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Hybrid Discrete Choice Models**

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Measuring consumer preferences using hybrid discrete choice models

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Abstract

Wine is a complex product. Preferences for it are not only highly heterogeneous throughout the population, but also amply susceptible to context. The objective of this study is to discover and measure these preferences, focusing on a set of non-sensory attributes of wine.

To identify the most relevant non-sensory attributes of wine, from the consumers' standpoint we considered four sources: existing literature, a Delphi survey (applied to wine marketing experts), in-depth interviews and a web-page survey answered by fairly large sample of wine consumers. Not all sources were consistent on which attributes were the most important. Notably, consumers did not select price as a relevant attribute on the web survey, even though it had been considered relevant in the in-depth interviews. Finally, six wine attributes were selected for inclusion in a stated choice (SC) experiment: grape variety, alcohol level, label design, product recommendations, price and discounts.

An efficient experimental design was then developed and a web based SC survey was applied to 274 regular wine consumers (who had already answered the previous web survey). These consumers have high income (among the richest 20% of the Chilean population), only 28% of them are female and 33% are 35 years old or younger. The SC experiment simulated a purchase, at a retail store, for a casual meal with friends. A fixed fictional brand was used for all the wines presented on the experiment. With this data we estimated various discrete choice models, including mixed logit and hybrid choice models.

Grape variety was found to be the main driver of preferences. Evidence of preference for higher alcohol levels was also discovered. Price proved to be highly endogenous, as it is strongly related to wine's expected quality. Recommendation by a friend and critics were equally valued, except in the case of (self-declared) expert consumers. Preferences over label designs showed high variability. The results also suggest that price is a key attribute in the construction of expected quality by the consumer before tasting the product.

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1 Food, beverages, consumers and discrete choice

Discovering consumer's preferences is never an easy task. This is particularly true for the food and beverages industry where consumer preferences tend to be not only subjective and heterogeneous, but also highly susceptible to context (Jaeger & Rose 2008; Hersleth *et al.* 2003) and even variable within the same individual (Mueller & Szolnoki 2010).

Grunert (2005) developed a conceptual two-stage model to explain how consumers decide their purchases when facing a food or beverage product. The first stage is before tasting the product, and the second after tasting it. In the first, consumers try to construct expected quality of the product based on available cues, as they cannot eat or drink it and therefore are not aware of all relevant information. After consumption of the product, expectations built in the previous stage interact with the actual experience and a final perceived quality is achieved. From this process, two classes of attributes are defined:

- *Intrinsic* attributes. These are inherent to the product itself, and are strongly identified with its physical and chemical composition. Colour, taste and aroma are typical examples.
- *Extrinsic* attributes. These consider all non-intrinsic attributes, such as all items surrounding the product (e.g. price, labelling, packaging, advertising, etc.).

The research presented in this paper focuses on the effect of extrinsic attributes. Therefore, it aims to understand and model the construction of expected quality in consumers' mind, when deciding to buy a new product, that is, one they have not tried before. Wine is chosen as a case study, because of its complexity, both in its sensory and non-sensory dimensions.

An on-line (web-page) stated choice (SC) experiment simulating the purchase of wine at a specialty store was design and applied to a sample of 273 individuals. Discrete choice models (DCM) were used to estimate each attribute's marginal utility. This methodology has advantages over *hedonic rating* (Mueller *et al.* 2009; Louviere & Islam 2008, Mueller *et al.* 2010a), a common technique used in food science, which asks consumers to assign a score to each alternative.

Given that excessive cognitive charge (respondent burden) should be avoided on SC experiments (Caussade *et al.* 2005), it is important to only include the most relevant attributes of the product in the experiment. To identify them, a first qualitative stage was conducted. Label design, grape variety, alcohol content, wine recommendations, price and discount were identified as the most relevant extrinsic attributes of wine. The modelling stage revealed that grape variety was the most relevant attribute for consumers. It was also found that consumers have a strong reliance on price to build the product expected quality. But his price-quality association generates problems (endogeneity) when estimating the relevance of price. Even though we found that using latent variables to correct for this problem seems promising, it may not be a definitive solution.

The remaining of the paper is structured as follows. Section 2 presents the most relevant attributes of wine according to our various sources of information. Section 3 discusses some aspects of the SC experiment design, while Section 4 presents its main results (i.e. the estimated models). In section 5 we discuss our results and in Section 6 we summarize our main conclusions.

2 Determining the most relevant extrinsic attributes

As wine is a complex product many attributes are involved in its description. A regular bottle of wine will show in its label at least the winery's name, the brand (i.e. a specific product of a winery), the alcohol content, the harvest year, the grape variety, the place of origin, the type of wine (i.e., in Chile Reserve, Great Reserve, Premium) and some design elements such as bottle shape and colour.

Many wines also include a brief sensory description on the back label, and some even recommend particular types of meals to have the wine with. Price, discount and promotions are also basic descriptors of the wine offer. Finally, any kind of previous information consumers may have about the wine, such as recommendations (from friends, family or salesmen) or advertising, may influence their decision.

To consider all possible attributes in a single model and, even more, to design an experiment capable of measuring them all is unpractical and most probably futile. Therefore, the most important attributes must be identified before any experiment is designed. Given the scarce literature about wine consumers in Chile (Schnettler & Rivera 2003; Jiménez *et al.* 2006; Mora *et al.* 2010), we decided to identify the most important attributes of wine using four sources of information: (i) published technical literature, (ii) a Delphi survey, (iii) in-depth interviews with consumers and (iv) a web-page survey. All these are briefly discussed below.

2.1 Attributes mentioned in the literature

According to the literature (Table 1), the most popular attribute is place of origin (*Appellation d'origine contrôlée* or other designation of origin). Price is also a relevant attribute for any product, and therefore it is expected to be considered in most research papers. The influence of sensory attributes in wine purchases is largely discussed in the literature, but it exceeds this paper's objectives. Brand is also common in wine research papers, but is not relevant in the case of studying the choice of new wines. Grape variety, label design and discounts are less common attributes.

Table 1 - Attributes most commonly considered in the literature

Attribute	Mentions	References
Origin	12	Angulo <i>et al.</i> (2000), Barreiro Hurlé <i>et al.</i> (2008), Carew <i>et al.</i> (2010), Hollebeek <i>et al.</i> (2007), Lockshin <i>et al.</i> (2006; 2009), Loureiro <i>et al.</i> (2003), Martínez-Carrasco <i>et al.</i> (2006), Mtimet & Albisú (2006), Mueller <i>et al.</i> (2010a; 2010c), Verdú <i>et al.</i> (2004)
Price	9	Barreiro-Hurlé <i>et al.</i> (2008), Hollebeek <i>et al.</i> (2007), Lockshin <i>et al.</i> (2006; 2009), Martínez-Carrasco <i>et al.</i> (2006), Mtimet & Albisú (2006), Mueller <i>et al.</i> (2010a; 2010b), Mueller & Szolnoki (2010)
Sensory attributes	7	Bastian <i>et al.</i> (2010), King <i>et al.</i> (2005), Lattey <i>et al.</i> (2009), Mueller <i>et al.</i> (2009; 2010c), Mueller & Szolnoki (2010), Verdú <i>et al.</i> (2004)
Brand	6	Lockshin <i>et al.</i> (1997; 2006; 2009), Mueller <i>et al.</i> (2010a; 2010c), Mueller & Szolnoki (2010)
Grape variety, alcohol content, organic, aging, label design, chemical profile.	4 each	Angulo <i>et al.</i> (2000), Mtimet & Albisú (2006), Mueller <i>et al.</i> (2010a; 2010b; 2010c), Carew <i>et al.</i> (2010), Lockshin <i>et al.</i> (2009), Barreiro-Hurlé <i>et al.</i> (2008), Forbes <i>et al.</i> (2009), Martínez-Carrasco <i>et al.</i> (2006), Verdú <i>et al.</i> (2004), Jarvis <i>et al.</i> (2010), Mueller & Szolnoki. (2010), Blackman <i>et al.</i> (2010), Cortez <i>et al.</i> (2009), Hersleth <i>et al.</i> (2003), King <i>et al.</i> (2010)
Harvest (year), discount, packaging	3 each	Angulo <i>et al.</i> (2000), Carew <i>et al.</i> (2010), Verdú <i>et al.</i> (2004), Hollebeek <i>et al.</i> (2007), Lockshin <i>et al.</i> (2009), Mueller <i>et al.</i> (2010a; 2010c), Mueller & Szolnoki (2010)

2.2 Delphi Survey

A Delphi survey¹ (Helmer, 1967; Green *et al.* 2007) was applied to wine consumer experts in Chile (i.e. people from the wine industry in contact with consumers; we excluded oenologists and wine makers) to identify the more important attributes of wine from a consumer's standpoint. The survey had two stages; respondents were asked to distribute 100 points among 35 wine attributes at each.

In the first, the questionnaire was sent to 24 experts: six marketers, specialized journalists and academics, and 18 salesmen from *El Mundo del Vino*, a well-known wine specialty store. Both groups considered price to be a main driver of wine purchases (Table 2), but results show that experts' opinions, though informative, present easily detectable bias (i.e. marketers, journalists and academics focused on intrinsic attributes, while salesmen probably overestimate their own influence). The second stage (not reported here) did not show significant differences from the first.

Table 2 - Ranking of attributes according to first stage of the Delphi survey

Ranking	Attribute	Average First Group	Second Group
1	Price	11.1	11.1
2	Aroma	10.5	8.4
3	Taste	7.5	5.7
4	Salesman's advice	6.9	8.6
5	Previous consumption	6.4	5.2
6	Label design	5.4	6.0
7	Supermarket discount	5.3	4.8
8	Friend's advice	4.7	4.4
9	Advertising	4.3	5.3
10	Cork type	3.4	4.0
11	Critic's advice	3.3	3.3
12	Winery	2.9	3.0
13	Brand	2.9	2.7
14	Internet promotion	2.8	2.9
15	Grape variety	2.7	4.1

2.3 In depth-interviews

A small qualitative study was performed to gain insight about wine consumption. It was hoped that by understanding consumer's deep motivations (Zaltman 2003), a better comprehension of consumer's heterogeneity could be achieved².

1 Delphi surveys are used to gain expert consensus without the unwanted influences of a traditional expert panels (middle point opinions instead of consensus, excessive influence of one individual because of her status, etc.). A Delphi survey is an iterative process. On the first stage, a set of experts are asked their opinions on the subject under scrutiny. These should be expressed as unambiguously as possible (hopefully, in numeric form). Once all answers are collected, the experts are asked the same question again, but this time the "average" opinion from the previous stage is informed. It is expected that answers converge to a consensus (Dalkey 1969).

2 According to Zaltman (2003), all purchasing processes are dominated by two variables: consumers' deep motivations and their idea of the product. Deep motivations are fundamental desires of the individual (for example, to be healthy or to feel protected). An idea of a product is a conceptualization of it (i.e. a way of understanding the product). If an idea of a product fulfills a deep motivation, then the consumer wants the product.

To this end, 14 episodic interviews³ were carried out. Consumers volunteered to participate and, from all the contacts gathered, a heterogeneous sample was selected based on their socio-demographic characteristics. The research question behind this part of the study was “What is the process of buying and consuming wine like?” The question is wide enough to allow for deep motivations showing themselves, but narrow enough to keep the study strictly in the consuming process, without diverging to the social conception of wine or alcohol, for example.

Only the seven more informative interviews were analysed using the thematic coding proposed by Flick (2000) and consensus maps (Zaltman 2003; Novak & Cañas 2008) were also built (not reported here; the interested reader might consult Palma 2013). Four deep motivations were discovered:

1. **Social cohesion:** Represents the social environment in which wine drinking often happens. In many societies wine is the preferred drink with meals, and is also used in celebrations and social gatherings. And even though drunkenness is often condemned, the alcoholic nature of wine is valued, as it relaxes people and facilitates social relations.
2. **Sophistication:** This is born from the desire of being unique. A sophisticated individual wants to be different from others (e.g. being an expert on wine allows him/her to differentiate). This does not necessarily imply that the individual's interest in wine is purely utilitarian, as s/he may truly enjoy it. Sophisticated individuals will seek to learn more about wine just as music-lovers do not only listen to music, but educate themselves on it.
3. **The good life:** Represents the tendency to be self-indulgent, in the sense of attempting to add pleasure to everyday life. It is not necessarily a highly hedonist way of living, but more of a reward for one's efforts (i.e. an “I deserve to be happy and enjoy myself” way of thinking). The good life can be lived socially, as long as society provides space to do so, or individually, in which case the sensory aspect of wine drinking becomes dominant.
4. **Tradition:** This relates to the influence of family in wine consuming behaviour. The image of the father (or grandfather) at the head of the table, having wine with the meal, helps legitimizing wine consumption, and gives wine a masculine touch.

Both social cohesion and sophistication proved to be useful when modelling consumer preferences (as will be seen in section 4).

2.4 Web survey

A web-page survey concerning four topics was developed: (i) demographics, (ii) wine drinking and buying habits, (iii) attitudes towards wine and (iv) wine's most relevant attributes. *El Mundo del Vino*, a well-known wine specialty store in Chile, facilitated us with its contact's database. Therefore, all respondents had at least visited or shown some kind of interest in specialty wine stores. 837 answers were collected.

Males older than 35 years of age represent 46% of the whole sample. Even though there is no national profile for Chilean wine consumers, it is evident that the sample is not representative at a national level, given that 80% of respondents earn more than 24,000 US\$ per year⁴ and 77% have at

3 An episodic interview is a one-on-one interview, where respondents are asked to narrate a number of events, allowing them to accentuate the aspects they consider more relevant (Flick 2000).

4 According to the 2011 CASEN survey (Ministerio de Desarrollo Social 2012a), the autonomous (i.e. without government support) mean annual national household income is US\$ 18,790. But given the highly skewed income distribution in Chile, at least 60% of the population earns a lot less than that (the official minimum wage is only around US\$ 4,800/year).

least 16 years of formal education⁵. Still, they are representative of the kind of consumers a wine specialty store serves. Concerning the sample consuming behaviour, less than 10% of individuals drink fewer than once a week, while around 50% drink only once or twice per week, probably on weekends. The remaining 40% of respondents drink more than twice a week (heavy users); in fact, only heavy users tend to drink during weekdays. In terms of price, the most common niche in the sample is from 10 to 20 US\$, and this is independent of consuming frequency. Supermarkets are the most popular distribution channel to buy wine. Internet purchasing seems to be relevant only for heavy users.

Based on the findings of the in-depth interviews, eight phrases were elaborated to measure consumers' deep motivations. However, only six of them were useful (see section 4.2). Consumers had to manifest their level of agreement with each phrase through a seven point scale, where 1 means absolute disagreement and 7 complete agreement⁶.

Finally, the web-page survey included a long list of wine attributes that consumers had to rate from 1 to 7, indicating their relevance on the choice process. Even though some researchers (Zaltman 2003; Mueller *et al.* 2010a) argue that self-reported buying processes are often unreliable, this information was collected in order to compare it with other sources. As scores are only comparable within subjects, all responses were normalized by each individual's mean score and variability, and a constant was added to assure non negativity. Table 3 presents the ranking of attributes according to consumers.

As can be seen, *price* is positioned surprisingly low probably because when consumers decide to buy wine, they select a price niche *a priori*. Inside that price niche, cost differences are small and have little influence on the purchase decision. On another hand, just as the experts did consumers value sensory attributes (*taste, aroma, colour* and even *meal matching*) highly, and place previous experience (to have tried the wine themselves) high in the ranking. The only extrinsic attributes among the first five positions in the ranking, are *grape variety* - which is supposed to strongly correlate with the sensory properties of wine - and *type of wine*, which strongly correlates with price. Wine *recommendations* only show up on the 10th (friend's) and 13th (critic's) place, while other extrinsic attributes are scattered along the ranking.

3 Experimental design

The SC survey (Ortúzar & Willumsen 2011, section 3.4) was set up on SurveyGizmo, an on-line survey platform and it was sent to the 837 consumers who had answered the web-page survey. This allowed us to reduce the time required to complete it as the demographic and attitudinal data obtained at the previous survey was available. Each person faced six choice scenarios with four alternatives each. All scenarios included a non-purchase alternative (see Figure 1).

3.1 Attribute selection

Six attributes were finally selected for inclusion in the choice experiment: *label design, grape variety, alcoholic content, price, discount* and *recommendation*. To improve realism, *type of wine* was added as an additional seventh attribute, although it directly correlates with price through a deterministic rule⁷.

5 According to the 2011 CASEN survey (Ministerio de Desarrollo Social, 2012b), the average years of schooling in Chile do not exceed 15, even for the richest 20% of the population over 35 years of age.





6 As the 1 to 7 scale is used in the Chilean educational system to grade students everybody is familiar with it.

7 All wines with prices lower than 7 US\$, were labelled as Varietal; wines from 7 to 20 US\$ were labelled Reserve, and wines above 20 US\$ were labelled Grand Reserve.

Table 3 - Attribute importance ranking according to consumers

Ranking	Attribute	Average standard score
1	Taste	6.74
2	Grape variety	6.51
3	Aroma	6.36
4	Previous experience	6.31
5	Type of wine (reserve, great reserve, etc.)	6.19
6	Colour	5.7
7	Harvest year	5.63
8	Meal matching	5.52
9	Winery	5.51
10	Friend's advice	5.51
11	Place of origin	5.48
12	Price	5.36
13	Critic's advice	4.31
14	Prizes and medals	4.81

Figure 1 - Screen-shot from the web-based choice experiment

Wine A	Wine B	Wine C	Wine D
			
Carmeneré 14,5° G.L.	Merlot 12,5° G.L.	Syrah 8,5° G.L.	Cabernet Sauvignon 14,5° G.L.
You remember reading a favoring critic about this wine	You don't remember reading or hearing about this wine	You remember reading a favoring critic about this wine	The salesman recommended this wine to you
\$ 18000	\$ 18000 \$ 14400 -20%	\$ 22500 \$ 20250 -10%	\$ 18000 \$ 14400 -20%

6. Which wine would you buy? *

Wine A
 Wine B
 Wine C
 Wine D
 I would not buy any wine

Although *brand* had been highly appreciated, measuring a particular brand's effects was not an objective of our research. Contrariwise, *alcoholic content* did not appear as particularly relevant but it was included as it is of much interest to wine makers. *Recommendation* (advice) was also included for its relevant role in the purchasing process inferred from the in-depth interviews but it is an attribute often ignored on literature. *Context* is also an important attribute, so it was fixed for all exercises as “an informal dinner with friends”. This context occasion is considered within the classifications made by Hall (2003) and Martinez-Carrasco *et al.* (2006).

3.2 Attribute levels

Table 4 presents the levels for all attributes. A maximum of four levels was allowed to keep the number of choice situations for each person from growing excessively (Louviere *et al.* 2000).

Table 4 - Levels considered for the six attributes selected

Level	Label Design	Grape Variety	Alcohol content	Advice	Price	Discount
1	Delicate	Cabernet Sauvignon	8.5° G.L.	None	100%	0%
2	Contrast	Merlot	11.0° G.L.	Salesman	120%	10%
3	Natural	Carménère	12.5° G.L.	Friend	130%	20%
4	-	Syrah	14.5° G.L.	Critic	160%	-

Before presenting the choice exercises, consumers were asked to input the amount of money they would be willing to spend on a bottle of wine for the given occasion context (informal dinner with friends). This value was scaled, and discounts were applied over the scaled price.

Unlike other published studies (see Table 1 above), we considered price variations mainly within a price niche. However, measuring the reaction within a given price niche is harder because consumers seem to choose the price niche before selecting a bottle of wine. This means that buying wine may be considered a hierarchical process, where consumers choose the price niche first (mainly based on the context occasion) and only then, the particular bottle they might find more suitable. Ignoring this process, might render biased results.

The four red grape varieties included were those most common in Chile (ODEPA 2012). The alcohol content was made to vary enough to consider 8.5° G.L, a level almost inexistent in the Chilean market at the time of the study. The levels used for the label design were taken from Orth & Malkewitz (2008). In that research five classes of wine label designs were identified, but only three of them were considered to describe the Chilean market well enough. To avoid bias, three different labels were constructed for each level of label design, and they were assigned randomly.

3.3 Design Efficiency

A D-efficient balanced design (Rose & Bliemer 2009; Rose *et al.* 2008; Ortúzar & Willumsen 2011, section 3.4) was built using N-gene (<http://choice-metrics.com/>), generating two blocks of six scenarios each. Every respondent was randomly assigned to one block. To avoid order bias, both the exercise and the order of presentation of the scenarios were randomized. The design also avoided domination concerning grape variety, advice (recommendation), price and discount. A ranking of grape varieties was asked at the beginning of the survey, and the ranking of recommendations for each respondent was known from the previous web-page survey.

4 Results

From the 837 invited individuals, 272 completed the SC experiment, providing 2,076 usable observations⁸. Besides each alternative's attributes, demographic and attitudinal data was available for each respondent from the previous web survey (see section 2.4). With this dataset, two models were estimated: (i) a simpler mixed logit (ML) model, allowing for the pseudo panel effect implicit in SC data, using only the alternative's attributes (section 4.1) and (ii) a hybrid discrete choice

⁸ 125 respondents answered six choice situations, and 156 individuals answered six choice situations plus one ranking exercise, in which they were asked to rank the three most preferred wines from those (six) they had previously chosen.

(HDC) model, incorporating also latent variables (section 4.2).

4.1 ML model

An ML model⁹ (McFadden & Train 2000; Sillano & Ortúzar 2005; Ortúzar 2010) was estimated, with all attributes of the alternatives as covariates. The effect of contrast label designs was found to be insignificant. The effects of friend's and critic's advice were statistically equal. Estimated coefficients, t-tests and other relevant goodness-of-fit statistics are shown in Table 5.

The effect of Grape variety was divided in two parts. The first part is the average effect over the sample (i.e. how much a particular Grape variety is liked in the sample), and is the same for all individuals. The second part is an effect reflecting the personal preferences for Grape variety (i.e. the relevance of being the best-liked variety, the second-best or the third-best grape variety, for each individual). Both effects add to generate the global effect of Grape variety¹⁰. Each respondent's grape variety ranking was asked before starting the SC exercises. They had to rate each Grape variety from 1 to 7 (with 7 meaning "This is my favourite grape variety").

4.2 HDC model

In the HDC model (Walker & Ben-Akiva 2002; Bolduc & Alvarez-Daziano 2010; Raveau *et al.* 2010) the wine attributes were interacted with three latent variables associated with the individuals: sophistication, sociability and price-quality association. The model was estimated sequentially using Python Biogeme (Bierlaire, 2003).

The utility function of any alternative can be written as follows:

$$U_{ij} = \sum_k \beta_k x_{ik} + \sum_l \sum_k \gamma_l x_k \eta_{jl} + \varepsilon_{ij}$$

Where:

x_{ik} is attribute k of alternative i .

η_{jl} is the latent variable l of individual j

ε_{ij} is a logit error (Gumbel distributed)

β_k and γ_l are parameters to be estimated.

Latent variables were constructed through a MIMIC model (Bollen, 1989), where the structural equations were linear and the measurement equations were ordered logit (Greene & Hensher 2010). Indicators were taken from the web survey (section 2), i.e. the level of agreement with the proposed phrases, while demographic and consuming-behaviour data of the respondents was used as covariates on the structural equation (Figure 2).

⁹ To take into account the correlation between all responses by the same individual (pseudo panel effect), an error component was added to the utilities of all alternatives. This error component was assumed to distribute $N(0, \sigma)$, where σ is a parameter to be estimated.

¹⁰ For example, an individual whose favorite grape variety is *carménère*, would have the following effect for *carménère* variety in the ML model: *average effect of carménère + favourite variety* = 0.387 + 1.55 = 1.937

Table 5 – Results for the ML and HDC models

Attribute	Level	ML Model Coeff. (t-test)	HDC Model			
			Main Effect	Interaction		
				Sophistication	Sociability	Price-Quality
Label design	Contrast	-	-			
Base: Delicate	Natural	0.175 (3.25)	0.182 (3.21)			
Grape variety (average)	Merlot	-0.195 (-2.07)	-0.223 (-2.19)			
Base: Cabernet	Carménère	0.387 (4.09)	0.387 (4.43)			
	Syrah	-0.379 (-4.17)	-0.377 (-3.93)			
Grape variety (relative)	Favourite variety	1.55 (13.18)	1.630 (11.52)		-1.01	
Base: Least favourite	Second favourite	0.913 (8.57)	0.978 (7.27)		(-6.59)	
	Third favourite	0.534 (5.49)	0.665 (5.53)		-0.384 (-1.86)	
Alcohol content	11.0° G.L.	0.286 (2.50)				-0.366 (-2.06)
Base: 8.5° G.L.	12.5° G.L.	0.593 (5.98)	0.529 (5.71)			
	14.5° G.L.	0.701 (7.42)	0.663 (7.09)			
Advice	Friend's	0.683 (7.68)	0.559 (5.13)			-0.810 (-4.25)
Base: No advice	Critic's		0.526 (4.60)			-0.942 (-4.83)
	Salesman's	0.162 (3.50)	0.267 (2.63)			-0.620 (-3.65)
Type of wine Base: Varietal	Reserve or Grand Res.	0.515 (1.72)	1.61 (2.99)			
Price (US\$)		-0.0196 (-2.69)	-0.082 (-3.31)			0.067 (3.04)
Discount	10%	0.438 (5.58)	0.329 (3.02)			0.150 (1.85)
Base: 0%	20%	0.563 (6.06)	0.483 (4.21)			
Error component standard deviation		0.488 (5.78)				
Number of observations		2,076			2,076	
Log-likelihood		-2,926.52			-2,877.02	
Rho ²		0.161			0.169	
Corrected Rho ²		0.157			0.162	
No. of draws		2000			2000	

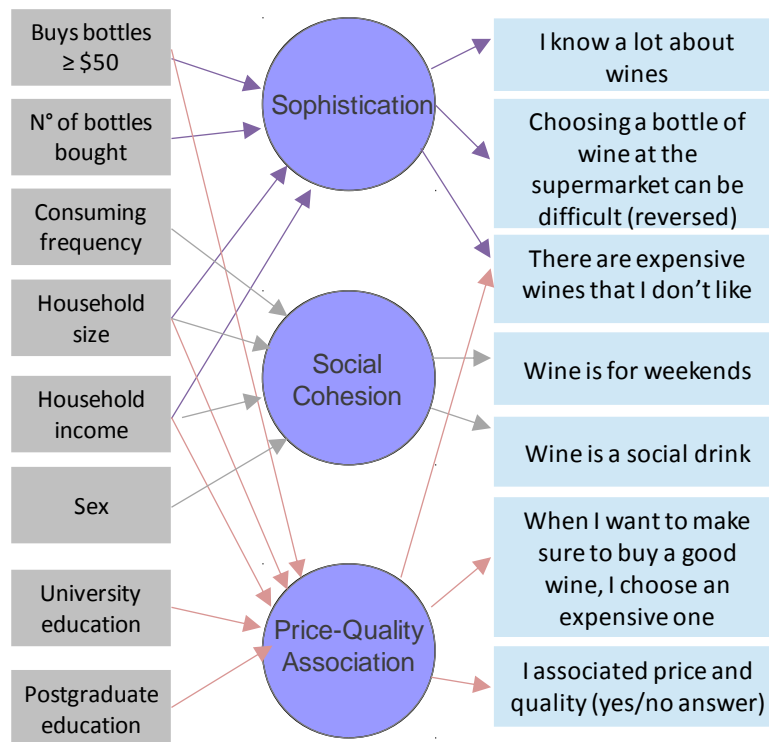


Figure 2 - Structure of the MIMIC model

The MIMIC model was estimated through maximum likelihood. The coefficients of the structural equations are reported on Table 6. Utility cut-points of the ordered logit are not reported. Once the MIMIC model was estimated, the three latent variables were constructed for each individual, and then included in the discrete choice model, with a normally distributed error component to account for the estimation error in the previous (MIMIC) stage.

Interactions between latent variables and wine attributes were only considered in a linear way (i.e. multiplying the attribute and the latent variable). Most interactions were found to be insignificant. Coefficients, t-tests and goodness-of-fit are presented in Table 5.

Table 6 - Coefficients of the MIMIC model's structural equations

	Sophistication	Sociability	Price-Quality
Buys bottles over \$50	0.300 (1.58)		-0.523 (-2.17)
Bottles bought	0.0126 (1.99)		
Consuming frequency (times per week)		-0.141 (-3.12)	
Household size (number of people)	-0.121 (-2.15)	0.169 (2.09)	0.130 (2.69)
Household income (in thousands US\$/year)	0.0057 (1.77)	-0.119 (-1.92)	-0.0105 (-2.16)
Female		-0.456 (-1.96)	
University education			0.342 (1.49)
Postgraduate education			0.490 (1.86)
Log-likelihood	-3,428.645		

5 Discussion

5.1 ML and HDC Models

The ML model only considers the wine attributes, as we did not interact them with characteristics of the respondent. The HDC model, on the other hand, considers interaction between the attributes of the alternatives (i.e. wines) and the characteristics of the consumer, through the use of latent variables.

As mentioned in section 4, three latent variables were constructed: sophistication, sociability and price-quality association. Figure 3 shows their distribution on the sample. All of them have mono-modal distributions (i.e. one single peak), even though price-quality association has a heavy tale to the left. Sociability has the most spread distribution, probably due to being constructed with only two indicators.

The HDC model seems to fit the data better than the simpler ML model. Still, given that neither of them is nested in the other, it is not possible to determine whether their fit is statistically different. Notwithstanding, the HDC model allows to consider heterogeneity among consumers, a critical requirement when studying a market.

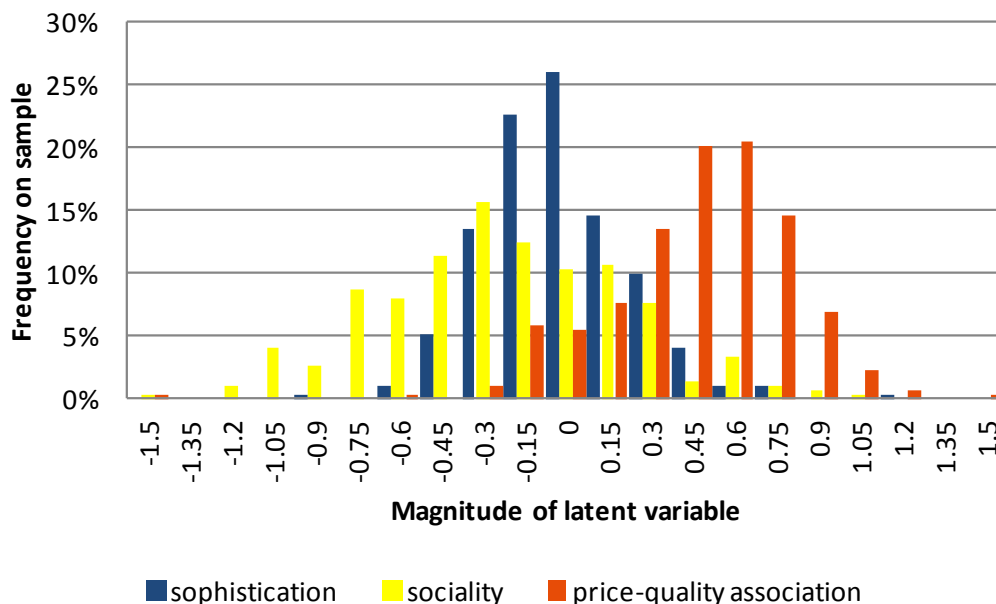


Figure 3 - Histogram of latent variables on the sample

5.2 Influence of attributes

Grape variety appears to be the most relevant attribute for the Chilean premium wine consumer. It is not possible, though, to assert that one variety dominates over the rest, as all consumers have their own rankings. For this reason it is necessary to know a consumer's ranking of preference for grape varieties to predict more accurately her probability of choosing a particular wine. This makes aggregate predictions more difficult, and once more puts on evidence how important preference heterogeneity is.

That being said, the modelling technique allows to measure average tendencies (i.e. average preferences for grape variety, corrected by personal ranking). These reveal that Carménère - the

Chilean “flag” grape at present - is the most preferred grape variety. This does not mean, obviously, that everyone's favourite is Carménère.

As consumers become more sophisticated, the personal ranking of grape variety becomes more flexible (i.e. the personal ranking loses importance). This could be explained because sophisticated consumers see each grape variety as more suitable for a given occasion, rather than better or worse than other under any situation. An example of this would be food pairing.

Type of wine presents the next highest coefficient, suggesting that it could be one of the most influential attribute for our sample. Nevertheless, it only affects individuals who buy more economic wines (i.e. under 7 US\$). This means that the word “Reserve” on the label is highly appreciated by consumers who normally buy younger wines. However, consumers who normally buy “Reserve” wines (i.e. above 7 US\$), do not make significant differences between a “Reserve” and a “Grand Reserve” wine.

Lower *alcohol content* was avoided by our consumers. Respondents seemed to consider that low alcohol level was an indicator of low-quality wine (this was mentioned during focus groups and in-depth interviews). This tendency was found to be slightly attenuated on consumers with low sociability, but this effect was only significant for wines with 11 ° G.L.

Advice also plays a relevant role on consumer's choice. Critic's and friend's advice seem to have similar influence, while the effect of salesman's advice is lower (but still preferable to none). Highly social-oriented consumers value advice less, and also make little difference among the source of this advice. This is reasonable, as these consumers are more interested in the consuming occasion, than in the wine itself.

Just as was expected, *discount* does not show a linear effect. For example, a 20% discount was not twice as attractive as a 10% discount. This could happen if consumers become suspicious as the size of the discount increases¹¹. The HDC model also shows that consumers who have a stronger association between price and quality, may value discounts more. This is because discounts allow consumers to buy “better” (i.e. more expensive) wine, at a reduced price. The effect of price is discussed on section 5.3.

Label design was found to have little impact on consumers' choice process. We propose two possible explanations. The first one is that preferences for label design are too heterogeneous and, therefore, become non-significant because of the net effect¹². A second and more reasonable explanation is that label design is more relevant when selecting a bottle from a larger set of alternatives (for example, a shelf on a supermarket), but not so much when choosing among a small set of alternatives, where other attributes become more relevant. This hypothesis could not be tested with our data.

Table 7 shows the marginal effect of changes on attributes levels on choice probability. They were calculated based on a situation with only two alternatives: one with all attributes on their base level¹³, and other with only the considered attribute change. Willingness to pay (WTP) values for each attribute are also included in the table. In the case of the HDC model, the mean of all latent variables was used. Even though these effects are neither constant for all individuals, nor among all possible choice sets, they help understanding the relative weights of each attribute.

11 During in-depth interviews previous to the choice experiment, some consumers indicated that high discounts on wine made them think retailers were compensating for some kind of defect on the product, or that it was not good enough for its initial price.

12 The net effect would be that the same number of people likes and dislikes a given label design, and therefore, the average effect on the population would be zero or near zero.

13 The base level for price was considered 20 US\$ (i.e. the mode among the prices that respondents said they were willing to spend for the described occasion). This implied that the base wine was a “Reserve”.

Table 7 - Marginal effect (%) and willingness to pay (WTP) (US\$) for changes on attributes.

Attribute	Level	ML Model		HDC Model	
		Marginal Effect	WTP	Marginal Effect	WTP
Grape Variety	Merlot	-4.9	-10.0	-5.6	-4.8
	Carménère	+9.6	+19.8	+9.6	+8.4
	Syrah	-9.4	-19.4	-9.3	-8.1
	Favorite	+32.5	+79.3	+34.0	+35.9
	Second favorite	+21.4	+46.7	+23.3	+21.8
	Third favorite	+13.0	+27.3	+16.3	+14.6
Alcohol Content	11,0 ° G.L.	+7.1	+14.6	+3.2	+2.8
	12,5 ° G.L.	+14.4	+30.3	+12.9	+11.4
	14,5 ° G.L.	+16.8	+35.9	+16.0	+14.3
Label design	Natural	+4.4	+9.0	+4.5	+3.9
Advice	Critic's	+16.4	+34.9	+20.3	+18.6
	Friend's	+16.4	+34.9	+20.0	+18.3
	Salesman's	+4.0	+8.3	+11.9	+10.5
Type of wine	Reserve or Grand Res.	-12.6	+26.3	-33.3	+34.8
Price	For each USD	-0.5	-1.0	-1.1	-1.0
Discount	10%	+10.8	+22.4	+9.7	+8.3
	20%	+13.7	+28.8	+11.8	+10.4

5.3 About price

Price was found to have little effect on consumer choices, implying large willingness-to-pay figures (Table 7). This has two complementary causes. The first is that consumers seem to choose the price niche before selecting the product. Our experiment emulated this procedure by asking the respondents - before they answered any choice situation - how much would they be willing to pay for a bottle of wine for the given occasion. Once the price was recorded, all prices in the SC experiment were pivoted (mainly upward) on that reference value. This caused, of course, all alternatives to be in the same price niche, reducing the variability of price. For lower price niches, these variations might have even been ignored by consumers.

The second cause is that price is a highly endogenous variable, because consumers tend to associate price and quality. If a respondent assumes that a higher price implies higher quality (as at least 33% of the respondents allegedly did), then the price coefficient would be measuring two effects: (i) the negative effect of paying more and (ii) the positive effect of acquiring a product of higher quality. The addition of both effects results in an average effect closer to zero, which helps to explain the small coefficient estimated for this variable.

Correcting for both causes is not easy. If bigger variations of price are allowed for, i.e. offering alternatives in different price niches to respondents, then it may be likely for respondents to incur in lexicographic behaviour (Tversky, 1972), disregarding all alternatives above or below a given price. This would not only reduce the information obtained from each exercise, but would violate the

hypothesis funding our analysis.

In relation with the second cause, there are mainly two ways of correcting for endogeneity on discrete choice models (Guevara & Ben-Akiva 2010): (i) using a control function and (ii) using latent variables. The first one requires the use of instrumental variables, which are not available for a SC experiment of this nature.

About the second alternative, the most classical way of using latent variables to address the endogeneity problem is to model the unobserved attribute causing the endogeneity. However, in this case, the unobserved attribute is (expected) quality, for which there are no indicators but the choice itself. Therefore, we constructed the price-quality association latent variable, which measures to what extent a consumer relates these two attributes, and therefore is a proxy to how serious the endogeneity problem is for each individual.

The use of the price-quality association latent variable helps reducing the endogeneity problem, at least to some extent. This becomes evident on the fact that price has now two coefficients, one negative for price without interaction (which measures the negative effect of paying more), and one positive when interacting with the latent variable (which measures the positive effect of obtaining higher quality). Just as expected, the inclusion of this latent variable causes an increment of absolute magnitude of the price coefficient. Yet, the positive coefficient of the interaction also has the same order of magnitude, causing the WTP estimates to be similar to those of the ML model. Whether this is due to remnant endogeneity or to too little variation in the price attribute cannot be answered for sure. However, the behaviour of interactions with the price-quality latent variable, support the idea that this construct works as expected, and therefore, does correct endogeneity to some (albeit an insufficient) degree.

6 Conclusions

Hybrid discrete choice models are a useful tool to study consumer preferences for food or beverages without considering intrinsic (i.e. sensory) attributes, a relevant situation when modelling the first purchase of a new product. These models are able to capture both the preferences for specific attributes, as well as a structure in preference heterogeneity, through the use of latent variables.

It is critical to identify the main attributes that define the product's expected quality in the mind of consumers before implementing the choice experiment. As an important part of the choice process is unconscious, asking the consumers what they look for in a food or beverage might not provide a trustworthy set of attributes. Therefore, this list should be contrasted with other sources of information, such as expert's opinion and qualitative analysis of the product's choice process.

Capturing preference heterogeneity is necessary to provide a useful description of the market. Latent variables proved to be useful achieving this task, having the benefit of relating this variability to observable characteristics of the individuals.

The proposed methodology allows identifying which attributes are used by consumers as cues for the expected quality of the product, and how much influence each of them has, without asking consumers directly, neither asking them to do anything different from what they would do in a real buying context.

Unlike other research, price variation of the alternatives was (mainly) considered within each price niche, revealing that price is a strong cue of quality for consumers. This association between price and quality causes a serious endogeneity problem, often overlooked in wine preference literature. Endogeneity causes the marginal utility of price to be underestimated (i.e. less negative than it should be) which implies upward-biased willingness-to-pay for the remaining attributes. Using a

latent variable that explicitly measures the association between price and quality helps identifying consumers who incur more heavily in this behaviour, but it doesn't solve the problem.

Besides endogeneity, there seems to be a two-step choice process present on wine purchasing. In a first step, consumers choose the price niche they are buying at and, conditional on that choice, a bottle is selected among those in that price range or threshold. This process also makes price less relevant, as price variations within a price niche may be even neglected by consumers. This hypothesis remains to be tested.

More research is required on understanding how consumers select the price niche they are buying in, and how this is affected by the expected consuming occasion (a context which was fixed for this study). This paper presents the first results of a four-year research project. Following steps will focus on intrinsic attributes, and how they interact with extrinsic ones.

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