MEMORANDUM

No 06/2009

The Premium for Organic Wines: Estimating a Hedonic Price Equation from the Producer Side

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ISSN: 0809-8786

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This series is published by the
University of Oslo
Department of Economics

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The premium for organic wines.
Estimating a hedonic price equation from the producer side

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Abstract

Organic production techniques are an increasing, though minor so far, part of agriculture, and organic wines are increasingly produced and appreciated. Nevertheless, since the organic technique is more costly, a crucial question is whether organic wines benefit from a price premium. In this paper a hedonic price function has been estimated for Piedmont organic and conventional wines. Unlike the current literature on the determinants of wine prices, we used data on the production side in addition to variables of interest for consumers. One question was whether farm and operator's characteristics of no interest for consumers affect wine prices. The second question was whether organic wine obtains a price premium relative to conventional wine. Our results show that, along with characteristics that are of interest to consumers, like the appellation and the variety, some farm and producer characteristics that are not directly relevant for consumers do significantly affect wine prices. We also find that, though there is not a premium in the sense of an addition to other price components, given farmers' and wines' characteristics, organic wines do command higher prices.

JEL classification: C21, L11, Q12
Keywords: Organic wine, hedonic price, price premium, Piedmont

The financial support of Regione Piemonte for the survey of organic farms on which this study is based is gratefully acknowledged. We wish to thank Orley Ashenfelter for very helpful comments and suggestions on an earlier draft, as well as participants at the Enometrics XV Conference (Collioure, France, May 29-31, 2008). The usual disclaimer applies.

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The premium for organic wines.

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1. Introduction

Organic production techniques are an increasing, though minor so far, part of agriculture. The growth of organic production is also favoured by the European Common Agricultural Policy, based on the consideration that it is more environment-friendly. On the consumers' side, organic products are increasingly consumed, both on the basis of environmental concerns and on their reputation of being healthier and tastier (AC Nielsen, 2005). Agricultural area under organic production has grown in Europe (EU-15) from 2.3 in 1998 to 5.1 million hectares in 2003. In Italy the area under organic production was 577 thousand hectares in 1998, 1.05 million hectares in 2003, and 1.15 million hectares in 2006 (Eurostat).

Among organic products, organic wine is also growing. Organic grape area in Italy grew from 27 thousand hectares in 1998 to 38 thousand hectares in 2006. This is still a small part of overall wine-growing. In Piedmont, organic vineyards cover around 1400 hectares and organic wines account for around 2 percent of the regional wine sales (Corsi, 2007). Overall, the market for organic wines is still thin, and not all organic wines are sold as such[3]. Nevertheless, the trend in consumption and production is ascending.

In general, organic products are considered healthier and more environmentally friendly by consumers, which commands higher prices. Though, for organic wine there are some specificities. Indeed, it has some characteristics of interest for consumers in common with the other organic products (in particular, absence of chemicals and, hence, a healthier image, and the response to environmental concerns). On the other side, quality is crucial for wine appreciation by consumers, and from this point of view, organic wine so far has not a great reputation in terms of quality.

From the production side, organic techniques are usually more costly than conventional ones, which would in turn command higher selling prices. Though, since equilibrium price obviously results from both supply and demand factors, it is important to assess whether organic quality may raise wine price, ceteris paribus.

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[3] Organic production is regulated by EU (EC) Reg. 2092/91, now substituted for by (EC) Reg.834/2007, which is to be enforced as of 1st January 2009. On the basis of these regulation, only agricultural products following the prescribed production rules, and undergoing a certification process, can be sold as "organic". Organic products marketed without the certification are to be considered as conventional.

The literature on the determinants of wine prices is becoming quite large, and suggests that several attributes can affect price. They can be grouped into characteristics that are under control of the wineries and those that are exogenous (San Martin et al., 2007). Among the latter, weather conditions are important determinants of wine price (Ashenfelter et al., 1995; Ashenfelter, 2008; Di Vittorio and Ginsburgh, 2002; Wood and Anderson, 2002), though the influence of weather conditions on price is probably stronger for high quality wines. Gergaud and Ginsburgh (2008) also discuss the relative importance of natural conditions and of technology in determining wine prices. The largest part of the literature, nevertheless, is focussed on the consumer side, and explores the variables that can affect consumers' marginal willingness to pay for particular characteristics. Most of them stem from the experience good (and possibly, credence good) nature of wine, including sensory quality, appellations, experts' ratings (Nerlove, 1995; Combris et al., 1997; Lecocq and Visser, 2006; Oczkowski, 2001; Schamel, 2006; Benfratello et al., 2008; among others).

It is nevertheless important to recall (Rosen, 1974) that hedonic price stems both from consumers' marginal willingness to pay for the characteristic *and* from marginal cost for producing it. Therefore, hedonic prices also reflect production conditions and, in principle, it is possible to estimate them from production characteristics influencing the marginal cost. To the best of our knowledge, hedonic prices for wine have never been estimated from the producer side, i.e., on the basis of production characteristics apart from natural endowments. In this paper, hedonic price equations are estimated for organic and conventional wines precisely exploiting also information on the production side, i.e., from the characteristics of the farms and of the wines, using a unique dataset consisting in a total survey of organic farms in Piedmont. Organic farmers, nevertheless, may also produce conventional products, and this is also the case for those who are wine-makers, which allows for estimation of wine price equations differentiating the organic nature of wine. Because the producers in the sample are all organic farmers, we have to account for the possible fact that the producers belong to a selected group. We will thus account for this selection effect when estimating the price equations. Our analysis concerns production prices rather than retail prices, and the results can therefore be of interest in suggesting production strategies to prospective organic wine-growers.

2. Data

Data for the estimation of the hedonic price equations are drawn from a total survey, funded by Piedmont Region, of all organic farms enrolled in the regional official list. At the time of the survey (2006), 1655 organic farms were operating in the Region (1.4 percent of the total number of farms recorded at the Agricultural Census in 2000). Piedmont (located in the North-West of Italy) is wellknown for wine production, and some of its wines (e.g., Barolo and Barbaresco) have a worldwide reputation.

The questionnaire included data on the farm and on the operator, and data on plant and animal products produced by the farms (area or number, yields, price by destination), including products processed on the farm. Data for this analysis were obtained by selecting those farms that processed wine on the farm. After elimination of observations with missing values or not usable for the estimates, a total of 171 farms resulted, for a total of 389 wines produced: the number of wines produced in each farm ranges from 1 to 8. Wines (classified by variety and appellation, if any) could be organic or conventional, since not all organic farms only produce organic products, or because wine-makers choose not to certify their wine as organic. Organic wines were 304, and conventional ones were 85, and this allows observation of production prices also according to their organic or conventional characteristic. For conventional wines, quantities and average prices were surveyed. For organic wines, quantities and prices were surveyed by destination, namely: sold as conventional, sold on the farm, on farmers' markets, on the Internet, through home delivery, to co-operatives, to wholesalers, to supermarkets, to specialized organic shops, to restaurants[4]. The average price is 3.525 Euro (Table 1), which indicates that among these farms there are no great and famous producers. Prices exhibit nevertheless a non-negligible variation, and range from 40 cents to 21 Euro per liter. The average price of organic wine, regardless of its destination, is 3.527 Euro, while for conventional wine the price is slightly lower (3.518 Euro). On the basis of these data only, not controlling for explanatory variables, organic wine does not seem to benefit of a price premium relative to conventional wine.

Characteristics of each wine comprise: two different appellation levels (DOC, Denominazione di Origine Controllata – Controlled Designation of Origin, and DOCG, Denominazione di Origine Controllata e Garantita - Controlled and Guaranteed Designation of Origin, the latter implying more stringent controls and qualification), represented by dummy variables, the variety, also represented by dummy variables (the reference is wines without a defined variety, or varieties comprising very few cases), and the organic quality. For an appellation being attributed to a wine, fulfilling production rules, including a limitation in yields, is required, and hence, using an appellation affects production costs. Nevertheless, appellations also have different attractiveness for consumers as signals of quality, and the effect of appellations therefore also reflects consumers' appreciation. Around 77 percent of wines belong to a DOC, and a further 6 percent are DOCG.

[4] Self consumption was also considered; the lowest alternative price was assumed to be the price of self-consumed wine.

In Piedmont, wines are for the largest part made from specific varieties and are not assembled. The most frequent variety in our sample are Barbera (23 percent) and Dolcetto (18 percent); Nebbiolo accounts for almost 7 percent. Varieties may differ as to the yields, care needed for growing them, responsiveness to weather and pest attacks, and wine-making processes. Hence, different varieties may imply different production costs but, again, different prices may also reflect different consumers' appreciation and willingness to pay. The same applies to the organic rather than conventional method (78 percent of our sample is organic wine). Though our survey did not report production costs, organic wine-growing and wine-making are usually considered more costly than conventional ones. Delmas et al. (2008) report that organic wine-growing costs in California are 10 to 15 percent higher than for conventional grapes. But, again, the price premium for organic wine may also reflect consumers' preferences.

By contrast, some farm and operators' characteristics reflect production costs and farmers' skills and apparently have no impact on consumers' preferences. Nevertheless, since hedonic prices theoretically are simultaneously determined by marginal costs and marginal willingness to pay, these farm and operator's characteristics are to be interpreted as determinants of unobservable wine quality that has some cost for the producer and for which consumers are willing to pay. Farm operators' characteristics refer to their human capital. Age is an indicator of skills acquired through experience. Education is another indicator of human capital, and was recorded as the maximum degree attained. This was translated into years of schooling, assuming the regular number of years were followed. A dummy variable indicates if high school diploma and university degree were in the agricultural field. A further dummy variable indicates whether the farm operator followed a professional agricultural course in the last three years. All these characteristics are assumed to affect wine prices, though the direction may be a priori unclear: skills acquired through working experience or formal education may translate into higher efficiency and, hence, lower production costs, though this would not necessarily reduce selling prices. On the other hand, farmers can acquire through education and experience the capacity to improve the quality of their wines and, possibly, greater marketing skills, and hence they can get higher prices through accumulation of reputation or through the choice of the appropriate marketing channels.

Production characteristics include the degree of farm specialization in wine-growing and the quantity of wine produced. The former variable tries to capture the effects of the production mix, since organic farms typically comprise different crops and animal raising. While this is consistent with the spirit of organic farming, which in principle should try to close the biological circle within the farm through the utilization of manure, on the other hand specialization can offer greater opportunities in terms of operating and marketing skills. Specialization is measured as the share of grapes on total utilized agricultural area. The average is 64 percent. The variable of quantity of wine produced tries to capture economies of scale in wine-growing and wine-making. Organic farms in Italy, like conventional ones, are small, and the average quantity of wine produced is only 5053 liters, though with a large variation.

In Italy some selected wines are listed in *Gambero Rosso* guidebook. This is a famous wine guidebook, rating wines across all Italian regions. Inclusion in *Gambero Rosso* is highly prestigious, and is a strong quality signal. In our sample a little more than 6 percent of the wines are presented in this book. We have included the entry of the wine in the *Gambero Rosso* among the explanatory variables.

We did not include weather variables among the explanatory variables, since our database is cross-sectional, and concerns one region, so weather conditions in the reference year are quite homogeneous, and we can disregard them.

(Table 1 here)

Data for estimating the participation to organic farming equation needed to correct the selection bias were drawn from a random sample of 10,000 individual farm records of the 2000 Agricultural Census in Piedmont. The Census included information on whether wine was made on the farm, and whether the farm produced organic products. On-farm winemakers were 1443, i.e., 14.4 percent of the sample. Among them, those who had some organic production (not necessarily wine) were 1.3 percent, a percentage that mirrors the general percentage of organic farms in the region. Other information used in the estimation of the probability of producing organic wine were the location (mountains, hills or plains), farm size (hectares), and some operator's characteristics (age, attendance to professional courses). All these variables are assumed to influence the choice of wine-makers to have some organic production.

(Table 2 here)

3. The econometric models and estimates

We assume in general that the log price of one unit of wine is given by the following hedonic price equation:

(1) $\log P_i = X_i\beta + \varepsilon_i$

P_i is the price of one unit of wine (Euro/liter), X_i is a vector of explanatory variables that we expect may affect the price of wine, β is a vector of unknown coefficients and ε_i is white noise.

Two different models were estimated. The first one (unified model) assumes that explanatory variables affect the wine price in the same way, regardless of its organic or conventional nature, and that organic characteristic only shifts the price. This model is therefore estimated on the whole sample, introducing a dummy variable for the organic characteristic. The second model (split model) assumes that the explanatory variables may differently affect the price for organic and for conventional wine. Accordingly, this model is estimated separately for organic and conventional wines. The two models can be represented as follows:

Unified model:

(2) $\log Pi = \alpha + X_i\beta + Z_i \gamma + \varepsilon_i$

Split model:

(3) $\log P_{oi} = \alpha_o + X_i\beta_o + \varepsilon_{io}$

(4) $\log P_{ci} = \alpha_c + X_i\beta_c + \varepsilon_{ic}$

where Z_i is a dummy variable which takes the value 1 if the wine is organic, 0 otherwise, and the subscripts *o* and *c* refer to organic and conventional, respectively.

The first model is nested in the second one. This can be seen by considering that equation (2) can be written:

(5) $\log P_i = (\alpha_o + X_i\beta) Zi + (\alpha_c + X_i\beta) (1 - Z_i) + \varepsilon_i =$

$= \alpha_c + (\alpha_o - \alpha_c) Zi + X_i\beta + \varepsilon_i$

while equations (3) and (4) can be merged into:

(6) $\log P_i = (\alpha_o + X_i\beta_o) Zi + (\alpha_c + X_i\beta_c) (1 - Z_i) + \varepsilon_i$

The two models can be confronted by testing the restriction that $\alpha = \alpha_c$ and $\gamma = (\alpha_o - \alpha_c)$

As mentioned above, the winemakers in the sample are all - to a varying extent- organic producers. Thus we should expect that this selection may matter for the price of the wine. More specifically, the expected value of the log price given that the wine producer is an organic producer may in principle deviate from the unconditional expectation of the log price. To account for this selection effect we have estimated the probability for on-farm winemakers of being organic producers based on a larger data set from year 2000. Let $\Phi(y_i\alpha)$ be the probability that a winemaker is an organic producer. We assume that this probability is the normal cumulative. $1-\Phi(y_i\alpha)$ is the probability that a winemaker is not an organic producer. This bivariate probit is assumed to depend on variables (y_i) of which there are some that are not among the explanatory variables in the hedonic price equations[5]. The estimates of the coefficients α are given in Table 3. From that table we observe that the farm being located in the mountains contributes positively and significantly to the probability that the wine producer is an organic farmer. Moreover, the larger the farm is the higher is the probability that the winemaker is an organic farmer. This contrasts with the often held view that organic farms are small and marginal farms, but a comparison between organic farm characteristics and overall farm characteristics (Corsi, 2007) shows that in reality this is not the case, since the average size of organic farms is higher than the overall average size. Also, age has a significant and negative impact on the probability that the wine farm operator is an organic producer, which reflects the fact that younger people are more willing to adopt a new technique like organic farming, given their longer time horizon for the investment in human capital. Indeed, organic farming probably requires more professional skills than conventional farming, also due to the need to gather technical information less available than the one needed for conventional agriculture. This is also reflected by the significantly higher likelihood that the wine-maker farmer is an organic producer if he/she has attended a professional course.

Table 3 here.

Based on the estimates in Table 3 we can compute the following variable denoted λ_i, which is given as $\lambda_i = \frac{\varphi(y_i\alpha)}{\Phi(y_i\alpha)}$. Here $\varphi(.)$ is the density in the normal probability distribution, and $\Phi(.)$ the corresponding cumulated probability distribution. It can then be shown (using equation (1)) that $E[\log P_i | \text{ organic producer}] = X_i\beta+\delta\lambda_i$.

[5] We experimented different specifications of the participation equation and of the wine price equations, since several variables were good candidates for both. The final specification is quite robust to the inclusion of other variables. In particular, we found that location (mountains, plains) and farm size were never significant for wine prices, and that gender was never significant in both.

Table 4 gives the results of regressing log price of wine for the full sample of 389 observations in Piedmont against the explanatory variables described above (the unified model). While for continuous variables the coefficients, multiplied by 100, are to be interpreted as the percentage change in the price for a unit change in the explanatory variable, the percentage effect of a change of a dummy explanatory variable from 0 to 1, shown in the column: "Price premium", is equal to $100 \cdot [\exp(c) - 1]$, where *c* is the relevant coefficient (Halvorsen and Palmquist, 1980).

We note that the selection effect is significant and positive, which means that the expected price of wine, conditional on the winemaker being an organic wine producer, exceeds the unconditional expectation of the price of such wines.

Second, we note that the appellation system matters for the price. The appellation DOC, relative to no appellation, raises the price by nearly 38 percent. The DOCG classification raises the price by further 22 percent. Moreover, to be listed in Gambero Rosso is estimated to have a positive impact (at the 10 percent significance level) on the price of the wine, with a 27 percent increase. We consider these effects to reflect the consumers' willingness to pay for high quality wine, based on quality signals and experts' rating of wine, and on costs needed for producing high quality wines.

The only grape with a significant positive premium is the Nebbiolo grape. This is an expected result, since this is the grape variety from which the most prestigious wines are made. The price premium is as high as 69%. Somewhat surprising is that Cortese – a grape used to produce white wines- carries a significant and substantial negative price premium. The coefficients of the other varieties are not significant, which implies that their price does not significantly differ from the reference wines with no particular variety (table wine).

Whether the wine is produced in a small or a large quantity seems to have no effect on the price; therefore, economies of scale, if existing, do not translate into a price premium. However, the more specialized the producer is in producing wine in terms of total agricultural area devoted to grape production, the higher is the price of his wine. The price premium is close to 0.5 percent for each additional 1 percent of agricultural area devoted to wine-growing. This result can be interpreted both in terms of better quality (and hence, higher prices) of specialized farmers, and in better marketing skills of farmers devoting specifically to wine-growing[6]. The age of the wine producer is

[6] Of course it might also be that the higher the price the farmer can obtain on his wine the more of the total area is devoted to wine-growing. If so, there should be an endogeneity problem, but tests do not indicate this. We regressed the residuals of the price equations on the share of grape area over total area, and never found significant values.

not significant. Neither having attended a professional course nor a specialized education in agriculture has a significant impact on the price of the wine produced. Probably this kind of education is not specific to wine-making and does not add specific skills in this field. The level of general education, however, has a positive impact, with close to a 5 percent price premium added for every extra year of general education. This may in part be due to a general better insight and possibly to family background characteristics. The higher the education level is of the wine producer, the better he is in wine-growing and wine-making, and in a better situation he is for exploiting marketing opportunities. Moreover, the higher his education, the better off his family tends to be, which probably reflects more profitable vineyards. The better off the family is, the better is the possibility to buy the best slots for making wine.

Of great concern for us is the finding that organic produced wine - all other things equal- obtains a higher price in the market than conventional wine. Under the assumption of the unified model, i.e., that organic quality raises the price but does not change the impact of the other variables on wine price, we find that keeping under control all other variables the price premium, which did not exist on average price data, is actually sizeable, 27 percent.

Though, as already mentioned, an alternative model assumes that organic quality implies different impacts of the other variables on wine price relative to conventional quality, and the two models can be confronted by testing the restriction that $\alpha = \alpha_c$ and $\gamma = (\alpha_o - \alpha_c)$. A likelihood ratio test strongly rejects the hypothesis. The relevant chi-square test is 41.15 with 2 d.f. The conclusion is therefore that organic and conventional wine prices are affected differently by the explanatory variables. Tables 5 and 6 give the estimates of the split model. It is interesting to note that if we do not account for the selection effect, the unified model is not rejected. The results of the split model for organic wine are to a large extent similar to the unified model. The selection effect is significant and positive. Appellations (DOC and DOCG) are both significant, and add to the price 38 and 54 percent respectively. Also the effect of Nebbiolo grape is similar to the one of the unified model (70%), while the negative effect of Cortese grapes is no more significant. The specialization effect is significant but lower (0.3 percent higher for each 1 percent increase in grape over total area). General education also is significant, and each additional year adds about 4 percent to the price. Unlike in the unified model, having attended professional courses raises the organic wine price by 34 percent, which could be taken as an effect of the higher professional skills required by organic farming. Finally, the organic wine being listed in Gambero Rosso guidebook is weakly significant, with an estimated price increase of 20 percent.

As to conventional wine price, the selection variable is not significant, meaning that for them the effects of the variables are not different from the ones of general wine-makers, which is a quite reasonable result. Unlike organic wines, only two variables are significant, which can be partly due to the much lower number of observations. The specialization variable is positive and significant, and exhibits a much stronger effect than on organic wine price. Also general education, the other significant variable, has a positive effect on price, stronger than on organic wine price.

Because the unified model is rejected, one cannot claim that there is a premium for organic wine as such. In other words, the organic quality does not directly add to other characteristics in raising the price. Rather, the characteristics influence the price in different ways, depending on the wine being organic (Table 5) or conventional (Table 6). Moreover, the constant terms in the organic price equation and in the conventional price equation do not significantly differ, since their 5 percent intervals overlap. Therefore, one may not even conclude that at the zero level of all other characteristics, the price of organic and conventional wines are different.

One may therefore wonder whether wine-growers "do the right choice" growing organic or conventional grapes and selling organic or conventional wine, given the characteristics of the farm and farmers. Given these characteristics the question thus is whether they would get a higher price if growing and selling organic wine rather than conventional wine. To answer this question, one can predict the average price organic wines would get and compare it to the average price the very same wine would get if it was grown and sold as conventional. Formally, one can test:

$$(7)\ \bar{p}_{oo} > \bar{p}_{oc}$$

that is:

$$(8)\ \frac{1}{N_o}\sum_{i=1}^{N_o}(\alpha_o + X_{oi}\,\beta_o) > \frac{1}{N_o}\sum_{i=1}^{N_o}(\alpha_c + X_{oi}\,\beta_c)$$

where N_0 is the number of organic wines.

Similarly, one might wonder whether those who made conventional wine would get higher prices had they made organic wine, given their characteristics, which could be tested formally as follows:

$$(9)\ \bar{p}_{co} > \bar{p}_{cc}$$

that is:

$$(10)\ \frac{1}{N_c}\sum_{i=1}^{N_c}(\alpha_o + X_{ci}\,\beta_o) > \frac{1}{N_c}\sum_{i=1}^{N_c}(\alpha_c + X_{ci}\,\beta_c)$$

where N_c is the number of conventional wines.

To calculate the predicted average log prices, we have employed Krinsky and Robb's (1986) Monte Carlo simulation approach. We randomly drew (1000 draws) from the multivariate normal distribution with mean $(\hat{\alpha}, \hat{\beta})$, the means of the estimated coefficients, and variance-covariance matrix V, the estimated variance-covariance matrices. For each draw of the coefficients we combined the draw of the coefficients with the individual observed values of the explanatory variables. Then we took the average of the log price over the observations and we repeated the procedure over the 1000 draws to obtain the average log prices. The results are given in Table 7. The mean log price of organic wine, using the coefficients and variables related to organic wine, is predicted to be 1.083. When using the coefficients of the conventional price equation, but the co-variates of organic wine, the mean log price is lower, 0.895.

To test whether these prices are significantly different, we tested the one-sided significance of

$$H_0: \bar{p}_{oo} - \bar{p}_{oc} = 0$$

using the methodology suggested by Poe et al. (2005). We calculated the difference between all permutations of the random values of the average prices, and counted the number of the negative or null ones, which turned out to be 5.2 percent[7]. This indicates that, conditional on the characteristics of the wine and of the farm, producing organic wine results in a significantly higher price than when producing conventional wine.

The mean log price of conventional wine, predicted with the parameters and the variables of making conventional wine, is 0.954. When replacing the coefficient with those of the organic log price regression, we predict the mean log price to be 1.187. In this case, the test is on

$$H_0: \bar{p}_{co} - \bar{p}_{cc} = 0$$

and the probability of a negative or null difference is even lower, i.e., 0.09 percent. Thus also those farmers that actually produced conventional wine, given their characteristics, would on the average gain significantly higher prices had they produced organic wine.

[7] The differences were calculated over the permutations of the 1000 average prices calculated from the random draws. The procedure is demanding in terms of computer time, since the total number of computed differences is 1,000,000.

4. Conclusions

In this paper hedonic price functions have been estimated for Piedmont organic and conventional wines. Unlike the current literature on the determinants of wine prices, we used data on the production side in addition to data on characteristics of interest to consumers. One question was whether farm and operator's characteristics apparently of no interest for consumers affect wine prices. The second question was whether organic wine obtains a price premium relative to conventional wine.

As expected the classification of wines in the Piedmont region done by the wine authorities matters for the price of wine. And also as expected the Nebbiolo grape is priced far better in the market than other grapes. These are nevertheless characteristics that may affect consumer evaluation of wines.

Among the characteristics that apparently are of no interest to consumers, we found that human capital characteristics of the wine producer affect the price. General education level of the wine producer has a positive impact on wine prices. Also, we found that specializing in wine relative to producing a broader specter of agricultural products has a significant positive impact on the price of wine obtained by the producer.

Finally, an important finding is that the way the wine is produced - organic or non-organic – affects the price obtained in the market. Organic quality does not simply add to the price, but modifies the impact of other variables. So, there is not a price premium in the sense of additional value added by the organic quality. But we found that those wine-growers who made conventional wine would obtain on the average higher prices had they grown organic grapes and made organic wine. Conversely, those wine-growers that actually made organic wine obtained higher prices than what they would get had they grown conventional grapes and made conventional wine. The overall conclusion is therefore that, though there is not a premium in the sense of an addition to other price components, given farmers' and wines' characteristics organic wines do command significantly higher prices.

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Table 1. Summary statistics of wine observations, Piedmont, 2006.

	Total (389 obs.)		Organic (304 obs.)		Conventional (85 obs.)	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
Average wine price (Euro/ liter)	3.525	2.551				
Organic wine price (Euro/liter)			3.527	2.528		
Conventional wine price (Euro/liter)					3.518	2.647
DOC (1,0)	0.766	0.424	0.750	0.434	0.824	0.383
DOCG (1,0)	0.062	0.241	0.059	0.236	0.071	0.258
Arneis (1,0)	0.015	0.123	0.013	0.114	0.024	0.152
Bonarda (1,0)	0.013	0.113	0.013	0.114	0.012	0.108
Cortese (1,0)	0.028	0.166	0.030	0.170	0.024	0.152
Chardonnay (1,0)	0.051	0.221	0.046	0.210	0.071	0.258
Grignolino (1,0)	0.028	0.166	0.030	0.170	0.024	0.152
Freisa (1,0)	0.036	0.187	0.026	0.160	0.071	0.258
Moscato (1,0)	0.021	0.142	0.023	0.150	0.012	0.108
Barbera (1,0)	0.234	0.424	0.224	0.417	0.271	0.447
Dolcetto (1,0)	0.183	0.387	0.197	0.399	0.129	0.338
Nebbiolo (1,0)	0.069	0.254	0.069	0.254	0.071	0.258
Total quantity of wine, liters	5053.27	8877.97	5409.63	9650.87	3778.76	5098.63
Wine area relative to total agricultural area	0.636	0.373	0.607	0.388	0.736	0.296
Operator's age	48.9	12.9	49.1	13.1	48.2	12.3
Attendance to professional courses (0, 1)	0.689	0.464	0.681	0.467	0.718	0.453
Years of general education	11.3	3.6	11.4	3.4	11.3	4.2
Agricultural education (1,0)	0.141	0.349	0.105	0.307	0.271	0.447
Organic wine (1,0)	0.781	0.414	1	0	0	0
In Gambero Rosso (1,0)	0.062	0.241	0.076	0.265	0.012	0.108

Table 2. Summary statistics of on-farm winemakers, Piedmont 2000 (1443 obs.)

	Mean	Std.Dev.
Location: Plains (0, 1)	0.119	0.323
Location: Mountains (0, 1)	0.032	0.176
Farm area (ha)	6.24	11.62
Operator's age	58.8	14.0
Attendance to professional courses (0, 1)	0.089	0.285
Organic production (0, 1)	0.013	0.114

Table 3. Estimate of the probability of being organic wine producer among winemakers in Piedmont 2000, (bivariate probit).

Variables	Estimates		t-values
Constant	-1.608		-4.0
Location: Dummy for plains	-0.422		-0.97
Location: Dummy for mountain	0.917		2.9
Area of the farm	0.010		2.0
Operator's age	-0.015		-2.1
Attendance to professional courses	0.567		2.4
No of observations, N		1443	
Log-likelihood		-88.1281	
Prob[ChiSqd > value] =		0.0001	

* $\text{Pseudo R square} = 1 - \frac{\text{LogL}}{\text{N Log } 0.5} = 1 - \frac{\text{Log}(-88.1281)}{1443\ (-0.6931)} = 0.9119$

Table 4. Estimate of log price of wine in Piedmont, 2006 with a dummy for organic produced wine.

Variables	Estimates of coefficients	t-values	Price premium (%)
Constant	-1.510	-4.915	
DOC (1,0)	0.320	3.333	37.7
DOCG (1,0)	0.469	2.877	59.8
Arneis (1,0)	-0.001	-0.005	-0.1
Bonarda (1,0)	-0.249	-1.034	-22.0
Cortese (1,0)	-0.391	-2.151	-32.4
Chardonnay (1,0)	0.016	0.115	1.6
Grignolino (1,0)	-0.186	-1.086	-17.0
Freisa (1,0)	0.113	0.721	12.0
Moscato (1,0)	0.000	0.002	0.0
Barbera (1,0)	-0.014	-0.161	-1.4
Dolcetto (1,0)	0.041	0.436	4.2
Nebbiolo (1,0)	0.525	4.252	69.0
Total quantity of wine, liter	$-0.481*10^{-5}$	-1.434	$-0.481*10^{-3}$
Wine area relative to total agricultural area	0.451	5.290	45.1
Age of producer, years	0.003	1.186	0.3
Professional course (1,0)	0.151	1.730	16.3
Years of general education	0.048	5.769	4.9
Agricultural education(1,0)	0.088	1.014	9.2
Organic produced wine (1,0)	0.239	3.609	27.0
In Gambero Rosso (1,0)	0.210	1.801	23.4
Lambda[1]	0.432	3.242	
No of observations	389		
Adjusted R square	0.358		
F[21, 367]	11.31		

[1] Lambda is a selection variable and equals the inverse of the Mill's ratio: $\frac{\varphi(x)}{\Phi(x)}$ and is computed based on the estimates given in Table 3.

Table 5. Estimate of log price of organic wine in Piedmont, 2006

Variables	Estimates of coefficients	t-values	Price premium (%)
Constant	-1.054	-3.452	
DOC (1,0)	0.323	3.309	38.1
DOCG (1,0)	0.429	2.579	53.6
Arneis (1,0)	-0.032	-0.127	-3.1
Bonarda (1,0)	-0.197	-0.809	-17.9
Cortese (1,0)	-0.218	-1.174	-19.6
Chardonnay (1,0)	0.052	0.356	5.3
Grignolino (1,0)	-0.123	-0.707	-11.5
Freisa (1,0)	0.236	1.296	26.6
Moscato (1,0)	0.001	0.005	0.1
Barbera (1,0)	0.060	0.647	6.2
Dolcetto (1,0)	0.064	0.670	6.6
Nebbiolo (1,0)	0.532	4.251	70.2
Total quantity of wine, liter	$-0.310*10^{-5}$	-0.961	$-0.31*10^{-3}$
Wine area relative to total agricultural area	0.339	3.888	33.9
Age of producer, years	0.003	1.018	0.3
Professional course (1,0)	0.256	2.886	29.1
Years of general education	0.037	4.127	3.8
Agricultural education(1,0)	0.081	0.842	8.4
In Gambero Rosso (1,0)	0.185	1.692	20.3
Lambda[1]	0.380	2.896	
No of observations	304		
Adjusted R square	0.358		
F[20, 283]	9.46		

[1] Lambda is a selection variable and equals the inverse of the Mill's ratio: $\frac{\varphi(x)}{\Phi(x)}$ and is computed based on the estimates given in Table 3.

Table 6. Estimate of log price of conventional wine in Piedmont, 2006

Variables	Estimates of coefficients	t-values	Price premium (%)
Constant	-1.700	-1.528	
DOC (1,0)	0.230	0.778	25.8
DOCG (1,0)	0.568	1.133	76.5
Arneis (1,0)	-0.400	-0.569	-32.9
Bonarda (1,0)	-0.431	-0.601	-35.0
Cortese (1,0)	-0.890	-1.671	-58.9
Chardonnay (1,0)	-0.020	-0.058	-2.0
Grignolino (1,0)	-0.087	-0.166	-8.3
Freisa (1,0)	-0.102	-0.286	-9.7
Moscato (1,0)	0.208	0.250	23.1
Barbera (1,0)	-0.195	-0.750	-17.7
Dolcetto (1,0)	-0.048	-0.159	-4.7
Nebbiolo (1,0)	0.556	1.499	74.3
Total quantity of wine, liter	-0.126*10-4	-0.747	-0.126*10-2
Wine area relative to total agricultural area	0.674	2.331	67.4
Age of producer, years	0.003	0.363	0.3
Professional course (1,0)	-0.107	-0.340	-10.2
Years of general education	0.053	2.133	5.4
Agricultural education(1,0)	-0.003	-0.014	-0.3
In Gambero Rosso (1,0)	0.879	1.181	140.9
Lambda[1]	0.592	1.203	
No of observations	85		
Adjusted R square	0.325		
F[20, 64]	3.02		

[1] Lambda is a selection variable and equals the inverse of the Mill's ratio: $\frac{\varphi(x)}{\Phi(x)}$ and is computed based on the estimates given in Table 3.

Table 7. Price simulations; average log price per liter computed from making 1000 draws from the joint distribution of the estimated coefficients and with mean values of the associated variables

Average log price	Mean
Log price| organic parameters and organic variables	1.083
Log price| conventional parameters and organic variables	0.895
Log price| conventional parameters and conventional variables	0.954
Log price| organic parameters and conventional variables	1.187