Quality, Information and Wine Labelling:
Experiences from the British Wine Market

Introduction

Economists may observe choices made by consumers and they may observe demand, but they do not observe preferences. For a given product, we could therefore attempt to reconstruct the consumer's hierarchy of attitudes towards product attributes, within his or her utility structure, and from the consumer's stated behavioural intentions (multi-attribute attitude models, conjoint analyses). Instead of relying on stated intentions, we could employ revealed preference analyses, which obtain predictions by combining observations of realised choices with assumptions about underlying decision processes (Rosen, 1974; McFadden, 1974).

In relying on observed choices, this paper aims to explore consumer preferences towards wine attributes by considering the consumers' degree of product involvement and their valuation of information. Hedonic analysis seems ideally suited to approach this problem, as the underlying hypothesis states that heterogeneous goods are aggregations of attributes in the Gorman (1980)-Lancaster (1966) sense and that economic behaviour relates to these attributes (Triplett, 1990).

In pursuit of consumer preferences towards wine attributes, hedonic analysis enables us, therefore, to identify the implicit valuations which consumers and marketers place on wine attributes. We attempt to comprehend variants of wine by estimating hedonic price functions for still light wine in the British off-licence market.[1]

The paper is organised in the following manner. Section one provides an introduction to the British wine market. In section two, the theoretical framework for describing agent's valuation of wine attributes is briefly developed from previous models of product differentiation, followed by a statement of objectives and hypotheses. The final section attempts an empirical assessment of postulates from section two, and concludes with an examination of marketing implications.

1 The market for still light wine in the United Kingdom

The wine market in the United Kingdom (UK) is dominated by still light wine imports (more than 90%, value 1994). English and Welsh wine, produced from fresh grapes, accounts for only 0.3% (value, 1997) of domestic consumption. Imports, primarily from the EU but increasingly from a wide range of third countries, make up the balance. Currently, there are more than 25 countries of origin represented in the UK wine market. Since the following empirical analysis relies on data from 1994, we will briefly introduce to developments on the supply and demand side around that period.

1.1 Wine distribution and imports

Two types of licences give the right to sell alcoholic beverages in the UK. The "off-licence", where the product is consumed outside the premises in which it was purchased (e.g. retail outlets), and the "on-licence" where alcohol is consumed *in situ* (e.g. pubs, clubs and restaurants).

Table 1.1.: Sales of still light wine [2] by type of licence, 1984-93 (% of volume)

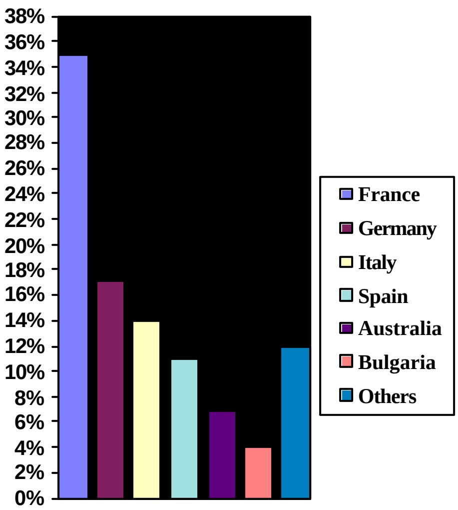
	Off-licence	On-licence
1984	70	30
1988	74	26
1992	83	17

Source: Economist Intelligence Unit (EIU), 1994

With more than 45,000 points of sale and 70% of total wine sales in 1993 (value), the off-licence sector dominates the wine market in the UK.
Regarding the evolution of sales by country of origin, the big four traditional suppliers, France, Germany, Italy and Spain, continue to dominate but, collectively, if not in all cases individually, have seen their share eroded. Their combined share declined from 89% of volume of imported wine from fresh grapes in 1983 to 78% in 1993.

Table 1.2.: Principal suppliers of still light wines to the UK

Principal suppliers of still light wines to the UK (volume, 1994):



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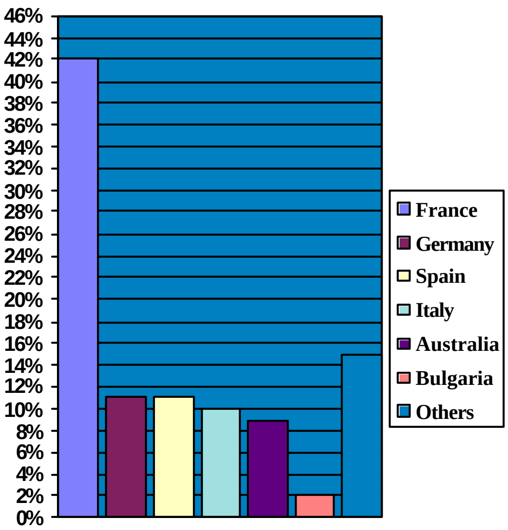

Source: CFCE, 1996

Table 1.2.: Share of sales of imported still light wine by country of origin, 1980-93 (% of total)

	1980	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
France	35.7	38.2	37.6	38.6	40.6	38.9	38.7	36.6	35.1	35.6	34.2	31.4
Germany	20.9	27.1	31.7	30.3	26.9	27.9	27.3	28.2	28.8	27.6	26.8	25.0
Italy	17.1	14.5	14.0	16.1	16.5	16.4	17.7	18.8	18.8	18.2	16.9	16.2
Spain	13.2	9.1	6.7	6.0	6.4	6.2	5.4	4.7	4.3	4.3	4.8	5.9
Portugal	2.1	0.8	1.2	1.3	1.6	1.8	1.4	1.4	1.3	1.4	1.7	1.8
Other EU	0.6	0.6	0.5	0.6	0.6	0.5	0.5	n/a	n/a	n/a	n/a	n/a
Yugoslavia	5.9	5.0	3.9	3.9	3.8	3.5	2.6	3.2	2.9	2.6	2.0	1.6
Bulgaria	0.0	0.7	0.6	0.7	1.1	1.7	2.8	2.8	3.7	3.7	3.8	5.1
Hungary	?							0.5	0.8	1.0	1.2	1.6
Cyprus	?							0.1	0.1	0.1	0.0	0.0
Australia	?							n/a	1.2	2.1	3.8	5.8
New Zealand	?							n/a	0.3	0.4	0.6	0.8
South Africa	? 4.6	4.1	3.7	2.5	2.5	3.2	3.6	0.2	0.2	0.2	0.4	0.9
USA	?							0.6	1.0	1.4	1.7	1.9

Chile	?							n/a	0.2	0.5	0.8	0.6
EU blends	?							1.3	0.9	0.5	0.4	0.2
Other	?							1.6	0.4	0.4	0.9	1.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: EIU (1994)

Most countries depend heavily upon off-licence sales, with France and, to a lesser extent, Germany depending disproportionally upon the on-licence trade.

Table 1.3.: Country shares of still light wine sales in the off-licence and on-licence trades, 1992:
(% of volume)

	Off-licence	On-licence
France	28.8	52.2
Germany	25.8	28.0
Italy	18.1	10.2
Spain	5.5	1.6
Bulgaria	4.5	0.5
Australia	4.3	1.7
UK (British & English)	2.7	0.1
Yugoslavia	2.0	1.7
Portugal	2.0	0.6
USA	1.9	0.4
Hungary	1.5	0.0
EU blends	0.3	0.5
Other origins	2.6	2.5
Total	**100.0**	**100.0**

Source: CFCE, 1994

1.2 The demand side

The per head consumption of wines has sharply increased, from 5.8li/year in 1971 to 15.8 li/year in 1991 (for all consumers > 15 years). Nevertheless, with the exception of Northern Ireland, Great Britain is the country within the EU with the lowest level of consumption.

Table 1.4.: Wine consumption per head in the EU (in litres)

	France	Italy	Luxembourg	Belgium	Denmark	Britain
1990	73,1	61,4	58,2	24,9	21,3	11,56

Source: CFCE, 1994

The British consumer purchases mainly white wines (60%), though red wines, taking almost 40% of the market share, have recently enjoyed a substantial expansion.

Table 1.5.: UK sales of imported still light wine by colour, 1980-93 (% of volume)

	RED	ROSE	WHITE
1980	36.8		63.2
1989	26.1	3.6	70.3
1993	33.2	2.9	63.7

Source: EIU, 1994

2 A model of product differentiation

Rather than taking hedonic price functions as a reflection of consumer behaviour only (Lancaster, 1971), Rosen (1974) developed Houthakker's (1952) market notion of hedonic prices further. In Rosen's (1974) model of product differentiation, market clearing conditions determine the set of hedonic prices, where hedonic prices are defined as the implicit prices of attributes as revealed to economic agents from observed prices and specific amounts of characteristics associated with them. What is being estimated in Rosen's (1974) description of a competitive equilibrium is the locus of intersections of the demand curves of different consumers with varying tastes and the supply functions of different producers with possibly varying technologies of production.

This paper departs from a one-period model of wine consumers' choice behaviour, in which the consumer chooses one wine variety at a time from among a number of different varieties. In a setting of perfect competition, a utility maximising consumer is faced with a cost-minimising supplier of wine attributes. Based on this conventional user value and resource cost- concept, a non-linear equilibrium shadow price schedule is assumed, as in Rosen (1974), where non-linearity is postulated due to the inability to unbundle attributes infinitely. However, although it is asserted that only certain attribute combinations can be selected in a reshuffled form (it may be possible to find a Cabernet Sauvignon 1992, aged in barriques for two years, *either* of French *or* Chilean origin), we assume that any quantity can be supplied to match consumer demand. Hence, we conjecture perfect divisibility. We also assume that retailers regard reputation as an asset, as they receive a competitive return on their reputation investment.[3]

Rosen's (1974) utility function is substituted in the present setting for a function, in which the one variety that is selected at a time emerges as a consequence of an optimising process, not as an extraneous assumption. Therefore, we employ Muellbauer's (1974) extension of Fisher and Shell's (1971) 'pure repackaging case',

$$U = U\{X_0(\sum_{i=0}^{m} a_i x_i), X_1, X_2, \ldots X_n\} \qquad (2.1.)$$

where $X_0(.)$ is the category utility function for the group $(x_1,...,x_m)$ and X_s , s = 1,..., n, are other wine attribute bundles sold or category functions for groups of other wine attribute bundles. The aggregate of all wine attribute bundles is the sum of the quality indices weighted by the number of units of each wine purchased. The quality indices (a_i) are supposed to depend upon the observed specification of the wines, hence may be made a function of the characteristics (b_{1i}, b_{2i}),

$$a_i = g(b_{1i}, b_{2i}) \qquad (2.2.)$$

2.1 Data

The data originates from a survey that was undertaken in August 1994 in 94 retail outlets of different commercial forms in England and Scotland.[4] It aims to give a representative sample of foreign still wines sold in the off-licence sector in those regions.

Each price for a bottle of wine collected is described by a combination of the following dimensions:

- the country of origin	- the importer
- the colour	- the brand (e.g. Gallo)
- the category (DOC, QbA, DO, etc.)	- the vintage
- the region of origin	- the place of bottling
- the appelation (Chianti, Rioja, etc.)	- the volume
- the producer	- the grape variety

All information that appears on the label of the bottles was collected, except for the degree of alcohol. The survey reveals in how many outlets per company a uniquely identified bottle was found. We employ this information as quantity proxy.

In total, 14,440 prices are identified by 575 attributes. Since there are 3940 uniquely identified bottles of still wines, each one of them appears on average in 3.7 retail outlets.

2.2 Objectives and hypotheses

In the following empirical section, we attempt to investigate the relationship between varietal and regional origin and quality as perceived by the consumers, by examining implicit prices for wine attributes through the estimation of hedonic price functions. In the absence of individual-specific characteristics, we cannot investigate welfare impacts following an identification of the structure of demand for attributes.

A consumer is envisaged to face a choice of wines from different countries of origin when confronted with the labels of the bottles on the shelf. It is asserted that a first group of categories of attributes (quality designation, grape variety, vintage, region and country of origin) determine the use value, hence the tasting qualities, of the wine. Another category group is deemed to have no bearing on this use value and is therefore asserted not to enter the consumer's utility function (the retailer). Consumers' willingness-to-pay should, therefore, be determined by variables from the first group of categories only, unless consumers regard certain retailer traits as relevant to the use value of the wines.

It is asserted that the degree of information which the consumer possesses about the wines purchased will be reflected in his or her degree of product involvement, hence the willingness of wine consumers to differentiate between and pay for different attribute bundles. It is assumed that the further down their decision trees consumers are willing to proceed, the higher will be their level of information about the attributes which they are comparing.

2.3 Specification and interpretation of the hedonic price functions

The testing procedure begins with the estimation of the hedonic price functions employing a General least squares (GLS) estimator.[5]

However, given the qualitative nature of the data and the necessity to retain comparability across attributes, the variables first have to undergo a modification that alters the interpretation of the estimates only. The modification does not alter the underlying meaning of the implicit price estimates as 'missing prices' in a hypothetical market where both consumers and producers were asked to attribute their valuation to the existence of a particular wine attribute, *ceteris paribus*.

As a result of this modification and after adjusting the coefficient estimates with the estimated variances, the final interpretation is that the coefficient estimates measure the relative impact on the dependent variable (the unit price evaluated at the sample means) of the presence of the attribute *ceteris paribus*.

Although the choice of the functional form for the hedonic price function should remain an empirical matter, theory seems to suggest that non-linear functional forms could frequently provide the more appropriate alternative. Also, on pragmatic grounds, with respect to heteroskedasticity, a non-linear form such as the semilogarithmic (log-lin) model could be preferable. In this instance, the coefficient of a dummy variable measures the discontinuous effect (the percentage effect) on the dependent variable of the presence of the factor represented by the dummy variable.

However, Kennedy (1981) objects to Halvorsen and Palmquist's (1980) interpretation of estimating the percentage effect on asymptotic grounds as their suggested procedure leads to a biased estimator for the dummy variable.[6] Instead of estimating g by

$$\hat{g} \; ? \; \exp(\hat{c}) \; ? \; 1 \tag{2.3.}$$

he suggests to follow Goldberger (1964) and to estimate g by

$$g^* \; ? \; \exp ? \hat{c} \; ? \; \frac{1}{2}\hat{V}(\hat{c}) ? \; ? \; 1, \tag{2.4.}$$

where $\hat{V}(\hat{c})$ is an estimate of the variance of $\hat{c}$, which is asserted to have less bias than $\hat{g}$.

Suits (1984) suggests a procedure for adjusting dummy variable coefficient estimates which leaves all variables in the equation. He interprets the estimates as deviations from average behaviour.[7] Following Suits (1984), we impose identifying restrictions, but instead of employing Kennedy's (1986) laborious extension of Suits (1984), we expand on Oczkowski (1994) and substitute the full constraint into the original equation. Following symmetrical estimations, it is possible to obtain all coefficient estimates. If, for example, the objective was to get coefficient estimates for wine colours (red, white, rose: c_1, c_2, c_3) and, say, all four producer regions of a given county (r_1, r_2, r_3, r_4), both constraints (2.5.) and (2.6.) could be substituted into the original equation as following:

$$\begin{aligned} &?_1 Pc_{i1} \; ? \; ?_2 Pc_{i2} \; ? \; ?_3 Pc_{i3} \; ? \; 0 \\ &?_1 \; ? \; [?(?_2 Pc_{i2}) / Pc_{i1} \; ? \; (?_3 Pc_{i3}) / Pc_{i1}] \end{aligned} \tag{2.5.}$$

where Pc indicates the mean, hence the proportion of non-zero's, in the colour categories for each bottle of wine. And

$$\begin{aligned} &?_1 \Pr_{i1} \; ? \; ?_2 \Pr_{i2} \; ? \; ?_3 \Pr_{i3} \; ? \; ?_4 \Pr_{i4} \; ? \; 0 \\ &?_2 \; ? \; [?(?_1 \Pr_{i1}) / \Pr_{i2} \; ? \; (?_3 \Pr_{i3}) / \Pr_{i2} \; ? \; (?_4 \Pr_{i4}) / \Pr_{i2}] \end{aligned} \tag{2.6.}$$

where Pr reflects the proportion of non-zero's in the region categories for each bottle of wine. This, substituted into the original equation, gives

$$\begin{aligned} &P \; ? \; [?(?_2 Pc_{i2}) / Pc_{i1} \; ? \; (?_3 Pc_{i3}) / Pc_{i1}] C_{i1} \; ? \; ?_2 C_{i2} \; ? \; ?_3 C_{i3} \; ? \; ?_1 R_{i1} \; ? \\ &[?(?_1 \Pr_{i1}) / \Pr_{i2} \; ? \; (?_3 \Pr_{i3}) / \Pr_{i2} \; ? \; (?_4 \Pr_{i4}) / \Pr_{i2}] R_{i2} \; ? \; ?_3 R_{i3} \; ? \; ?_4 R_{i4} \end{aligned} \tag{2.7.}$$

and,

$$P \; ? \; ? \;_2[C_{i2} \; ? \; (Pc_{i2} \,/\, Pc_{i1})C_{i1}] \; ? \; ? \;_3[C_{i3} \; ? \; (Pc_{i3} \,/\, Pc_{i1})C_{i1}]$$
$$? \; ? \;_1[R_{i1} \; ? \; (\mathrm{Pr}_{i1} / \mathrm{Pr}_{i2})R_{i2}] \; ? \; ? \;_3[R_{i3} \; ? \; (\mathrm{Pr}_{i3} / \mathrm{Pr}_{i2})R_{i2}] \; ? \; ? \;_4[R_{i4} \; ? \; (\mathrm{Pr}_{i4} / \mathrm{Pr}_{i2})R_{i2}] \tag{2.8.}$$

The corresponding linear hedonic model assumes therefore,

$$p \; ? \; ? \;_2[X_{a2}] \; ? \; ? \;_3[X_{a3}] \; ? \; ? \;_1[X_{b1}] \; ? \; ? \;_3[X_{b3}] \; ? \; ? \;_4[X_{b4}] \; ? \; ? \tag{2.9.}$$

where p is a $N ? 1$ vector of observations on the dependent variable, unit price P, there are $k = 5$ $N ? 1$ vectors of X of observations, $?$ and $?$ define the corresponding scalars, and $?$ is a $N ? 1$ vector of unknown stochastic disturbances. A symmetrical substitution generates estimates for the remaining coefficients $?_1$ and $?_2$ (symmetrical regressions).
However, the above specification embodies an equivalence effect. The effect of grape variety, for example, i.e. the estimated implicit price differences between Cabernet Sauvignon and Shiraz, are assumed to be the same across all regions.[8] Therefore, a model should be specified that provides sufficient flexibility as to allow differential effects to show. Interaction terms are therefore introduced, which enable us to test for these differential effects.[9]

3 Estimation and results

In terms of the estimation, sensitivity analysis and simplification, the paper follows Leamer (1990), while pursuing the 'classical approach' to sensitivity analysis, hence applying Belsley Kuh and Welsh (1980). Despite the cross-sectional nature of the data, we follow Hendry in terms of 'general to specific' modelling (Davidson, Hendry, Srba and Yeo, 1978).

More specifically, the present modelling strategy proceeds by first and foremost applying specification uncertainty diagnostics. In particular, we consider the problem of heteroskedasticity in terms of the Breusch-Pagan test, we perform auxiliary regressions and account for condition numbers (Belsley et al., 1980). Jointly, the Akaike information criterion (AIC) is employed, and it is preferred to the Schwarz criterion in the present context of a large number of potential variables, as the latter criterion penalises model complexity more heavily than other criteria. To emphasise, the coefficient of determination is not of primary interest. The objective is rather to identify a robust estimation procedure that provides stable implicit price estimates.

The regressions are implemented as weighted least squares regressions, where ordinary least squares (OLS) are applied to a transformed model. Consider the following linear regression model,

$$Y_t \; ? \; X_t^{'} ? \; ? \; ?_t \quad \text{where } E[?_t^{'} ?_t] \; ? \; ?^2 / W_t \qquad \text{for } t \; ? \; 1, \ldots, N$$

and the dependent variables Y_t, the exogenous variables X_t and the weights W_t are observed and the unknown parameters are $?$ and $?^2$. Each observation of the dependent and independent variables is replicated W_t times, and is multiplied by the square root of the weight variable. The weighted least squares estimator is then obtained by applying OLS to the transformed model:

$$\sqrt{W_t}\; Y_t = \sqrt{W_t}\; X_t^{'} ? \; + v_t$$

The resulting GLS regressions were performed for two reasons. First, and most importantly, employing GLS rather than OLS as an estimation rule is pursued on the basis that each attribute (and its price) in the context of hedonic market studies is important only to the extent that it captures some relevant fraction of the market (Griliches, 1971). Here, the weights applied in the GLS regressions reflect in how many retail outlets out of each retailer a uniquely identified bottle was found. It is therefore implicitly assumed that the sample fractions are directly proportionate to the number of bottles sold, although this is clearly an imperfect assumption. Second, the implementation of GLS allows us to account for heteroskedasticity due to omitted variables and/or due to misspecification.

It was suggested that certain categories of attributes (quality designation, grape variety, region and country of origin, vintage) determine the use value (tasting qualities) of the wine, and enter, therefore, the utility function of the consumer. Other categories were asserted not to have any bearing on the use value (the retailer). The willingness-to-pay of the consumer would therefore be determined by variables from the first group of categories. However, as the results indicate, the retailer (traits) seem to affect consumer choice in significant ways. Although it was not possible to compare exact attribute bundles across 'non-taste attributes' (namely the retailers), distinct and significant valuation of retailers were identified. The results indicate that consumers attach a high value to the information provided on the label. In all cases where conditional effects between attributes were found to have a significant impact on price, consumers are viewed to regard these attribute bundles as imperfect substitutes. In these instances of more than overall impacts, outstanding grape varieties are shown to have a strongly positive or negative regional impact on price just as outstanding regions have a similar grape varietal impact.

SUMMARY STATISTICS

VARIABLE DESCRIPTION	NUMBER OF OBSERVATIONS	MEAN***	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
PRICE **(£)**	14440** (3940*)	(5.51)	(4.5752)	(20.932)	1.09	99.99
RED	6933	0.49137	0.49999	0.24999	0	1
WHITE	7111	0.48655	0.49988	0.24988	0	1
ROSE	396	2.23E-02	0.14779	2.18E-02	0	1
ARGENTINIA	35	2.54E-03	5.03E-02	2.53E-03	0	1
AUSTRALIA	1495	6.95E-02	0.25441	6.47E-02	0	1
GERMANY	801	6.75E-02	0.25094	6.30E-02	0	1
BULGARIA	314	1.93E-02	0.13756	1.89E-02	0	1
CHILE	248	1.78E-02	0.13212	1.75E-02	0	1
SPAIN	1067	6.29E-02	0.24289	5.90E-02	0	1
HUNGARY	281	1.47E-02	0.12045	1.45E-02	0	1
ITALY	1240	8.83E-02	0.2838	8.05E-02	0	1
NEW ZEALAND	502	2.18E-02	0.14614	2.14E-02	0	1
PORTUGAL	485	2.92E-02	0.16835	2.83E-02	0	1
ROUMANIA	55	4.06E-03	6.36E-02	4.05E-03	0	1
SOUTH AFRICA	405	3.05E-02	0.17186	2.95E-02	0	1
FRANCE	7062	0.55838	0.49664	0.24665	0	1
CAB SAUV	841	5.00E-02	0.21797	4.75E-02	0	1
CHARDONN	1152	5.71E-02	0.23208	5.39E-02	0	1
CHENIN BLANC	73	4.57E-03	6.74E-02	4.55E-03	0	1
GEWÜRZ-TRAMINER	76	7.36E-03	8.55E-02	7.31E-03	0	1
PINOT NOIR	181	1.29E-02	0.11305	1.28E-02	0	1
RIESLING	227	2.03E-02	0.14106	1.99E-02	0	1
SANGIOVESE	14	1.52E-03	3.90E-02	1.52E-03	0	1
SEMILLON	918	5.25E-02	0.22314	4.98E-02	0	1
SAUVIGNON	712	3.43E-02	0.18193	3.31E-02	0	1
VINTAGE-83	16	2.03E-03	4.50E-02	2.03E-03	0	1
VINTAGE-85	48	4.57E-03	6.74E-02	4.55E-03	0	1
VINTAGE-86	75	9.14E-03	9.52E-02	9.06E-03	0	1
VINTAGE-87	216	1.57E-02	0.12447	1.55E-02	0	1

VINTAGE-88	304	2.79E-02	0.16476	2.71E-02	0	1
VINTAGE-89	608	5.23E-02	0.22263	4.96E-02	0	1
VINTAGE-92	2780	0.20964	0.40711	0.16574	0	1
VINTAGE-94	109	6.35E-03	7.94E-02	6.31E-03	0	1
ASDA	530	3.17E-02	0.17529	3.07E-02	0	1
CWS	118	1.17E-02	0.10743	1.15E-02	0	1
CO-OP	131	1.68E-02	0.12835	1.65E-02	0	1
M&S	216	2.28E-02	0.14942	2.23E-02	0	1
SAFEWAY	329	2.11E-02	0.14362	2.06E-02	0	1
BREEDE	5	1.27E-03	3.56E-02	1.27E-03	0	1
COONAWARA	162	6.35E-03	7.94E-02	6.31E-03	0	1
HUNTER VALLEY	172	5.33E-03	7.28E-02	5.30E-03	0	1
LA MANCHA	61	5.08E-03	7.11E-02	5.05E-03	0	1
RIOJA	301	1.95E-02	0.13844	1.92E-02	0	1
VALENCIA	239	1.40E-02	0.11734	1.38E-02	0	1
VENETO	399	2.84E-02	0.16621	2.76E-02	0	1
VARIABLE DESCRIPTION	NUMBER OF OBSERVATIONS	MEAN***	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
DOURO	99	6.35E-03	7.94E-02	6.31E-03	0	1
BORDEAUX	760	5.63E-02	0.23062	5.32E-02	0	1
LANGUEDOC	1617	0.10939	0.31217	9.74E-02	0	1
LIBOURNE	139	1.17E-02	0.10743	1.15E-02	0	1
MEDOC	348	3.32E-02	0.17931	3.22E-02	0	1
PROVENCE	101	9.14E-03	9.52E-02	9.06E-03	0	1
SAUTERNES	32	4.06E-03	6.36E-02	4.05E-03	0	1
CÔTE CHALONNAISE	56	5.84E-03	7.62E-02	5.81E-03	0	1
CÔTE BEAUNE	134	1.88E-02	0.13577	1.84E-02	0	1
CHABLIS	176	1.57E-02	0.12447	1.55E-02	0	1
CÔTE DE NUIT	139	1.42E-02	0.11838	1.40E-02	0	1
SONOMA VALLEY	342	5.58E-03	7.45E-02	5.55E-03	0	1

* There are 3940 unique and hence different bottles in the sample. Corresponding descriptive statistics are in brackets. Since the same unique bottle appears frequently in different outlets, the total sample size is given by 14440.
** The difference between the total sum of all observed prices after accounting for replicates [14440] and the sum of observations for the above attributes as they remained in the final specification, is therefore due to:
(1) statistically non-significant attributes
(2) the nature of the data set:
some wines are specified by less attributes than others: (a) indication of the retailer's name from which the price was collected is only given if the retailer's name appears on the label of the bottle, or (b) it is due to legal restrictions (i.e. EU or national law does not allow to indicate the region of origin or the vintage for certain wines).
*** The sample mean applies to the observations not accounting for replicates, which explains the divergence between the proportion of non-zero's of each attribute in each category (i.e. the mean value) and the number of observations.

VARIABLE DESCRIPTION [10]	ESTIMATED COEFFICIENT	**RELATIVE IMPACT %**	STANDARD ERROR	T-RATIO 4380 DF
*RED	2.17E-02	2.20	3.33E-03	6.52
WHITE	-1.65E-02	-1.63	3.39E-03	-4.86
ROSE	-0.11894	-11.23	1.60E-02	-7.43
*ARGENTINIA	-3.02E-01	-26.19	5.29E-02	-5.71
AUSTRALIA	5.18E-02	5.32	9.39E-03	5.52
GERMANY	-0.32895	-28.04	1.16E-02	-28.49
BULGARIA	-0.49689	-39.17	1.79E-02	-27.82
CHILE	-0.11033	-10.47	2.17E-02	-5.09
SPAIN	-0.2267	-20.29	1.46E-02	-15.54
HUNGARY	-0.42088	-34.36	1.90E-02	-22.15
ITALY	-4.07E-02	-3.99	1.07E-02	-3.82

NEW ZEALAND	0.22765	25.55	1.52E-02	14.99
PORTUGAL	-0.22167	-19.89	1.61E-02	-13.75
ROUMANIA	-0.66143	-48.44	4.33E-02	-15.28
SOUTH AFRICA	-0.17792	-16.31	1.65E-02	-10.78
FRANCE	0.11566	12.26	3.00E-03	38.57
CABERNET SAUVIGNON	7.01E-02	7.26	1.20E-02	5.83
CHARDONNAY	0.14265	15.33	1.09E-02	13.13
CHENIN BLANC	-9.25E-02	-8.91	3.84E-02	-2.41
GEWÜRZTRAMINER	0.30119	35.06	3.59E-02	8.38
PINOT NOIR	0.22924	25.73	2.41E-02	9.52
RIESLING	0.31192	36.56	2.51E-02	12.42
SANGIOVESE	-0.41385	-34.12	8.41E-02	-4.92
SEMILLON	-0.33959	-28.82	2.48E-02	-13.70
SAUVIGNON	0.11072	11.69	1.59E-02	6.97
VARIABLE DESCRIPTION	ESTIMATED COEFFICIENT	**RELATIVE IMPACT %**	STANDARD ERROR	T-RATIO 4380 DF
**RIESLING-AUSTRALIA	-0.42895	-34.93	3.91E-02	-10.97
**SEMILLON-FRANCE	0.11463	12.10	2.85E-02	4.02
**SAUVIGNON-FRANCE	-0.25047	-22.19	2.82E-02	-8.90
**CHENIN BLANC-NEW ZEALAND	-0.38472	-31.99	4.05E-02	-9.51
**SAUVIGNON-CHILE	-0.22339	-20.04	2.38E-02	-9.37
**CHARDONNAY-SPAIN	0.19389	21.23	5.24E-02	3.70
**CHARDONNAY-ITALY	-0.20566	-18.67	4.57E-02	-4.50
VINTAGE-83	0.53356	69.98	7.83E-02	6.82
VINTAGE-85	0.30769	35.89	4.51E-02	6.82
VINTAGE-86	0.4222	52.44	3.55E-02	11.91
VINTAGE-87	0.24358	27.55	2.14E-02	11.38
*VINTAGE-88	0.25322	28.80	1.75E-02	14.50
VINTAGE-89	0.13636	14.60	1.18E-02	11.61
VINTAGE-92	-0.11126	-10.53	3.99E-03	-27.87
VINTAGE-94	-0.16615	-15.35	3.07E-02	-5.42
ASDA	-0.12022	-11.33	1.22E-02	-9.90
CO-OP	0.11389	12.03	2.41E-02	4.74
M&S	0.20807	23.11	1.83E-02	11.37
CWS	-0.1276	-12.01	2.71E-02	-4.71
*SAFEWAY	-6.44E-02	-6.25	1.59E-02	-4.06
HUNTER VALLEY	0.21069	23.41	2.56E-02	8.23
*BREEDE	-0.27812	-25.02	1.40E-01	-1.99
COONAWARA	0.33012	39.06	2.67E-02	12.38
LA MANCHA	-0.3135	-26.98	4.21E-02	-7.44
RIOJA	0.17332	18.89	2.28E-02	7.59
VALENCIA	-0.29628	-25.66	2.46E-02	-12.07
VENETO	-0.30042	-25.96	1.85E-02	-16.20
DOURO	-0.12939	-12.19	3.53E-02	-3.67
SONOMA VALLEY	-0.18303	-16.74	1.73E-02	-10.56
BORDEAUX	-0.19021	-17.33	1.09E-02	-17.49
LANGUEDOC	-0.33309	-28.33	7.57E-03	-44.03

LIBOURNE	0.35815	43.02	2.63E-02	13.62
MEDOC	0.42075	52.29	1.66E-02	25.36
PROVENCE	-0.35315	-29.79	3.15E-02	-11.21
SAUTERNES	0.84878	133.33	5.49E-02	15.47
CÔTE CHALONNAISE	0.3774	45.72	4.13E-02	9.14
CÔTE BEAUNE	0.91027	148.41	2.61E-02	34.88
CHABLIS	0.3924	48.01	2.35E-02	16.73
CÔTE DE NUIT	0.92502	152.10	2.63E-02	35.16
CONSTANT	1.5234		1.73E-02	479.90

? R-square adjusted: 0.52
? Breusch-Pagan: Chi-Square = 138 with 59 D.F.
[for 60 D.F., *P*(chi squ > 79.08) = 0.05; for 50 D.F., *P*(chi squ > 67.5) = 0.05]
? Variables preceded by a * are taken from symmetric regressions
? variables preceded by ** are interaction terms
*** the impact of the attribute on price is measured as in equation (2.4.)

The estimates are interpreted as follows. The valuation which a consumer is assumed to place on the colours of wine is as anticipated, as the parameter estimates for red (+2.2), white (-1.6) and rosé (-11.2) take the expected signs.[11]

Among the countries of origin, being French achieves the greatest impact on price (+12.3%), whereas Romania shows the greatest negative impact (-48.4%). Perhaps surprising is the only moderate positive impact of Australian origin (+5.3%), especially when compared to France, and a rather high negative impact on price of wines of Chilean origin (-10.5%). As for Chilean wines, the sluggish expansion of imports and the increase in popularity that is only recent, following the introduction of new wine making technologies, may be part of the explanation.

Not necessarily surprising is the highly different impact of being of New Zealand origin, as compared to average (+25.5%). This valuation could be explained by the fact that Chardonnay as well as Sauvignon Blanc produce probably the top quality whites from the Island (+15.3% and +11.7% respectively). Equally expected is the impact on price of German (-28%), Bulgarian (-39.2%), Hungarian (-34.4%) and Romanian origin (-48.4%).

Expected is also consumers' valuation for two mediterranean competitors, Italy (-3.9%) and Spain (-20.3%). Italy represents thus the most typical of average prices amongst all countries of origin. Although Italian Merlot, Cabernet Sauvignon and Chardonnay is sold in the British market, these grape varieties do not represent the qualities for which Italy has long been known for. The expected negative price contribution comes therefore about as Italy is only recently increasing it's supply of the world's most favourite grape varieties. Spain's reducing impact on price could be partly explained by the (low) performance and high importance (in volume terms) by its wines from La Mancha (-26.9%), where nearly half of Spain's production originates from, as well as from Valencia (-25.7%).

The impact of regions on price are, therefore, in line with expectations for La Mancha, for Rioja (+18.9%), as well as for Provence (-29.8%), the Côte Chalonnaise (+45.7%) and Veneto (-25.96%). However, surprising is both the negative impact of Sonoma Valley (-16.74%) as well as that of the Douro (-12.2%).[12] While wines from the Douro valley have recently become more highly valued, it is hard to explain the poor performance of Sonoma.

As for French regions, an implicit valuation of the AOC system seems to be revealed, since the impact of Libourne (+43%), Medoc (+52.3%) and Sauternes (+133.3%), all in the heart of Bordeaux, is distinctly higher than that of generic Bordeaux wine (-17.3%). Unexpected, however, may appear the magnitude of impact for Chablis and Côte de Beaune (+48% and +148.4% respectively). However, consider the high impact of wines from the Côte de Nuit (+152.1%) jointly. The fact that top quality reds come from both Côte de Beaune and Côte de Nuit, whereas Chablis is highly regarded for its Chardonnay, seems to be also reflected in the relative contribution of white versus red wines.

Coefficient estimates for grape varieties are striking in that consumers appear to value the price premium associated with Chardonnay from any origin more than twice as highly as they do Cabernet Sauvignon (+15.3% and +7.3% respectively), and this on the background of a reverse valuation in terms of colours and the fact that both grapes take the largest proportion amongst the red and white wines in the sample, respectively. Comparing the grape varieties according to colour, the high valuation of Riesling relative to Chardonnay seems also somewhat surprising, in particular if the highly negative impact on price of Riesling from Australia (-34.9%) is considered. However, since Riesling is a rather classical grape for France and Germany, the high valuation might be associated with those countries, whereas Australia is more valued for its Chardonnay. This could partly explain why the impact of Riesling is not only overall, but related to Australia (-34.9%).

The highly positive impact of Sauvignon Blanc (+11.7%) relative to Semillon and Sangiovese is expected, especially when taking account of its classic background from the Loire Valley, Bordeaux and its rising success in the New World. However, all the more surprising is that the national impact of Sauvignon Blanc is highly negative, for both France (-22.2%) as well as for Chile (-20%).
Perhaps surprising is the impact that Chardonnay has in the case of Spain (+21.2%) and Italy (-18.7%). Given its classic roots in Burgundy and its success in Australia, the significant impact in the case of Spain appears to be particularly unexpected. The negative valuation of Italian Chardonnay, however, seems to support the above suggestion that consumers may not consider Italy as a classic source for 'quality Chardonnay'.

As for red varietals, the highly positive impact on price of Pinot Noir (+25.7%) relative to Cabernet Sauvignon (+7.3%) is not too surprising, considering the impact of the Côte de Nuit, the heartland of Pinot Noir. It was therefore expected to find that Pinot Noir shows more than just an overall impact, hence consumers would value it regionally, as reflected in its interaction term. This, however, did not materialise.

Consumer's valuation of the different vintages should be regarded with caution, given the level of aggregation in this all-country model. However, a rather consistent pattern emerges, whereby the increasing valuation of older vintages should reflect both interest rate differentials as well as cost of stockage. Nevertheless, the 1986 and 1988 vintages stand out as being particularly valued (+52.4% and +28.8%, respectively).

As for the retailers, consumers value retailer traits as expected in the case of Asda (-11.3%) and Marks & Spencer (+23.1%).[13] However, the rather high impact of Co-op on price is somewhat surprising (+12%), though it may be partly explained by consumers valuing its long opening hours.

4 Marketing implications

If an attribute is found to explain a positive/negative price deviation from the unit price evaluated at the sample means, it indicates that retailers could investigate profitably the gains and losses of altering a particular range of wine qualities on offer.

Supposing the retailer intends a stock-transfer of French Sauvignon Blanc (FSB) to Chilean Sauvignon Blanc (CSB), a proportionate adjustment to the mean price can be found in three steps.

(1) It is necessary to identify the proportionate loss for the type of wine that is replaced, and the degree of statistical uncertainty concerning this value. Therefore, all the attributes involved for which explicit coefficients have been estimated have to be identified first.

We could investigate the certainty of the joint effects, as derived from the variance covariance matrix [***V***(x)] of the estimated coefficients.[14] However, in the following example, we will not consider [***V***(x)]. Instead, we compute the proportionate loss and its statistical doubt in three sub-steps.[15]

1. Find the total sum of the relevant estimated coefficients:

Chile	France	CSB	FSB	TOTAL
- .1103	- .1156	- .2234	+ .2505	= -.1988

2. Compute the corresponding joint standard error, assuming all the parameters have zero covariances:

SE Chile	SE France	SE CSB	SE FSB	TOTAL SE
{ (.0217) ^{2}	+ (.003) ^{2}	+ (.0238) ^{2}	+ (.0282) ^{2} } $^{1/2}$	= .0429

3. Find the proportionate loss or gain from the log-lin model, considering both all relevant estimated coefficients and the corresponding certainty of the joint effects:

$$g^* = \exp\left(\hat{c} - \frac{1}{2}\hat{V}(\hat{c})\right) - 1, \qquad (2.4)$$

where $\hat{V}(\hat{c})$ is an estimate of the variance of $\hat{c}$, the coefficient of the dummy. Therefore,

$$g^* = \exp\left((-.1988) - \frac{1}{2}(.0429)^2\right) - 1 = \mathbf{-\ .181}$$

The proportionate loss is therefore 18.1%, and applies to the market share of French Sauvignon Blanc.

(2) Identify the market share of wine to be removed from the overall sample, hence the retailer's intended stock transfer: The 184 bottles of French Sauvignon Blanc correspond to 1.27% of the total sample of 14.440 bottles.

(3) Obtain the adjusted premium for the affected variety, Sauvignon Blanc, relative to all other varieties from equation (2.4), and weight this affected pivot variable (the grape variety) by (1) and (2):

The adjusted coefficient for Sauvignon Blanc is + 11.69%.
As a result, the monetary impact of this stock transfer, hence the proportionate adjustment to the overall mean price, is:

$$.01274 \times 1.1169 \times (-\ .1809) = -\ .00258\%$$

Given the mean price of 551 pence per bottle, the proportionate adjustment to the mean price would be **- 1.4 pence** a bottle, if a stock-transfer of French Sauvignon Blanc to Chilean Sauvignan Blanc was intended.

Concluding remarks

A model of product differentiation is employed to investigate the relationship between origin attributes and quality. We obtain information on wine consumer preferences for attributes contained in the label on wine bottles. By means of a parametric approach, implicit prices for these attributes are derived from prices and quantities of wines sold in the British off-licence market.

The results indicate that in some cases consumers attach a high value to the information about those attributes, namely the retailers, that were initially asserted as having no bearing on the use value of the wines. The corresponding price impacts are considered to be a reflection of differences in retailer traits. Interaction terms are employed in order to reveal the differential effects between attributes, and where these are found to be relevant, consumers are viewed as regarding attribute bundles as imperfect substitutes. The results suggest that this is particularly the case for identical grape varieties originating from different countries and regions within those countries. Therefore, Chardonnay from Spain, Chardonnay from Italy, Sauvignon Blanc from Chile, Sauvignon Blanc from France, Chenin Blanc from New Zealand, Semillon from France and Riesling from Australia are considered as distinctly different attribute bundles. In contrast, the consumer does not appear to value those grape varieties as distinct attribute bundles, that originate from different countries than those named above.
A highly distinct valuation of grape varieties according to region of origin emerges only for Australia and France. When accounting for the relative importance both of grape varieties and of regional origins, the results suggest an asymmetry between possibly the most classical 'New World' wine producer, Australia, and the most classical 'Old World' wine producer, France. Consumers' willingness and ability to differentiate regional differences is most prevalent in the case of France. Consumers demonstrate also a high degree of recognition of regions in the case of Australia, but it must be remembered that consumers differentiate even more between grape varieties in the case of Australian wines. Results indicate therefore that grape varieties are highly important in the choice of Australian wines, whereas regional origins are valued most in the case of French wines.

Marketing implications for retailers are derived. Assuming a static setting, these enable the retailer to determine potential costs or benefits of altering a spectrum of wines on offer. Since the analysis is applied to the attribute level, the method proposed has a significant advantage as compared to a direct price observation. We can distinctively identify the reason for the lower price of, say, a Chilean wine as a general thing against a specific *source*.

[1] Still light wine is defined as the product obtained exclusively from the total or partial alcoholic fermentation of fresh grapes or fresh musts, with a total alcoholic strength usually not exceeding 15% volume. This definition would include table and most quality wines.

[2] Including made wine (British Wine), almost all of which is sold in the off-licence trade.

[3] Shapiro (1983) demonstrates that the introduction of reputation as an asset that must initially built up allows the construction of an equilibrium model that includes perfect competition, free entry, and quality choices by firms under imperfect information.

[4] The survey is published by the *Centre Francais du Commerce Exterieur* (CFCE), Paris.

[5] The following regressions are performed by using SHAZAM, version 7.0.

[6] Halvorsen and Palmquist (1980) demonstrate in the context of binary-coded dummy variables that in the instance where the dependent variable is *lnY*, the coefficient of the dummy expresses change in units of *ln Y* since it reflects the difference in subgroup means between the designated group and the reference group in units of the dependent variable. The authors report the general form of a log-lin equation as,

$$\ln Y = a + \sum_i b_i X_i + \sum_j c_j D_j \qquad (2.4.1.)$$

where the X_i reflects continuous variables and the D_j represent dummy variables. In the above, simplified case of a single dummy variable, the interpretation of the coefficient of the dummy variable is revealed by transformation of equation (2.4.1.):

$$Y = (1 + g)^D \exp(a + \sum_i b_i X_i),$$

where $g = (Y_1 - Y_{ref}) / Y_{ref}$. Y_1 and Y_{ref} are the predicted values of the dependent variable when the dummy variable is equal to one and stands for the reference group, respectively. The coefficient of the dummy variable in equation (2.4.1.) is therefore

$$c = \ln(1 + Y_1 - Y_{ref}) / Y_{ref}.$$

Since *g* displays the relative effect on *Y* of the presence of the factor represented by the dummy variable, the percentage effect of the dummy variable on *Y*, in units of *Y*, is found by applying the antilog function,

$$100 \cdot g = 100 \cdot \{\exp(c) - 1\},$$

which is therefore the percentage difference associated with being in group 1 rather than being in the reference group. Thus, if for example -.246 would emerge, after taking the antilog to the base *e* and after subtracting 1, the expected value of *Y* for the designated group is found to be 24.6% lower than the value for the reference group. The expected implicit price for a bottle of wine from region A would thus be 24.6% lower than the expected price for a bottle from region B, the reference group.

[7] Instead of forcing one of the coefficients of the dummy variables to be zero, all of them could be restricted to zero and the resulting intercept can be interpreted as the average of the intercepts of all observations in the sample. Thus, rather than comparing differences between individual estimates and the estimate of the omitted dummy, the interpretation of all estimates as deviations from average behaviour allows a more effective interpretation and presentation of results.

[8] This assumes that the traditional way of dropping one category to avoid perfect multicollinearity, is pursued.

[9] The interaction terms of primary interest are those for *region/variety*. The coefficient estimates for those product variables estimate then the differential effect of region by variety. For example, the interaction term for grape variety and region estimates the extent to which, say, the effect of being Chardonnay differs for Hunter Valley versus Napa Valley.

[10] Variables in shaded background are regions of origin.

[11] Since the majority of top quality wines is red rather than white, the relative valuation is as expected (assuming we regard red and whites not as complements).

[12] Classic regions that have a good reputation for their quality are Rioja, Côte Chalonnaise, and Sonoma Valley.

[13] The fact that all wines for which the name of the retailer is given correspond to own-label wines, implies that the interpretation of results follows accordingly. Thus, estimates for a given retailer do not refer to all wines sold in this particular chain, but rather to it's own-labelled wines.

[14] Let $\boldsymbol{x}$ be an n-vector-valued random variable, and let a linear combination of interest be written as $\boldsymbol{a}'\boldsymbol{x}$ for some nonrandom vector $\boldsymbol{a}$ (a column vector of constants). Then the variance of this linear combination is $\boldsymbol{a}'\boldsymbol{V}(\boldsymbol{x})\boldsymbol{a}$. An estimate of the variance should therefore be obtained by pre-multiplying the corresponding segment of the variance covariance matrix by the unit vector (recognising positive or negative correlation between coefficients), and then post-multiplying by the transpose of the unit vector, and finally taking the square root. If, instead of a replacement of like varieties (French by Chilean), a case was considered where the type of wine is replaced by a like type (another white wine), whose effect is not specified, then only the negative value of the weighted covariance variance matrix (the mean dummies $\boldsymbol{d}$ will multiply the log effect by $\boldsymbol{d}$ to $\boldsymbol{dV}(\boldsymbol{x})$) has to be considered, as the standard errors are in proportion.

[15] A 'second best' option would also be to take the revenue loss on sales on French Sauvignon Blanc of 19.88% which, given the standard error of .0429, suggests a 95% confidence interval of 11.5% to 28.3%.

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