

## Price Heterogeneity and Vine Homogeneity: An Ordered Logit Hedonic Price Estimation

**Eugenio Pomarici, Francesco Caracciolo, and Luigi Cembalo**

*Department of Agricultural Economics and Policy, University of Naples Federico II, 80066, Portici,  
Naples, Italy*

*francesco.caracciolo@unina.it , pomarici@unina.it ; cembalo@unina.it*

### Abstract

Consumers face complex choices when they buy wine: wine is a highly differentiated product sold at prices that vary over a wide range. This paper aims to provide monetary valuation of some relevant credence attributes of the wine, such as certifications and quality ratings made by expert tasters. In order to value the latter, a hedonic price estimation was performed on a specific Italian grape variety (Aglianico). The implicit price of DOC-DOCG certification is of extreme importance. It gives access to a collective reputation and enables a premium price to be captured from consumers.

**Key words:** *attributes, certification, hedonic, wine.*

**JEL classification:** [D12, C25]

### 1 Introduction

World market of wine has been readily increasing in the past decades. Markets are showing a constant increase in competition, fueled by both the growth in qualitative and quantitative supply of new producing countries, and by an improvement of quality of wine produced in the traditional countries. At the same time, the change of consumption pattern and habit has been evolving particularly fast in traditional wine producing and consuming countries, such as Italy and France (Anderson, 2004), where the per capita consumption was about 100 liters per year in the seventies while, nowadays, accounts for about 40-50 liters (OIV, 2011). At the same time, wine market shows, in almost all traditional wine consuming countries, a stabilization in wine consumption and a market saturation. In this context, consumers face complex choices when they buy or consume wine. Most of the complexness is due to the fact that wine is a highly differentiated product sold at prices that vary over a wide range. On the other hand, wine embodies a bundle of intrinsic and extrinsic characteristics that generate a perception of quality that makes different consumers to deem a wine in different ways (de Magistris *et al.*, 2011). Put differently, consumption of wine is based on attributes like vine, quality, prestige, regional origin, and taste, just to name some. While markets for attributes can be considered implicit, implicit prices of the attributes determine wine's price (Bombrun and Summer, 2003).

In this paper, market values for most of wine attributes are measured through the estimation of a hedonic price function, which relates the price of a wine to its various attributes. Consumers' evaluation of wine attributes has important implications for producers' long-term investment decisions, for retailers' purchasing decisions and for the design of wine marketing campaigns.

Hedonic price estimation in wine sector has been applied worldwide. All works have in common to consider a broad range of wines, such as "reds" or "whites", "quality wines", or "DOCs"

(Angulo *et al.*, 2000; Combris *et al.*, 1977; Combris *et al.*, 2000; Fogarty, 2006; Schamel, 2003; Schamel and Anderson, 2003). In this paper, a hedonic price estimation of a specific Italian vine (Aglianico) was performed. Though Aglianico (Pomarici *et al.*, 2004) is an autochthon historical vine of southern Italy, most of the production comes from the Campania Region. Usually, wines made of local vines have small price variability and, very often, they are high value ones. In the case of Aglianico, although the overall homogeneity of the marketable product, price variability is high and this represents one good reason to look into the relations between price and wine attributes. Companies' revenue margins and market share are strictly price dependent, and the analysis of the price determinants is relevant to go into a deeper and more analytical knowledge about the sector marketing strategies and their efficacy. The paper goal is therefore to provide new insights for marketing, evaluating the role of credence attributes, such as certifications and the quality ratings made by expert tasters. This paper is an attempt to enrich the scientific debate on the effective marketing role of the different credence attributes'.

Data used comes from three different wine catalogues in which only price categories are available. Therefore, over 1,000 wines were collected in four prices categories ranging from 1 (0-5 Euro) to 4 (over 15 Euro). Explanatory variables come from different sources and were: province of production, certifications (DOC, DOCG, POD, PGI), degree of Aglianico vine content, number of bottles produced, year of vintage, firm degree of specialization, firm typology, and three sources of expert quality ratings. Due to the nature of the dependent variable, the hedonic price function was estimated in the form of an *Ordered Logit* model.

The paper is organized as follows. After a brief summary of the economic dimension of Aglianico vine in Southern Italy (section 2), the empirical model used in the analysis is discussed (section 3). In section 4 information on the data source are provided, followed by the presentation of the results. Section 5 concludes the paper, discussing briefly the main findings of the research.

## **2 Native varieties and Aglianico vine**

After the 80's wine-methanol scandals, Italian wine production is evolving, broadening largely the supply; multitudes of native vines combine historical and cultural factors due the intricate variations in typography. They provide a strategic asset in the current conditions of the market, involving also resistance to global standardization. The efficacy of this strategy is demonstrated by a growing interest of important segments of consumers to the native wines with a strong territorial identity and a specific original flavor.

In this evolutionary context Aglianico vine has become an important reference point for southern Italy wine production. It occupies approximately 23% of Campania and the 34% of Basilicata regional entire vineyard area, involving many denominations of origin, 20 DOC/DOCG and 15 IGT certifications (Pomarici *et al.*, 2004). Its diffusion dates back centuries, stemming essentially from self-consumption of small family vineyards in Southern Apennines. After the crisis of methanol, the revival of native Italian viticulture was observed, and Aglianico was often used in years 80 and 90 to blend Sangiovese, Montepulciano, Cabernet Sauvignon and Merlot being the acreage initially dominated by other Italian and international wines. In the last 15 years as soon as the appeal of blend declined, the native varieties importance rose, and the Aglianico acreage increased, benefitting awards from both Italian and foreign specialized guides. As Table 1 shows, considering the time span from 2000 to 2010, on the whole Aglianico wines

improve their quality ratings expressed by the experts, moving up from the lower category. Numerous small and medium firms increase the Aglianico supply. The spread of the vine moved from the inland mountains of Campania, to other regions of Italy, Molise and Puglia, arriving even in the Ionian Calabria (Pomarici *et al.*, 2004). The Aglianico spread is also reflected in the presence of Aglianico wines in catalogues. Considering three among the most consulted and well-know wine Italian catalogues (AIS: Ais Duemilavini; GR: Gambero Rosso; VER: Veronelli) the presence of Aglianico has tripled in the last decade (+290%), comparing the doubling of the overall wine presence (+198%) (Table 2).

The long history of the Aglianico vine, the originality of the expression of sensory wines obtained, a reasonable price of the bottles on the market, are the key factors of the spread of the vine: consumers may find a red absolutely typical for a price acceptable. Next paragraph will introduce the Hedonic price approach, to value the Aglianico wine characteristics and their effective market appreciation

**Table 1.**  
Quality ratings made by expert for Aglianico, (2001 vs 2010).

Aglianico reviewed	AIS		GR		VER	
	2001	2010	2001	2010	2001	2010
Low rate	48	6	60	32	38	15
Average rate	40	86	35	61	53	56
High rate	12	9	4	6	9	29
Total	100	100	100	100	100	100

AIS: Duemilavini 2010. *Il libro guida ai vini d'Italia*;  
GR: Gambero rosso 2010. *Vini d'Italia 2010*;  
VER: Veronelli, 2010. *I vini di Veronelli 2010*.

**Table 2.**  
Aglianico presence in Italian wine catalogue books.

	2010			2001		
	AIS	GR	VER	AIS	GR	VER
Total wine reviewed	16000	18000	16800	7000	12045	6495
Aglianico reviewed	161	231	345	104	91	64
Total firms reviewed	1600	2253	3000	1000	1681	1524
Producing Aglianico firms reviewed	70	121	155	43	43	33
% aglianico reviewed wine/total reviewed wine	1.0	1.3	2.1	1.5	0.8	1.0
% producing Aglianico firms reviewed /Total firms reviewed	4.4	5.4	5.2	4.3	2.6	2.2
Average rating of Aglianico	2.0	1.7	2.1	1.6	1.5	1.7

### 3 Methodology and empirical framework

The hedonic pricing method assumes that goods are composed by a set of characteristics and they can be described by a set of attributes or characteristics. While there is no explicit price for each characteristic that compose the good, the composite good has a price: by analyzing the systematic variation in the price of the composite good it is therefore possible to value the attributes that compose the final good. The hedonic price estimation in wine sector has been applied worldwide. What in common in almost all works is that in the hedonic price function are included not only the objective characteristics appearing, for example, on the label of the bottle, but also sensory characteristics of the wine specifically collected for a peculiar wine or set of high quality wines (Combris *et al.*, 1977; Combris *et al.*, 2000; Fogarty, 2006; Schamel, 2003; Schamel and Anderson, 2003). In the case of this study, sensory characteristics of the wine are collected through three catalogue books, among the most popular being used in Italy. The guides report several information on wineries, including retail prices and quality ratings made by expert tasters.

From an empirical point of view, hedonic price estimation can be cumbersome when the sample of the analyzed wines is too heterogeneous. The endogenous quality signal of market price can vary largely among the wines, biasing the estimation of the attributes implicit prices (Oczkowski, 2001). The sampled wine set, including mainly one vine typology, is relatively homogenous, minimizing the differences on the final price due the collective reputation of the production districts, the comparative market advantages due to terroir and price differentiation deriving from largely different costs curve among the production systems (Costanigro and McCluskey, 2011). Price segmentation should therefore depend mainly by explicit quality characteristics of the product and by specific credence attributes, such as ratings of experts and product certifications of origin. In this way, holding constant the *terroir* bias, price heterogeneity will reflect mainly other quality characteristics of the product.

Commonly hedonic price analysis applies an ordinary least square estimation in order to estimate the implicit of the attributes. In this study, on the contrary, an ordered logit estimation was performed. The reason is that prices collected are expressed in ranges that makes the dependent variable consisting of a set of cases ordinally measured. Ordered logit represents a generalization of the Logit model and it is specifically applied to analyze ordinal data (Winkelmann and Boes, 2006).

The model assumes a latent unobserved continuous process (1):

$$(1) \quad y_w^* = \mathbf{x}_w \boldsymbol{\beta} + e_w, \quad E[e_w | X_w] = 0, \quad e_i \text{ i.i.d. } \textit{Logistic} (0,1) \text{ with } w = 1, \dots, W.$$

It underlies the ordinal observed outcome  $y_w$  (2):

$$(2) \quad y_w = \begin{cases} 1 & \text{if } k_0 < y_w^* \leq k_1 \\ 2 & \text{if } k_1 < y_w^* \leq k_2 \\ 3 & \text{if } k_2 < y_w^* \leq k_3 \\ 4 & \text{if } k_3 < y_w^* \leq k_4 \end{cases}$$

where  $k_0 = -\infty$  and  $k_4 = \infty$ ;  $k_1$   $k_2$   $k_3$  are unknown threshold parameters to be estimated in order to indicate the range of the logistic distribution associated with specific values of the stated

response variable  $y_w^*$ .  $\mathbf{x}_w$  is the vector of explanatory variables and  $\boldsymbol{\beta}$  is the vector of unknown parameters. The parameters are obtained by maximizing the log-likelihood: for example the probability that  $y_i = 1$  is equal to:

$$\pi_{w1} = P(y_w = 1 | \mathbf{x}_w) = F(k_1 - \mathbf{x}_w \boldsymbol{\beta}) - F(k_0 - \mathbf{x}_w \boldsymbol{\beta})$$

where  $F$  is the cumulative distribution function (c.d.f.) of  $e_j$ . In the ordered logit the error term  $e_j$  is assumed to be distributed as a standard logistic.

In our study, the hypothesis being tested is that the market price of the selected wine, (in terms of the probability that a wine is being priced in a determined price class) is function of extrinsic characteristics of the wine, the winery specific factors influencing the firm' cost curve but also by the credence attributes. Next paragraph will present data and the main results of the analysis.

#### 4 Data collected and estimation results

A set including 1,053 different Aglianico wines was collected from three wine catalogues. The dependent variable used in the analysis is organized in four prices categories ranging from 1 (0-5 Euro) to 4 (over 15 Euro).

Most of wines benefit a price lower than 10€ (73%) even though price heterogeneity it is assured by the 11.3% of the Aglianico wines with a price higher than 20€ (table 3).

Campanian Aglianico wine represents over 75% of the sample (Tab. 4). 93% of the Aglianico wines are produced by private companies, while the 13.3% of the wine is certified organic/biodynamic and more than 54% of the sample benefit an Origin certification.

**Table 3.**  
Price classification of sampled wine.

Price range	Dependent variable value	# cases	%
0-5€	1	359	34.09
5-10€	2	414	39.32
10-15€	3	161	15.29
15 €	4	119	11.3
Total		1,053	100

The high percentage of the latter segment is an expected result, since, as discussed previously, Aglianico vine is present in more than 30 denominations of origin. At least one over two sampled wines is cited in the *Veronelli* or in *Gambero rosso* catalogues.

**Table 4.**  
Explanatory variables included in the empirical model.

		Mean	St.dev.
	Campania	0.756	0.430
Location	Prov. AV.	0.279	0.449
	Private company	0.934	0.248
	Specialized	0.227	0.419
Organization	Q bottled	11.520	1.561
	Organic	0.133	0.340
	DOCG	0.099	0.298
Certification	DOC	0.540	0.499
Product	% Aglianico vine	87.544	26.884
	Presence AIS	0.254	0.435
	Presence Gambero Rosso	0.422	0.494
	Presence Veronelli	0.465	0.499
	Rate AIS	0.311	0.746
expert quality	Rate Gambero Rosso	0.383	0.769
ratings	Rate Veronelli	0.700	1.070

Only one over four is reviewed by the AIS wine guide. In this context, the individuation of the implicit price of the wine presence in the guides is a key issue to investigate credence attributes, comparing the value of experts' ratings across the three publications. Implicit prices of both the presence in the guides and rate of wine expressed by the experts are expected to be positive, increasing the market price, even though it is not known to what extent the market price is influenced.

Table 5 illustrates estimation results of the ordered logit described in the previous section: Most of the covariates included in the model are statistically significant ( $p$ -value < 0.05). On the contrary, Organic certification of the wine and vine specialization of the producing winery result not significant. Among the covariates, DOCG certification seems to show the greatest impact. As for quality experts' ratings, the presence in the AIS guide has per se a valuable impact, while the particular rate assigned by AIS experts is not impacting overall the selling price. Contrariwise, both the wine ratings of Gambero Rosso and Veronelli experts seem to influence the final Aglianico price.

**Table 5.**  
Ordered Logit hedonic pricing results.

		Coef.		t
Location	Campania	-0.476	**	-2.07
	Prov Av	-0.551	***	-3.47
Organization	Private company	0.818	***	2.86
	Specialized	0.222		1.22
	Q bottled	-0.178	***	-3.59
Certification	Organic	-0.009		-0.04
	DOCG	3.459	***	14.15
Product	DOC	0.856	***	6.21
	% Aglianico vine	0.007	***	2.83
	Presence AIS	1.024	***	3.36
expert quality ratings	Presence Gambero Rosso	0.037		0.17
	Presence Veronelli	0.081		0.46
	Rate AIS	-0.024		-0.15
	Rate Gambero Rosso	0.388	***	3.11
	Rate Veronelli	0.328	***	3.39
<i>n.obs 1,053</i>		<i>Loglikelihood=-1,055.1</i>		<i>Wald <math>\chi^2(15)=546.99</math> Prob &gt; <math>\chi^2=0.000</math></i>
<i>Starred levels of significance are 10% (*), 5% (**), 1% (***)</i>				

By estimating hedonic price modeling, it is straightforward to derive covariates marginal effects in terms of their implicit price. In the case of the ordered logit, covariates' marginal effect has to be interpreted in terms of its impact on changing the probability that the considered wines benefit a market price corresponding to the selected price classes. In order to elicit an implicit price, the change of probability to be assigned in the price classes has been transformed therefore in average change of wines expected value. The procedure consist in summing over the four price classes the predicted change of probability due the marginal increase of the covariate multiplied by the mean price of the corresponding group of wines (Table 6).

**Table 6.**

Covariates average marginal effect in terms of "expected value" (implicit price) and in probability to be priced in the classes.

	Expected value	0 - 5	5-10	10-15	>15
Campania	-€ 1.04	0.082 **	-0.012	-0.031 **	-0.038 ***
Prov Av	-€ 1.14	0.098 ***	-0.027 ***	-0.033 ***	-0.039 ***
Private company	€ 1.63	-0.151 ***	0.051 ***	0.049 ***	0.051 **
Specialized	€ 0.48	-0.039	0.007 *	0.014	0.017
Q bottled	-€ 0.45	0.031 ***	-0.007 ***	-0.011 ***	-0.014 ***
Organic	-€ 0.02	0.002	0.000	-0.001	-0.001
DOCG	€ 8.48	-0.359 ***	-0.244 ***	0.115 ***	0.489 ***
DOC	€ 1.79	-0.154 ***	0.041 ***	0.051 ***	0.062 ***
% Aglianico vine	€ 0.01	-0.001 ***	0.000 ***	0.000 ***	0.001 ***
Presence AIS	€ 2.31	-0.172 ***	0.013	0.072 ***	0.087 **
Presence Gambero Rosso	€ 0.08	-0.007	0.001	0.002	0.003
Presence Veronelli	€ 0.17	-0.014	0.003	0.005	0.006
Rate AIS	-€ 0.05	0.004	-0.001	-0.002	-0.002
Rate Gambero Rosso	€ 0.85	-0.068 ***	0.014 ***	0.024 ***	0.030 ***
Rate Veronelli	€ 0.71	-0.057 ***	0.012 ***	0.020 ***	0.025 ***

Starred levels of significance are 10% (\*), 5% (\*\*), 1% (\*\*\*)

Wine produced by private companies benefits a higher market price than that accorded to cooperative firms, while Campania origin of the firm influences negatively the average Aglianico selling price. As expected, DOCG certification influences greatly the price; DOCG implicit price is assessed to be on average 8 euro. As concerns the impact of the catalogues, AIS presence, regardless of the assigned score, is valued to increase the average market price of around 2euro. Gambero Rosso and Veronelli show similar implicit prices, estimated to be around 0.80euro per each additional assigned score. The effect of the three guides is really comparable. As showed previously, few Aglianico wines are included in AIS, while Gambero Rosso and Veronelli assess a larger number of Aglianico wines. Therefore while the citation of the wine in the AIS catalogue is a sufficient condition to influence the selling price, the same is not true for the other considered guides that review a larger number of Aglianico wines, dilute probably the premium price. In Gambero Rosso and Veronelli cases therefore the premium price is proportional to the effective scores assigned by the wine quality experts.

## 5 Concluding remarks

The analysis carried out here is a first attempt to verify the role of credence attributes on wine price, trying to minimize the prominent effect of *terroir*. Collective reputation of the production districts provides comparative market advantages thanks to the role of *terroir* in wine consumer preferences, influencing largely market price. This paper performed a hedonic price estimation selecting only one specific Italian vine (Aglianico). Aglianico vine is a Southern Italy native varietal, involving many denominations of origin. Due the unconventional nature of the dependent variable expressed in categories, an ordered logit hedonic price modeling was implemented. Credence attributes influence greatly the market price of Aglianico wine. Wine



*terroir* is not the only important factor in determining the commercial value of the different wines. Among the credence attributes, DOCG certification influences greatly the price: implicit price of DOCG certification is higher than those concerning the quality experts rating. This result highlights the relevant role that this certification still maintains. It provides a strategic asset in the current conditions of the market, involving also resistance to global standardization. The efficacy of this strategy is also demonstrated by a growing interest of important segments of consumers to wines with a strong territorial identity and a specific original flavor. The certification of origin adoption appears as a forced choice for the quality wine producers, recompensing the producers more than experts' awards.

## References

- Anderson, K. ed. (2004). *The Worlds Wine Markets: Globalisation at Work*, Elgar, Cheltenham.
- Angulo, A.M., Gil, J.M., Gracia, A., and Sanchez M. (2000). Hedonic prices for Spanish red quality wine, *British Food Journal*, MCB University Press, Vol. **102** No. 7, 2000: 481-493
- Bombrun, H., Sumner, A. (2003). What determines the price of wine? The value of grape characteristics and wine quality assessments, *Agricultural Issues Center University of California* n. 18, 16.
- Combris, P., Lecocq, S., and Visser, M. (1977). Estimation of a hedonic price equation for Bordeaux wine: does quality matter?, *The Economic Journal*, **107**(441): 390-402.
- Combris, P., Lecocq, S., and Visser, M. (2000). Estimation of a hedonic price equation for Burgundy wine, *Applied Economics*, **32** (8): 961-967.
- Costanigro, M., McCluskey, J. (2011). Hedonic price analysis in food markets, in Lusk, J., Roosen, J, and J. Shogren (eds.), *The Oxford Handbook of the economics of food consumption and policy*, Oxford University press, Oxford.
- de Magistris, T., Groot, E., Gracia, A., and Albisu L.M. (2011). Individual preferences for premium red wine in Spain, *paper presented at the 5th EAAE European Forum on Food System Dynamics* Igl, Innsbruck, Austria, 2011
- Fogarty, J. (2006). The return to Australian fine wine, *European Review of Agricultural Economics*, **33** (4): 542-561.
- OIV (2011). Report of the Director General of the OIV on the world vitiviniculture situation in 2010, International Organisation of Vine and Wine, Paris.
- Oczkowski, E. (2001). Hedonic Wine Price Functions and Measurement Error, *Economic Record*, **77**: 374–382.
- Pomarici, E., Rocco, L., Raia, S., and Tedesco R. (2004). Aglianico in Campania: diffusione e importanza del vitigno e prospettive competitive, in Moio L. (edited by), *Colori, odori ed enologia dell'Aglianico*, Regione Campania, SeSIRCA, Naples, Italy.
- Schamel, G. (2003). A hedonic pricing model for German wine, *Agrarwirtschaft*, **52** (5): 247-254
- Schamel, G., Anderson, K. (2003). Wine Quality and varietal, regional and winery reputations: hedonic prices for Australia and New Zealand, *The Economic Record*, **79** (246): 357-369
- Winkelmann, R., Boes, S. (2006 ). *Analysis of Microdata*, Springer, Berlin. 2009.