply side of the Australian wine industry have yet to be finalised, and are still very much regarded as a work in progress.

*The Welfare Model: Implications of Product diversity*

The welfare model incorporates the above-discussed demand and supply analysis to develop a function that represents the social impact associated with a variable or set of variables. In the case of this study, focus is placed on product diversity (that is, number of brands).The general total welfare model can be outlined as follows:

$$
\begin{aligned}
TW &= CS(N) + PS(N) \\
&= \left( \int_{p^*}^{p^{\max}} \Pr_{qi}.n \right) + PS(N) \\
&= \sum_{j}^{n} \left\{ \int_{p^*}^{p^{\max}} \left[ \int_{-\infty}^{\infty} L_{qi} f(\beta_j).d\beta_j \right] .n.d\beta_j \right\} + \sum_{d} PS_d(N_d) \\
&= \sum_{j}^{n} \left\{ \int_{p^*}^{p^{\max}} \left[ \int_{-\infty}^{\infty} \frac{e^{(\beta_1 x_1, \beta_2 x_2, \beta_3 x_3, \beta_4 x_4, \beta_5 x_5, \beta_6 x_6)}}{\sum_{j=1}^{6} e^{(\beta_1 x_1, \beta_2 x_2, \beta_3 x_3, \beta_4 x_4, \beta_5 x_5, \beta_6 x_6)}} f(\beta_j).d\beta_j \right] .n.d\beta_j \right\} + \sum_{d} PS_d(N_d)
\end{aligned}
$$

where, $TW$ = the total welfare for the population,

$n$ = the number of consumers in the population, assumed to equal total population consumption, and

$d \in J$, but includes a combination of attributes *grape variety* ($x_{j_1}$) and *quality segment* ($x_{j_4}$) only.

When empirically estimated, a welfare function will be developed for each combination, *d*, meaning that the above total welfare function will be summed over *d* as opposed to *j*. That is,

$$W_1 = \sum_{d=1}^{n} \left\{ \int_{p^*}^{p^{\max}} \left[ \int_{-\infty}^{\infty} \frac{e^{(\beta_1 x_1, \beta_2 x_2, \beta_3 x_3, \beta_4 x_4, \beta_5 x_5, \beta_6 x_6)}}{\sum_{j=1}^{6} e^{(\beta_1 x_1, \beta_2 x_2, \beta_3 x_3, \beta_4 x_4, \beta_5 x_5, \beta_6 x_6)}} f(\beta_j).d\beta_j \right] .n.d\beta_d \right\} + \sum_d PS_d(N_d)$$

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$$W_n = \sum_{d=n}^{n} \left\{ \int_{p^*}^{p^{\max}} \left[ \int_{-\infty}^{\infty} \frac{e^{(\beta_1 x_1, \beta_2 x_2, \beta_3 x_3, \beta_4 x_4, \beta_5 x_5, \beta_6 x_6)}}{\sum_{j=1}^{6} e^{(\beta_1 x_1, \beta_2 x_2, \beta_3 x_3, \beta_4 x_4, \beta_5 x_5, \beta_6 x_6)}} f(\beta_j).d\beta_j \right] .n.d\beta_d \right\} + \sum_d PS_d(N_d)$$

The first order condition of each of the above functions, with respect to the number of brands, *N*, will yield a marginal welfare function that explains the impact on social benefit of introducing a new brand into that market. In practical terms, this will be done for each wine type, defined by *d*. That is, for example, a marginal welfare function will be developed for "popular-premium shiraz"[2], along with each other combination of grape variety and quality segment.

## 4. Data

The available data for the proposed empirical work consist of ACNielsen ScanTrack retail level scanner data. To date data have been obtained for the US market over the period 2003-2005. The top 200 brands are ranked according to total brand-specific sales. Each brand can be expanded to show the product characteristics, prices and sales volumes of each wine within their range. Product characteristics include grape variety, region of origin and container type (size). The price is an average unit price for each listed wine. Also available in the dataset is a price change variable which captures any variation in price from the previous period. This variable may be valuable in determining the direct effect of price discounting – a topic of great interest to wine producers in times of oversupply. Region of origin predominantly includes only the country of origin. More specific regional information, although it may appear to be important in the decisions of

[2] At this preliminary stage, quality segments used are those defined in Heijbroek (2003).

consumers, has been shown in Davis and Ahmadi-Esfahani (2005) to have relatively little effect on demand in the US market. The container type variable indicates the container size, and includes 187ml, 375ml, 750ml, 1.5L, 4L, 3L and 5L variants. This variable may provide some interesting inferences into a possible reaction of consumers to recent overall rises in wine alcohol content (Godden and Gishen 2005). The ACNielsen ScanTrack data are sourced from the "grocery" sector. Grocery accounts for 44% of total wine consumption in the United States. However, the ScanTrack data covers only off-premise sales (that is, wine that is bought and consumed in two separate locations), of which accounts for 79% of total US wine consumption. Therefore, the market coverage of the data is 34.8%; that is, 79% of 44% (ACNielsen 2004).

## 5. Propositions for the Australian Wine Industry

The model proposed here will yield a diverse range of empirical results that, when combined, will have implications for the Australian wine industry at a number of levels. The demand analysis will provide demand elasticities (and flexibilities) for each wine attribute. The welfare analysis will give some insight into the degree to which adding a new brand into the market will affect social benefit. When viewed separately, these analyses offer valuable information to current and potential Australian wine exporters. However, when combined and appraised simultaneously, an even more holistic policy recommendation for the wine industry can be made. The discussion here is based on no actual empirical findings, but rather presents a range of possible options that such an investigation may provide. The implications for the wine industry of each of these options are explored.

### *The Demand Analysis*

Price elasticities and flexibilities of demand for each wine attribute offer some insight into the price-quantity relationship of the wine market. The sensitivity of price to changes in sales can indicate whether or not excess demand may exist in a market. For example, if the price flexibility of demand for Barossa Valley Shiraz was smaller than Hunter Valley Semillon, this would indicate that consumers will more happily absorb greater quantities of Barossa Shiraz than Hunter Semillon. Consider the following scenario where, for

example, the above outcome existed in the United States, with the United Kingdom had the inverse relationship. Given this hypothetical finding, an appropriate policy recommendation for Australian producers would be to export a greater quantity of Hunter Semillon to the United Kingdom, and more Barossa Shiraz to the United States, holding other factors constant. The benefits this would provide Australian producers who are under the pressure of oversupply are clear.

*Welfare Analysis*

The analysis of product diversity includes the derivation and differentiation of a social welfare function, including both producer and consumer factors, to obtain a relationship between marginal social benefit and the number of brands in the market. In essence, it will be possible to determine the effect on social welfare of adding a new brand to the market.

However, the question is as to why one would aim to solve an "oversupply" problem through the analysis of product diversity. Despite their seemingly separate nature, sales volumes and product diversity are closely linked. In very simple terms, if there are too many brands of wine in a given market, future potential entrants will be unable to enter the market. This "crowding out" effect exists regardless of any excess demand that may exist in a quantity sense in that market. Therefore, excess product diversity can have the same effect as flooding a market with quantity beyond demand. This effect is very similar to strategic use of product diversity, suggested in Lancaster (1990) and Church and Ware (2000), of a firm producing more than one brand for the intention of crowding out their competitors. Regardless of whether this is a conscious decision or not by incumbent wine firms in export markets, the resulting effect of restricting the entrance of new producers into the market remains the same.

*Combined Implications*

In order to develop a holistic understanding of the market being studied, the two above analyses must be combined. Consider the case where the demand analysis implied that excess demand was present in the US market. Without corresponding analysis of product diversity, it is possible that a new entrant looking to take advantage of this excess demand

would find it impossible to launch a new brand in that market, if indeed product diversity was over-provided. Similarly, the welfare analysis may show that a particular market is under-utilised in terms of product diversity, when it may be saturated in terms of volume. In order to provide truly meaningful results, it is necessary to combine these two broad areas of analysis.

A number of scenarios are likely to be expressed in the findings. The combination of a small price flexibility of demand and a negative net benefit of launching a new brand implies that excess demand in volume may exist in the market. However, this also suggests that the optimal number of brands has been exceeded. Therefore, the policy implication associated with this scenario is to reduce the number of brands available, while providing a greater volume of each remaining brand.

The combination of a small price flexibility and a positive net benefit of launching a new brand in the market suggests that the market in question is under-utilised in terms of both potential sales volume and product diversity. The market has the ability to absorb more volume and additional wine brands. This scenario provides the most promising opportunity for new Australian exporters.

A large price flexibility of demand combined with a negative net benefit from launching an additional wine brand implies that both volume and product diversity are oversupplied in the market. This scenario appears the least promising for prospective Australian wine exporters. One would expect that this market situation would only occur in a transitional stage. For example, a positive supply shock in a market already over-utilised in terms of product diversity. According to product differentiation theory, such a scenario is highly unsustainable.

The final scenario possibility is a large price flexibility of demand combined with a positive net benefit associated with an additional brand. This suggests that the market may be saturated in terms of volume, but underutilised in terms of product diversity. New entrants will not succeed in such a market, unless incumbent brands reduce their output below the effective demand evident in the market. It would be unlikely for this to occur in a competitive and strategic market.

## 6. Concluding Comments

Reducing grape and wine output is not an effective policy to address excess wine stocks and falling prices. It is more appropriate to focus on export markets as a potential source of excess demand, thereby allowing stocks to be reduced while promoting industry growth. Little empirical analysis of Australia's wine export markets has been conducted at present. The aim of this paper is to present a model by which preferences for wine by consumers abroad can be studied. The approach proposed extends beyond a simple demand analysis by conducting welfare analysis to determine the impact that product diversity has on the viability of export markets. The potential for a market to absorb greater quantities of wine is irrelevant if that market is over-provided with product diversity. Despite empirical results not being presented here, implications of various potential outcomes were explored. Upon the estimation of results, for the US market, propositions can be made with respect to which wines are best suited to that market.

Given that this paper is a work in progress, many areas of further research exist. The most notable being the estimation of the wine industry's supply side, in the form of a profit function. A lack of data disables the option of empirical modelling at this stage, leaving simulation as a viable alternative. The specific nature of this simulation has yet to be fully explored, and is likely to constitute a significant portion of further research on this topic.

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**Appendix: A Comparative Review of Discrete Choice Models of Demand**

Discrete choice analysis provides an effective method of conducting attribute-level demand analysis in a market made up of differentiated products. It is, therefore, appropriate for modelling the market for wine. The underlying construct of discrete choice models, as outlined in Hensher (2005), can be shown where a group of sampled consumers, $q = 1,\ldots,Q$, face a choice among $j$ alternatives, where $j = 1,\ldots,J$, across a set of $T$ choice settings, $t = 1,\ldots,T$. The random utility function for consumer $q$ is therefore expressed as:

$$U_{q,j,t} = V_{q,j,t} + \varepsilon_{qjt}$$

where $V_{q,j,t} = \beta' x_{q,j,t}$. The vector, $x_{q,j,t}$, represents the full set of explanatory variables, including product and consumer attributes, and descriptors of the choice setting $t$. $\beta$ and $\varepsilon$ are components that are unobserved to the researcher. The assumption of identical and independent (IID) type 1 extreme value distributions (EV1) for $\varepsilon_{qjt}$ yields the standard multinomial logit model:

$$\Pr\left[\text{choice } j \mid \text{consumer } q,\ \mathrm{X}_{qt}, \text{ choice setting } t\right] = \frac{e^{\mathrm{V}_{qjt}(\beta)}}{\sum_{j=1}^{Jq} e^{\mathrm{V}_{qjt}(\beta)}}$$

The highly restrictive IID-EV1 assumption requires the model to obey the property of "independence from irrelevant alternatives" (IIA), meaning that the ratio of two alternatives in the model are entirely independent of any other alternatives that may exist. This assumption is clearly unrealistic, especially when studying markets made up of many similar, but differentiated products, and has led to the development of several adaptations of the MNL model to address this problem.

The nested logit (NL) model partially relaxes the IIA assumption by assuming that the condition only holds within nests. That is, consumer decisions are broken up *a*

*priori* into different categories. Each category contains relatively closely related products. The assumption that IID holds within these categories, or "nests", but not between them, is more realistic, when compared to the MNL model. The nested logit is outlined in detail in Train (2003). Let there be $j$ existing alternatives that lie in $K$ non-overlapping nests, denoted $B_1, \ldots, B_K$. Consumer $q$ derives utility, $U_{qj} = V_{qj} + \varepsilon_{qj}$, from consuming alternative $j$ in nest $B_k$, where $V_{qj}$ is the observable utility component and $\varepsilon_{qj}$ is a random variable that represents the utility that is unobservable by the researcher. The choice probability for alternative $i \in B_k$ can be expressed as follows:

$$P_{qi} = \frac{e^{V_{qi}/\lambda k}\left(\sum_{j \in B_k} e^{Vj/\lambda_k}\right)^{\lambda_k - 1}}{\sum_{l=1}^{K}\left(\sum_{j \in B_l} e^{V_{qj}/\lambda_l}\right)^{\lambda_l}}$$

where, $\lambda_k$ measures the degree of independence in unobserved utility among alternatives in nest $k$.

For easier interpretation, the nested logit model can be written as two separate standard logit models. The nested logit probability is defined as the product of the two standard logit probabilities. For example, the probability of choosing alternative $i$ in nest $B_k$, is the product of the probability that an alternative in nest $B_k$ is chosen and the probability that alternative $i$ is chosen given that an alternative in $B_k$ is chosen (Train 2003, pp.84-86). This can be expressed as the following:

$$P_{qi} = P_{qi|B_k} P_{qB_k}$$

Another discrete choice model that has become increasingly popular in recent times is the mixed logit. In very general terms the mixed logit combines two distributions in order to allow for random taste variation across consumers. The mixed logit probability is an integral of the standard logit probability, over a density of parameters, $\beta$, which represent consumer preferences over product characteristics (Train 2003, p.138). That is,

$$P_{qi} = \int L_{qi}(\beta) f(\beta) d\beta$$

where $f(\beta)$ is a density function (or "mixing distribution") over parameters and $L_{qi}(\beta)$ is the standard logit probability,

$$L_{qi}(\beta) = \frac{e^{V_{qi}(\beta)}}{\sum_{j=1}^{J} e^{V_{qi}(\beta)}}$$

Therefore, the mixed logit probability takes the form,

$$P_{qi} = \int \frac{e^{\beta' x_{qi}}}{\sum_j e^{\beta' x_{qi}}} f(\beta) d\beta$$

In the special case, where $\beta_1, ..., \beta_j$ all take on the same value, $f(\beta)$ is equal to 1, and the above mixed logit probability becomes the standard logit probability. That is, when preferences become homogenous, the model becomes a standard logit. The mixed logit model's ability to capture consumer heterogeneity in preferences is its main feature in comparison to the standard logit model (Train 2003, p.139). It is for this reason that the mixed logit is perhaps the most suitable model for studying the demand for wine. Wine is clearly a highly heterogeneous product. This heterogeneity of production has come about through the nature of both the supply and demand side of the market. Due to the wide range of production areas, techniques and grape varieties, it would be effectively impossible for wine to exist as a homogenous product. It is for this reason that discrete choice models of demand are the most appropriate. However, the degree of heterogeneity in wine markets is also due to the heterogeneity of consumer tastes. Consumer demand for product diversity has led to winemakers supplying that diversity. For this reason, a discrete choice model that allows for diversity in consumer tastes (effectively doing away with the "representative consumer" approach) will provide the most realistic results.