Wine preferences based on intrinsic attributes: A tasting experiment in Alto Adige/Südtirol province

Luigi Fabbris, Alfonso Piscitelli

1. Introduction

Consumers choose a wine according to the information they possess regarding its intrinsic and extrinsic attributes (Charters and Pettigrew, 2003). Price, brand, region of origin, type of grapes, and awards achieved are the basic key extrinsic attributes used by different consumer groups when choosing wine (Combris et al., 1997; Batt and Dean, 2000; Lockshin et al., 2006; Martínez et al., 2006; Chrea et al., 2011; Brentari et al., 2011; D'Alessandro and Pecotich, 2013). Physical characteristics of the wine, such as taste, color, and flavor, are intrinsic attributes that play an important role in consumers' wine quality perception (Dodd et al., 2005; Carbonell et al., 2008; Rahman et al., 2014). Research evidence suggests that consumers tend to use both intrinsic and extrinsic attributes concurrently when choosing wine (Jover et al., 2004; Charters and Pettigrew, 2007; Veale and Quester, 2009; Mueller et al., 2010; Brentari and Zuccolotto, 2011). Different consumption situations may amplify or change the perception of wine characteristics (Hall and Lockshin, 2000); consumer drinking frequency also significantly and positively influences the perceptive ability of wine consumers (Rahman and Reynolds, 2015).

The classification of wine attributes into extrinsic and intrinsic refers to the hierarchical and multi-dimensional models, which in turn refer to a higher-level Total Food Quality model for product choice (Grunert, 1997). A model is multi-dimensional if the consumers' final evaluation includes more than one quality dimension and is hierarchical if each dimension of quality includes at least one product characteristic (Olson and Jacoby, 1972).

Most wine purchases do not provide the opportunity to taste them before purchasing. Nevertheless, consumers place the most emphasis on taste when it comes to wine evaluation, preference, and purchase because the intrinsic characteristics of previously experienced wines play a major role in repurchasing. Moreover, scholars (Oomen, 2015; Mueller et al., 2010) suggest that wine tasting may have such an important role in the purchase process that could ultimately lead to more sampling in wine shops. The tasting and repurchase decision process may be considered a first step towards predicting the market uptake of new wines (Mueller et al., 2001).

The goal of this study, given that the taste of wine plays an important role in people's choices, is to determine which intrinsic attributes influence wine preferences. For this, we have held an experiment on how a sample of wine consumers evaluate a set of intrinsic attributes in case they can taste the available wines. Also, we measured the impact the attributes have on consumers' preferences.

In September 2016, a sensory evaluation experiment was conducted on twelve white wines originating from six different grape varieties (Chardonnay, Müller-Thurgau, White Pinot, Sauvignon, Gewürztraminer, Riesling) of the Alto Adige/Südtirol province in Italy.

The pool of tasters included 33 individuals who typically consumed mild amounts of wine. They were selected on the basis of their interest in and availability for the experiment, as well as of their experience in wine consumption. Moreover, they were not connected to the "wine and spirits" business sector, nor were they wine makers. Neither the tasters nor the person pouring the wines knew the grape variety or cellar of any wine; hence, the tasting procedure was double-blind so as not to introduce bias or otherwise skew the results (Rivers and Webber,

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1907). Just the researcher (not involved in wine preparation) knew the symbols of the experimental design. This procedure was aimed to eliminate any emotional conditioning and address the assessors' attention directly and exclusively towards the technical aspects of wines.

The wine characteristics considered in this sensory evaluation experiment were collected through an anonymous paper questionnaire. This questionnaire asked for participants to make judgments on 11 intrinsic attributes of appearance, nose, and palate. After that, they were also asked to give an overall judgment for each wine. In addition, data on background characteristics of tasters, his or her drinking habits, and the relevance of wine in his or her diet and social life were also collected.

The experiment compared wines of the same terroir and of the same vintage and then belongs to the class of the so-called horizontal tasting. This way, it is possible to obtain comparative judgements between the selected wines.

The remainder of this paper is organized as follows: Section II introduces the sensory experimental procedure, Section III introduces the statistical approach for data analysis, and Section IV reviews the main results obtained in the study. Section V concludes the presentation of this research.

2. Fractional experiment

Each taster was administered four randomly selected wines from different grapes, in accordance with a fractional factorial experiment. A fractional, or partial-profile, design is an experimental design consisting of a carefully chosen fraction of the experimental runs of a full factorial design (Box et al., 2005). In our wine-tasting experiment, the sampling was carried out at the grape-variety level, administering just four of the six possible varieties to any taster, and selecting one of the two possible cellars. This is a case in which possible choices rather than choosers are sampled (Manski and Lerman, 1977).

The sampling design followed a systematic pattern. For each grape variety, $15 = [(6 \cdot 5)/2]$, different random sets were created so that each grape variety appeared 10 times in 15 trials. This way, each wine variety had 20 repetitions after 30 tasters performed their task, though the number of repetitions of each variety by cellar is 10. With the number of tasters being 33, the number of repetitions of each variety by cellar is slightly above 10.

Wines were randomly divided into two groups of grape varieties and placed in brown bags. The first group was identified by A1 through F1, while the second group was identified by A2 through F2. The tasters were rapidly trained to familiarize them with the terms of the experiment and with the scales used.

Each taster had five glasses, one for water and the remaining for wines. The four wines were poured in a flight, and then the tasting began. In the tasting session, the judges were given 6 centilitres of each of the four randomly selected wine varieties which were served at the same cold temperature. The protocol was open, meaning that tasters could taste and re-taste before assigning preferential judgments; for each tasted wine, they evaluated also the intrinsic attributes of each.

3. Estimation method

A conditional logit regression was performed on the judgment data of intrinsic attributes of the wine in order to model the participants' choices (McFadden, 1974; 1980; Soofi, 1992). This model is consistent with economic theory and allows the relation of choices to the characteristics of the possible alternatives. According to random utility theory, individuals who choose an alternative or a profile tend to maximize their own utility. Wine utility refers both to nutritional and emotional aspects. Utility is considered a function of observed characteristics (attribute levels) and unobserved characteristics of the alternative.

The utility function is specified by the attribute levels of the alternative and by a random error term:

$$U_i = V(\beta, X_i) + \epsilon_i,$$

where V is a function linking the attribute levels of the alternative i to the utility of the alternative, and ϵ_i is a random term following an i.i.d. type-1 extreme-value distribution (McFadden, 1974). The probability of choosing the alternative i is:

$$P(choice = i) = \frac{e^{V(\beta, x_i)}}{\sum_{i=1}^{I} e^{V(\beta, x_i)}},$$

where $V(\beta, x_i)$ is the utility function, also called *part-worth utility*, for alternative i, with $i = 1, \dots, I$. In other words, the probability of choosing an alternative i depends on both attribute levels of the profile i and attribute levels of all other profiles.

The vector of unknown utility parameters β is estimated through maximum likelihood of regularized weights. The solution is typically found using some non-linear, iterative maximization algorithm. The attribute levels are constrained, imposing that their sum equals zero. The resulting set of estimated parameters is unique, and the model is robust to violation of the assumption (Louviere et al., 2000).

The goodness-of-fit conditional logit model is evaluated through both the log likelihood ratio test and McFadden's $pseudo\ R^2$. The log likelihood ratio chi-square test determines whether including attribute-level variables significantly improves the model fit compared with a trivial model with no attribute. This highlights whether one or more preference weights are expected to be different from 0.

Test statistic D, log likelihood ratio, is calculated as:

$$D = 2\ log\left(\frac{L(M_{fit})}{L(M_0)}\right) = -2(LL(M_0) - LL(M_{fit})$$

where $L(M_0)$, $L(M_{fit})$, $LL(M_0)$ and $LL(M_{fit})$ are the likelihood and the log likelihood values of the trivial and the fitted models, respectively. The log likelihood ratio follows a chi-square distribution with degrees of freedom equal to the number of parameters to be estimated. McFadden's $pseudo\ R^2$ is calculated as:

$$Pseudo\ R^2 = 1 - \frac{LL(M_{fit})}{LL(M_0)} \quad ,$$

$Pseudo\ R^2$ varies between 0 and 1. A value of $pseudo\ R^2$ from 0.2 on can be considered a good model fit, while a value of 0.4 indicates an extremely good fit (McFadden, 1978).

The relative importance of an attribute (RIA) can be calculated as the percentage of estimated utility parameters of the levels of an attribute (the difference between parameters of the most preferred level of an attribute and the least preferred level of the same attribute):

$$RIA_j = 100\frac{\{\max(\beta_j) - \min(\beta_j)\}}{\sum_{j=1}^{J}\{\max(\beta_j) - \min(\beta_j)\}},$$

where j indicates an attribute and J the total number of attributes used in the profile definition. RIA measures may be influenced by number of levels composing an attribute (Orme, 2010). A RIA measure varies between 0 and 100.

4. Results

Our model has been fitted using the "clogit" function from the "survival" package in R (Therneau, 2015). Table 1 shows the utility parameter estimations of conditional logit models for the intrinsic attributes of the wines. Positive significant parameter estimation means a positive effect of the attribute (level) on the choice. On the contrary, a negative significant value implies an adverse effect of that attribute (level) on the choice. Attribute levels without significant estimates do not play any role into the choice process. In addition, the RIA estimates of the 11 attributes are also shown in Table 1.

First, the pseudo R^2equals 32.3%, which shows that the intrinsic attributes successfully explain the preferences of the involved consumers for the 6 wine grapes. Moreover, the coefficient estimates highlight that wine choices were driven chiefly by the following:

- a clear perception of wine flavors in the mouths of tasters (flavor intensity);
- a good balance of flavors, that is alcohol, acidity, tannins, sweetness and the possible fruits are in *harmony*;
- a complex bouquet (bouquet complexity) and the perception of an aroma.

The relevance of the three variables is confirmed by the estimates of the attribute importance, since the intensity of flavor, out of a hundred importance points, received 33.6, while overall harmony received 19.2, and the complexity of the bouquet received 14.3. Another slightly relevant attribute is evolutionary state, e.g. the classification of wines according to their aging potential, in fact RIA is 12.2%, but the coefficient is not statistically significant.

Unexpectedly, also appearance did not influence wines rankings: neither differences in color nor in clarity had a role in determining the final rankings. Another unexpected result is that aroma – an aspect that characterizes Gewürztraminer that the large majority of tasters judged as the most preferable among the administered wines (Table 2) – was not significant at all. This may mean that tasters evaluated the assessed wines giving much more importance to their palatal sensations than to the olfactory and visual ones. Indeed, palatal sensations refer particularly to the pleasure of eating and health implications related to wine consumption, while the others are merely aesthetic and transitory.

Table 1. Estimates of model coefficients applying conditional logit regression on wine choices and the relative (percent) importance (RIA) of attributes (n=33)

	$\hat{\beta}$	$se(\hat{\beta})$	*Z*	*Pr(>|z|)*	*Signific.*	*RIA*
V Clarity	0.183	0.480	0.382	0.498		3.2
V Color	-0.2292	0.474	-0.484	0.321		4.0
Visual attributes						***7.2***
O Intensity	0.490	0.470	1.042	0.810		8.5
O Complexity	0.822	0.470	1.750	0.030	*	14.3
O Aroma description	0.157	0.488	0.322	0.750		2.7
Olfactory attributes						***25.5***
G Body	-0.128	0.487	-0.264	0.950		2.2
G Balance	-0.006	0.540	-0.012	0.944		0.1
G Intensity	1.936	0.631	3.065	0.003	**	33.6
G Persistence	0.006	0.561	0.011	0.866		0.1
G Evolutionary state	0.702	0.525	1.337	0.348		12.2
Taste-Olfactory attributes						***48.2***
Harmony	1.109	0.517	2.144	0.026	*	19.2

*** $0.001 < \alpha^{oss} < 0.01$; * $0.01 < \alpha^{oss} < 0.05$; $R^2 = 0.323$ (max possible=0.694); Likelihood ratio test= 111.6; Wald test = 55.47 on 11 df; p=6.366e-08; Score (logrank) test = 91.9 on 11 df, p=7.105e-15.*

Table 2. Evaluation of the tested wines, by assessors' characteristics (n=33)

	Chardonnay	Gewürztraminer	Müller-Thurgau	Pinot Bianco	Riesling	Sauvignon
Overall	4	1	3	6	2	5
Women	6	1	5	3	4	2
Men	4	1	3	6	2	5
Younger	3	1	4	6	2	5
Older	5	1	3,5	6	2	3,5

5. Final remarks

The tasting experiment described in this paper draws the conclusion that mild wine-consumers chose wines according to all sensorial dimensions, and in particular flavor and odor, but the perception of harmony among wine attributes is relevant as well. We suggest that wine was evaluated according to easy-to-perceive (that is, non-technical), general-type attributes. In fact, the attributes highlighted by respondents, on top of the overall harmony, are the intensity of flavor and the complexity of the wine's bouquet. In contrast, the more an intrinsic attribute is peculiar of a grape – for instance, the aromas that could identify it, its color, the balance between opposing components, and the persistence of flavor – the less it factors into people's choices.

This outcome is consistent with the results that Rahman et al. (2014) obtained using a convenience sample (i.e., students, faculty and staff). Their research has highlighted that individuals place the most emphasis on taste when it comes to wine evaluation, preference, and purchase. Though, the easier aspects of wine likely dominate consumers' judgement. The authors state that, in fact, when a person is trying a wine for the first time, appearance might influence the perception of aroma and taste, and aroma might also influence the perception of taste. While our results may not be encouraging for wineries, it should be kept in mind by people who "construct" and sell wines because this knowledge is vital for increasing the success of their wine.

Going forward, we are prepared to repeat this experiment with other grapes and other participants to determine if this outcome is replicated when the study is conducted with different factors and a larger subject pool. Moreover, in order to improve the concentration of assessors on the tasting experiment, it may help if tasting is targeted to the intention to buy and also to the economic value of the tasted wines. Finally, since assessors tended to agree just on first position of the wine ranking, there is room for future analyses of the reasons why people showed such large variability on preferences.

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