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A hedonic price analysis for the Portuguese wine market: Does the distribution channel matter?

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ABSTRACT

Price is a core component of both wine firms' and consumers' decision-making and so there has been a lot of analysis of the determinants of wine price. Most of the research has used the hedonic price function and assumed that the wine market is homogeneous with respect to both distribution channel and price segments. In this paper, a hedonic price function is estimated using data from a specialist retailer and a large supermarket, i.e., retailers in two different consumer market segments, niche and mass market, respectively. We conclude that the wine market is heterogeneous, and the importance of the various price determinants differs between distribution channels and, in the case of the specialist retailer, throughout the conditional statistical distribution of the price. This result may help the wine companies to place themselves in the market value chain.

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1. Introduction

The wine market is becoming more and more competitive, as a result of the entry of new firms into the market and increasing competition with other alcoholic beverages, such as beer and spirits. This change occurs in the context of the globalisation of the wine market, a decline in per capita wine consumption in the traditionally producing countries, and a change in consumption patterns (wine consumers are becoming increasingly sensitive to both quality and price). These shifts in the profile and habits of consumers are reflected in greater wine knowledge, access to new communication technologies and distribution channels as well as changes to the decision-making process. Effectively, there is not one wine market, but several wine markets with different critical factors (price, taste and brand), and consumers may make their choice according to the type of wine, its age, colour or geographical origin, amongst other factors.

Purchasing a wine bottle is not an easy task for the consumer. It is commonly accepted that wine is a complex experience good. When making a purchase, the wine consumer has a wide range of products and multiple brands to choose from, and access to a high volume of information. The combination of the difficulties of processing this information and the presence of unfamiliar products/features explains why consumers link wine prices to a quality indicator (Williamson, Lockshin, Francis, & Loose, 2016).

In parallel with the changes occurred in consumption patterns, there have also been significant adjustments to patterns of wine distribution, resulting in a diverse range of market distribution channels. In general, wines in lower price segments are concentrated in hypermarkets, supermarkets and discount stores (grocery retailing), whereas the higher priced segments are marketed at on-trade (restaurants, hotels, bars, etc.) and in specialist shops. All these channels present a different supply chain, according to the number of trade agents involved. In general, the supermarkets and discounters buy directly from the wine companies, so there is only one mark-up, whereas the specialist retailers purchase through an agent or a wholesaler, which means there is a double mark-up that is reflected in higher consumer prices. Special attention should be paid to the role of distribution channels in determination of wine prices in line with the recent hedonic analyses and quantile regressions (Di Vita et al., 2015; Caracciolo et al., 2016). Nevertheless, most of the hedonic price function studies rely on the assumption that the prices of wine attributes do not vary with distribution channel (Combris, Lecocq, & Visser, 1997, 2000; Landon & Smith, 1997, 1998; Schamel, 2009; Panzone & Simões, 2009; Caldas & Rebelo, 2013; Oczkowski, 1994, 2016; Asgari and Reed, 2016).

Portugal is an important player in the international wine market. In 2016, it ranked 5th amongst European producers and the 11th amongst global producers. The domestic market has characteristics that influence price and distribution strategies. On the production side, there are a few large wine companies coexisting with a large number of small and medium enterprises. On the demand side, there is considerable heterogeneity in wine knowledge, purchasing power and consumption habits.

The main goal of this paper is to investigate the determinants of wine prices in the Portuguese market in different distribution channels, using a hedonic price approach. Two channels are considered: (i) a specialist retailer and (ii) a large supermarket chain with shops all over Portugal. The former is a player in the low-volume, higher price market segment, whereas the latter deals in high volumes of lower priced wines. We examine the price determinants of Portuguese still wines, namely the *objective attributes* (e.g., alcohol content, age and colour information), the *sensory characteristics* (e.g., medals awarded) and *reputation variables* (e.g., region of origin, type of producer-cooperatives or investor-owned- and wine classification). Through the estimation of an econometric model using quantile regression, we identify the most important price determinants for both distribution channels.

This paper is organised as follows. Section 2 reviews the relevant literature of wine hedonic price functions and Section 3 offers an overview of the Portuguese wine market, emphasising the role of distribution channels. Section 4 presents the data, model and results, and Section 5 concludes the paper.

2. Literature review

Price is a key factor in wine purchases. Wine prices are typically analysed using a hedonic pricing model based on Lancaster's approach, which relates the price of a good to its various attributes or characteristics. The principal theoretical foundation for the hedonic price function studies is Rosen's (1974) pure competition model for differentiated products, which assumes that market demand and supply for attributes interact to determine the implicit marginal market attribute prices.

Empirical application of the hedonic theory in the wine sector started in the early 1990s and was pioneered by Golan and Shalit (1993) and Oczkowski (1994). Generally speaking, these models specify three main types of variables. The first is the so-called *objective* attributes, such as colour, vintage, alcohol content and grape variety, which tend to be specified on the label and are therefore easy to identify. The second category is *sensory* attributes, such as aroma, finish or harmony, information about which usually comes in the form of expert opinions or medals awarded, and the final category is the *reputation (individual and collective)* of wines and producers amongst consumers. The individual reputation is essentially based on the producer and own brand, and the collective reputation refers to variables such as umbrella brand, geographic origin and type of producer.

Numerous studies have shown that wine price is strongly determined by the *objective* attributes, e.g., Oczkowski (1994), Combris et al. (1997, 2000), Angulo, Gil, Gracia, and Sanchez (2000), Luppe and Angelo (2005), Haeger and Storchmann (2006), Lecocq and Visser (2006), San Martin, Troncoso, and Brummer (2008), but these studies did not analyse quantity supplied or environment variables as potential price determinants. The inclusion of quantity is justified by several studies suggesting that when crops are small wine prices tend to increase (Costanigro, McCluskey, & Mittlehammer, 2007; Carew & Florkowski, 2008; Benfratello, Piacenza, & Sacchetto, 2009; Kwong, Cyr, Kushner, & Ogwang, 2011). The impact of bio/environmental variables (use of eco-friendly viticulture) on wine prices has also been addressed by several authors (Delmas & Grant, 2014; Kwong et al., 2011; Roma, Di Martino, & Perronne, 2013) who have stated that since it is more expensive to produce grapes organically than using conventional methods, organic producers should be paid a premium.

The evidence on the role of *sensory* variables in price formation literature is inconclusive. Some authors, such as Jones and Storchmann (2001), Schamel and Anderson (2003), Ling and Lockshin (2003), Lima (2006), Dubois and Nauges (2010), Benfratello et al. (2009), Hadj Ali, Lecocq, and Visser (2010), Caldas and Rebelo (2013), Oczkowski (2016), Ashton (2016) and Asgari and Reed (2016), have found that sensory variables influence wine prices, but others stated that they have a negligible influence (e.g., Haeger & Storchmann, 2006; Lecocq & Visser, 2006; Brentari & Levaggi, 2014), or only a modest one (e.g., Goldstein et al., 2008; Oczkowski & Doucouliagos, 2014). (Goldstein et al., 2008) pointed out the interesting fact that consumers unaware of the prices, on average, enjoy more expensive wines slightly *less*, since the correlation between price and expert ratings is small and negative.

There is a considerable body of research on the impact of *reputation* on wine prices and consumers' choices. Using data from a market for Bordeaux wines, Landon and Smith (1997, 1998) showed that both individual and collective reputation explains a substantial proportion of price variation and that long-term reputation is considerably more important than short-term improvements in quality. Subsequent studies by Oczkowski (2001), Ling and Lockshin (2003), Schamel (2009), Castriota and Delmastro (2008, 2009), Benfratello et al. (2009), Gergaud, Livat, and Warzynski (2012) and Frick and Simmons (2013) confirmed that there are reputation effects. Hadj Ali and Nauges (2007) analysed the role of *en primeur* prices as informative signals in the market of Bordeaux wines and showed that prices depend much more on reputation and much less on short-term changes in quality, measured by expert grades.

More recently, Oczkowski and Doucouliagos (2014) confirmed this result using a meta-regression analysis, but they suggest that producers need to sustain the sensory quality of wine over time if they wish to extract appropriate returns. Caracciolo et al. (2016) analysed the pricing of top individual Italian wine brands using quantile regression and demonstrated that individual reputation plays a major role in the pricing of both low- and high-priced wines, whilst collective reputation, operationalised as geographical designation, seems to be especially important in the pricing of more expensive wines. Ferro and Benito-Amaro (2018), using a sample of top quality wines in the American market, highlight the price differences by country of origin, producing region, winery and grape.

There is also a body of literature examining how cooperative wineries compete with investor-owned firm (IOF), profit-maximising firms on reputation and product quality/price. Dilger (2005) showed that in the case of German vineyards, cooperatives have various incentives to sell lower quality wines than IOF at relatively cheap prices and in high volumes. Castriota and Delmastro (2008) concluded that cooperatives' reputation seems to suffer as the number of members rises. Pennerstorfer and Weiss (2013) investigated the impact of free-riders on the quantity and quality of marketing cooperatives output and found that even if a cooperative is able to control the quantity of its output it will never supply a final good of a higher quality than an IOF. Schamel (2015) analysed data from IOF and cooperative wineries in Germany with a view to determining how reputation for quality wine production was influenced by the organisational structure of the producer (cooperative vs. IOF), the German wine quality category and grape variety. The results indicate that German cooperatives are stuck at the low end of the category system and are not able to compete with IOF wineries on quality, only on price; hence, their wines are sold in discount stores. Finally, Frick (2017) emphasised that compared with IOF, cooperatives perform worse in terms of product quality, price/reputation and are technical, allocate and productive inefficient.

The effect of distribution channels on wine price has also been addressed in the literature, although less frequently than the other variables mentioned above. Steiner (2004) used information on sales of Australian wines in the British retail market to show that consumers associate a sales channel with a particular quality of product (i.e., sales channels have a reputation for the attribute quality). Consumers perceive that retailers whose reputation is built on quality offer higher quality Australian wines and therefore consumers seeking high quality wines may value such retailers more highly than the average non-discriminating consumer. Panzone (2011) also analysed the price implications of the distribution channel, employing data from Eastern European wines sold in the UK market and considering three main categories of retailers (cellars; leading UK supermarkets; other UK supermarkets) and concludes that high quality retailers can capture a higher market premium. Brentari, Levaggi, and Zuccolotto (2011) carried out interesting research on pricing of Italian red wine in the domestic market during 2007–2008 using a hedonic price function. They showed that price formation followed quite different patterns in large-scale retailers and specialist wine shops. In the former, price was mainly dependent on the characteristics described on the wine's label (alcohol content being the most relevant); other indicators, even those that were statistically significant predictors of price, had little influence. In specialist shops, on the other hand, price was also dependent on the sensory characteristics of the

wine, and it was in this market that wines with particular tastes and characteristics could be sold for a higher price. Subsequently, the same authors (Brentari & Levaggi, 2014) analysed data from Italian mass market and specialist wine shops for 2005–2011, combining a hedonic price approach with dimensionality reduction statistical tools. They concluded that there is also a small mark-up for white wines sold in both channels. More recently, Di Vita et al. (2015) confirmed that sale location plays a very important role in wine pricing, highlighting the price premium that high-end wines attract when sold in specialist wine shops. Caracciolo et al. (2016) corroborated this result, stating that wine shops and discount stores represented diametrically opposite sales methods: in the case of wine shops, there is a positive correlation between price and this distribution channel, whereas prices in discount stores are subject to a negative premium.

Viana and Rodrigues (2007) analysed 14,000 observations from the largest Port wine firms in producers and found that the brand/type of Port and the producer's reputation were significant determinants of price. Using online data from a large retailer in Portugal, Panzone and Simões (2009) were able to determine regional premiums for Portuguese wines in the domestic market. They found that protected designation of origin (PDO) status does not by itself attract a price premium; rather it is the interaction between the PDO and the region of production that yields a premium. Their results provide evidence that price premiums depend on regional reputation. Later, Caldas and Rebelo (2013) analysed data for 11 Portuguese wine production regions and found that price is positively correlated with expert ratings and that region of origin is positively correlated with both ratings and price.

3. An overview of the Portuguese wine market: distribution channels

Portugal is an important player in the worldwide wine industry (Rebelo, 2017). In 2016, it ranked 5th and 11th amongst European and global producers, respectively, producing about 6 million hectolitres, which corresponded to 2.3% of the world production. In terms of volume of exports, Portugal ranked 5th in Europe and 9th in the world in the same year, exporting 2.8 million hectolitres (47% of domestic production), corresponding to about 2.7% of world exports. In terms of export value, Portugal still ranked 5th in Europe, but was one place lower in the global rankings, at 10th, with exports worth about 783 million euro, equivalent to 2.6% of the value of the global export market in that year. Fortified wines were an important component of Portuguese production, representing 13.4% of wine production in 2016, and 23% and 41% of exports by volume and value, respectively.

Table 1 details domestic sales of Portuguese wines between 2011 and 2016. In this last year 472.5 million litres of wine worth a total of 2,810 million euro were sold. Still wine represented 92.8% and 79.5% of total sales by volume and value, respectively. Port wine (2.3% by volume and 7.4% by value) was the second most important category, with sparkling wine (2.3% by volume and 3.4% by value) in third place.

Sales of foreign wines were negligible, with the exception of vermouth and champagne, reflecting that Portuguese consumers are loyal to domestic products and rely on the quality of national wines. Moreover, foreign wines – mostly French or Italian – are more expensive.

Table 1. Portuguese domestic wine market: volume and value of sales by category, 2011–2016.

Category (Volume_ millions of litres)	2011	2012	2013	2014	2015	2016	CAGR (%) 2011–2016
Fortified wine and vermouth	22.6	22.2	22.0	21.9	22.4	23.2	2.6
Port wine	10.0	10.2	9.9	9.9	10.3	10.9	8.8
Desert wine	0.0	0.0	0.0	0.1	0.1	0.1	-
Sparkling wine	8.2	8.6	9.3	9.9	10.0	10.9	32.8
Still wine	459.3	439.3	414.1	407.8	424.2	438.4	-4.5
Red	304.8	296.5	281.0	277.0	287.9	296.2	-2.8
Rosé	30.2	30.6	31.6	32.2	33.6	36.2	19.7
White	124.3	112.1	101.5	98.5	102.7	106.0	-14.7
Total volume (million litres)	490.0	470.1	445.3	439.7	456.8	472.5	-3.6
Category (Value_ million euro)							
Fortified wine and vermouth	453.3	445.8	444.8	442.3	456.7	478.2	5.5
Port wine	173.9	178.3	181.7	180.4	188.7	206.8	18.9
Desert wine	0.0	0.0	0.0	1.4	1.4	1.4	-
Sparkling wine	76.1	74.8	77.8	82.5	87.5	95.3	25.2
Still wine	2,244.0	2,098.4	1,998.0	2,051.9	2,135.3	2,235.1	-0.4
Red	1,527.4	1,451.5	1,395.7	1,441.9	1,498.3	1,567.8	2.6
Rosé	154.2	152.9	154.5	158.0	165.9	177.5	15.1
White	562.4	494.0	447.8	451.9	471.2	489.7	-12.9
Total value (million euro)	2,773.5	2,619.0	2,520.6	2,578.0	2,680.9	2,810.0	1.3

Source: Euromonitor International (2017). CAGR, compound annual growth rate.

Distribution channels for off-trade retailers (specialist retailers and supermarkets) and on-trade premises (restaurants, hotels and bars) are shown in Figure 1. Particularly in urban areas, increasing consumer sophistication and lifestyle changes are giving rise to new consumption opportunities, such as socialising in wine bars. The number of intermediaries between the winery and end consumer is an important driver of wine price.

As shown in Table 2, the market share of sales through off-trade channels increased slightly between 2011 and 2016, both in terms of volume and value. In 2016, off-trade sales represented 68.8% and 40.8% of total sales, by volume and value, respectively, compared with 67.6% and 39.5% in 2011. Note that although a greater volume of wine (roughly 2/3 of total sales) was traded through off-trade channels, the value of sales to on-trade premises was greater. The difference between value and volume market shares indicates that the average consumer price is lower in the off-trade channel, presumably reflecting the smaller number of intermediaries between winery and consumer and the higher mark-ups in the on-trade channel.

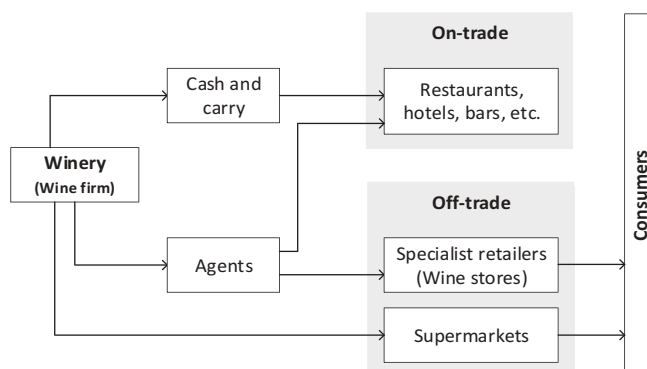
**Figure 1.** Distribution channels of Portuguese wine from the winery to the consumer.

Table 2. Volume and value for various distribution channels, 2011–2016, Portugal.

Distribution channel	2011	2012	2013	2014	2015	2016	CAGR (%) 2011–2016
Off-trade	331.0	320.5	306.0	300.7	315.7	324.9	–1.8
On-trade	159.1	149.5	139.4	139.0	141.1	147.6	–7.2
Total Volume (million litres)	490.0	470.1	445.3	439.7	456.8	472.5	–3.6
Off-trade	1,095.3	1,058.5	1,033.5	1,044.3	1,092.9	1,145.3	4.6
On-trade	1,678.2	1,560.4	1,487.1	1,533.7	1,588.0	1,664.6	–0.8
Total value (million euro)	2,773.5	2,619.0	2,520.6	2,578.0	2,680.9	2,810.0	1.3

Source: Euromonitor International (2017).

Table 3. Domestic off-trade sales of still wine by price segment, 2011–2016 (% of volume).

Type of wine	2011	2012	2013	2014	2015	2016
Red wine (price per litre)						
≤ €1.99	28.7	28.8	29.9	28.9	28.7	28.7
€2–3.5	29.8	29.7	29.8	29.6	29.5	29.4
€3.51–8.5	25.1	21.6	21.0	21.2	21.4	21.4
≥ €8.51	16.4	19.9	20.2	20.3	20.4	20.5
Rosé wine (price per litre)						
≤ €1.5	28.9	29.1	29.5	28.7	28.1	26.8
€1.51–2.5	29.7	29.4	29.5	29.4	29.3	29.0
€2.51–5	24.0	22.8	22.1	22.4	22.6	23.1
≥ €5.1	17.4	18.7	18.9	19.5	20.0	21.0
White-wine (price per litre)						
≤ €1.99	29.9	30.0	29.8	28.5	28.0	27.4
€2–3.5	29.6	29.8	28.5	28.0	28.1	28.0
€3.51–8.5	28.7	28.2	28.7	29.0	29.4	29.5
≥ €8.51	11.8	12.0	12.7	13.9	14.5	15.1

Source: Euromonitor International (2017).

The Portuguese wine market is dominated by still wines, specifically red wine. The category distribution (red; white; rosé) of off-trade¹ sales is shown Table 3. Between 2011 and 2016, the volume of high-price wine segment (above €8.51/litre for red/white wines and above €5.1/litre for rosés) increased (4.1 p.p. in red wine, 3.6 p.p. in rosé wine and 3.0 p.p. in white wine). Nevertheless, sales continued to be dominated by the low-price² segment. In 2016, 58.1% and 55.4% of red and white wines, respectively, were sold for less than €3.5/litre, and 55.8% of rosé was sold for less than €2.5/litre.

The supply side of Portuguese wine production is organised through 13 demarcated mainland wine production regions, meaning that the wine can be sold as a certified wine, taking advantage of this signal of quality and collective reputation for the consumer. Table 4 presents the domestic market share of certified wine through the off-trade channel, by volume and value for 2013–2016, as well as the average prices in 2016.

Despite the high number of demarcated wine regions, in 2016 53.6% of the still wine sold through the off-trade channel did not have a certificate of origin. The lower prices of such wines mean that in 2016 they had 29.6% of the market in value. In terms of volume, the Alentejo wine region was the most important (29.5%), followed by Minho (7.6%), Península de Setúbal (6.8%) and Douro (4.7%). In value terms, Alentejo (31.8%)

¹This information is not available for the on-trade channel.

²A serious issue in the Portuguese wine market is the excessive price discounts in the big supermarket (Euromonitor International, 2017), through a generalised practice of “wine fairs” and offering wine at high discount, with consumers’ buying wine at cheaper price and stock up for later consumption, generating “consumers addiction” to discounts.

Table 4. Domestic market share (%) of Portuguese still wine and average price (€/litre) in 2016.

	Volume (%)				Value (%)				Average price (€/litre)
	2013	2014	2015	2016	2013	2014	2015	2016	2016
Certified wine (AOC)	46.9	47.2	47.1	46.4	65.6	67.7	69.4	70.4	4.13
Algarve	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	5.75
Terras de Cister	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.22
Douro	3.5	3.8	4.5	4.7	7.4	8.1	9.1	10.0	4.50
Beira Interior	0.2	0.2	0.2	0.1	0.3	0.3	0.3	0.2	3.61
Trás-os-Montes	0.9	0.7	0.1	0.1	0.7	0.5	0.1	0.1	3.08
Terras do Dão	1.7	1.8	1.9	2.0	2.5	2.5	2.6	2.9	3.09
Alentejo	20.8	21.3	22.4	22.9	29.5	31.1	32.6	31.8	3.19
Minho (Verdes)	8.6	8.4	8.0	7.6	11.8	11.7	11.6	11.2	3.10
Lisboa	1.6	1.7	1.7	1.6	1.9	2.1	2.4	2.3	2.97
Península de Setúbal	6.3	6.2	5.8	6.8	8.1	7.9	7.7	8.7	2.71
Tejo	2.0	1.9	1.7	1.9	2.3	2.3	2.2	2.3	2.59
Beiras	0.2	0.3	0.1	0.0	0.2	0.3	0.0	0.0	1.91
Beira Atlântico	0.9	0.7	0.7	0.6	0.9	0.7	0.7	0.6	2.17
Wine (no certified)	53.1	52.8	52.9	53.6	34.4	32.3	30.6	29.6	2.10
Total									2.96

Source: <http://www.ivv.gov.pt/np4/606>.

was also the leading followed by Minho (11.6%), Douro (10%) and Península de Setúbal (7.9%). Wines from the Algarve (a small wine region with an economy dominated by tourism) were traded at the highest nominal price (5.75 euros/litre), followed by those from Douro (4.50 euro/litre). Wines from Alentejo, Minho and Setúbal were traded for average prices below the overall average price for certified wines.

4. Data, model and results

4.1. Data

In order to estimate the hedonic price function, data were gathered on domestic retail prices (euro per 75 ml bottle) for still Portuguese wines (red, white and rosé) sold through two distribution channels: (1) the specialist retailer “Garrafeira Nacional” ($N = 1,722$ observations; www.garrafeiranacional.com, on 24th November, 2017), which sells through

Table 5. Descriptive statistics by channel.

Variable	Distribution channel									
	Garrafeira – 1,722 observations					Continente – 725 observations				
	Mean	S.D.	Min	Max	Prop.1	Mean	SD	Min	Max	Prop.1
Price (euro)	26.90	53.54	1.85	589		9.61	11.04	1.39	92.5	
Alcohol content (AlcCont)	13.05	0.96	9	17		13.05	1.24	9	15.5	
Age	13.36	15.73	1	83		1.95	1.68	1	8	
Colour (red = 1; white+rosé = 0)					0.75					0.6
Awards or medals (yes = 1; no = 0)					0.2					0.14
Wine production region										
Douro (yes = 1;no = 0)					0.3					0.2
Verdes (yes = 1;no = 0)					0.04					0.1
Alentejo (yes = 1;no = 0)					0.2					0.4
Producer type (Cooperative = 1; Private firm = 0)					0.07					0.13
Reserve (yes = 1; no = 0)					0.2					0.2

Note: Prop.1 = proportion of 1.

bricks-and-mortar outlets and online; (2) the ‘Continente’ supermarket chain, a large chain with shops throughout Portugal ($N = 725$ observations; 3 January 2018). Data on the following *objective* attributes were collected: alcohol content, age and colour defined by a dummy for red, being the white/rosé as the baseline. *Sensory* attributes were operationalised as awards/medals won and *reputation* as origin region (3 regional dummies for Douro, Verdes and Alentejo), producer type (cooperative or private firm) and the wine category (Reserve; other). Descriptive statistics are presented in Table 5.

The *specialist* retailer (Garrafeira) offers a wide variety of wines, at an average price of 26.9 euro per bottle. This database includes both vintage (1934 onwards) and recently released wines. The alcohol content of the wines ranges from 9 to 17° and 75% are red wines. Approximately 20% are premium wines (i.e., had received an award or medal). Wines from Douro represent 30% of the offer, followed by those from Alentejo (20%). Private firms (only 7% are from cooperatives) produce almost all the wines and 20% are Reserve wines.

The range of the *supermarket* distributor is more limited. The wines are sold at an average price of 9.61 euro per bottle (range: €1.39–92.5). The alcohol content ranges from 9 to 15.5° and 60% are red wines. The offer is dominated by recent vintages (1–8 years old) and nearly 14% are premium wines. The regional distribution of the offer is different from that of the specialist retailer, with Alentejo being the main region of origin (40%), followed by the Douro (20%); wines from cooperatives are also a higher proportion of the total (13%). As in the case of the specialist retailer, 20% of the range consisted of Reserve wines.

4.2. Model

Assuming that the wine prices can be considered not only on average, but also in the tails of the conditional distribution, quantile regressions are applied considering distinct price segments. Compared with standard regression modelling, quantile regression provides a better understanding of the role of product attributes at different quantiles of the sample price distribution, by analysing different points of the conditional distribution.

Quantile regression, introduced by Koenker and Basset (1978), generalises the concept of a univariate quantile to a conditional quantile given one or more covariates. It minimises the weighted absolute deviations and predicts the conditional quantile functions, $Q_\tau(Y|X)$, as an extension to the regression model. The ordinary least-squares regression model (OLS) is described by the following equation:

$$E(y_i) = \beta_0 + \beta_1 x_{i1} + \dots + \beta_p x_{ip}, \quad i = 1, \dots, n$$

where the solution is the result of

$$\min_{\beta_0, \dots, \beta_p} \sum_{i=1}^N \left(y_i - \beta_0 - \sum_{j=1}^p x_{ij} \beta_j \right)^2$$

The regression model for the quantiles τ is

$$Q_\tau(y_i) = \beta_0(\tau) + \beta_1(\tau) x_{i1} + \dots + \beta_p(\tau) x_{ip}, \quad i = 1, \dots, n$$

In this case, the quantile regression estimator for quantile τ minimises the following objective function:

$$Q(\beta_\tau) = \sum_{i: y_i \geq x'_i \beta} \tau |y_i - x'_i \beta_\tau| + \sum_{i: y_i < x'_i \beta} (1 - \tau) |y_i - x'_i \beta_\tau|$$

where $\tau \in (0,1)$ and splits the data into q proportions below and $(1 - q)$ above, with the median being $\tau = 0.5$.

$\hat{\beta}_\tau$ is called the τ^{th} regression quantile. This method computes the residuals through bootstrapping and heteroscedasticity is not an issue. A linear regression curve returns the conditional mean of the distribution, whereas a quantile regression estimates different regression curves for various points of the distribution. Quantile regression is more flexible than OLS when it comes to modelling data with heterogeneous conditional distributions. No distributional assumptions about the error term are required.

4.3. Results

Results from the Box-Cox test (Box & Cox, 1964) point towards the use of linear functional form of the OLS regression, which is estimated as follows:

$$\begin{aligned} \text{Price} = & \beta_0 + \beta_1 \text{AlcCont} + \beta_2 \text{Age} + \beta_3 \text{Colour} + \beta_4 \text{Awards} + \beta_5 \text{Alentejo} + \beta_6 \text{Verdes} \\ & + \beta_7 \text{Douro} + \beta_8 \text{ProdType} + \beta_9 \text{Reserve} + \varepsilon \end{aligned}$$

Then, we estimate the following quantile regression model written as:

$$\begin{aligned} Q_\tau(\text{Price}|X) = & \beta_{0\tau} + \beta_{1\tau} \text{AlcCont} + \beta_{2\tau} \text{Age} + \beta_{3\tau} \text{Colour} + \beta_{4\tau} \text{Awards} + \beta_{5\tau} \text{Alentejo} \\ & + \beta_{6\tau} \text{Verdes} + \beta_{7\tau} \text{Douro} + \beta_{8\tau} \text{ProdType} + \beta_{9\tau} \text{Reserve} + \varepsilon_\tau \end{aligned}$$

where $0 < \tau < 1$ and represents the τ^{th} conditional quantile of Price given covariates X .

The results of both regressions are reported in [Tables 6](#) and [7](#) for the specialist retailer and the supermarket, respectively. Prior to these estimations, we performed a Chow test on regression of data from both distribution channels. The results indicated that there were structural differences between the channels and that any attempt to combine the data sets into a single model would fail.

For the specialist retailer, the quantitative objective variables alcohol content and age are positive determinants of price in all wine price quantiles and for the full sample, whereas colour (red) is only a positive determinant in the case of the most expensive wines (50-quantile and 75-quantile). The awards/medals variable, used as a proxy for sensory attributes, has a positive effect on price in all wine segments. Turning to reputation variables, the Douro region influences positively all price segments; producer type (cooperative) is only a determinant (negative) of price in the case of the cheapest wines, as well as for the full sample; Reserve status only has a positive effect on price in low-priced wines.

For the *supermarket*, the results show that the objective attribute alcohol content has a positive influence on price in all wine segments. Age has a positive impact in the low-price segments (25-quantile), an effect that is transmitted to the whole sample. Colour is not a determinant of price in the OLS, but the quantile regression suggests that red colour has a negative effect on the price of the cheapest wines. Awards/medals is a positive influence of the price of the most expensive wines (75-quantile), and also of the whole sample. Regarding the wine origin, only the Alentejo region does not have a significant influence

Table 6. Results quantile and OLS regressions for the specialist retailer.

	Quantile regression			OLS
	25-quantile	50-quantile	75-quantile	
AlcCont	0.293*** (0.0181)	0.216*** (0.0249)	0.292*** (0.0536)	0.29*** (0.0285)
Age	0.0325*** (0.00126)	0.0238*** (0.00209)	0.0192*** (0.00345)	0.0293*** (0.00173)
Colour	0.0326 (0.0697)	0.108* (0.0617)	0.178** (0.0744)	0.0982** (0.0476)
Awards/medals	0.410*** (0.0996)	0.637*** (0.0942)	0.665*** (0.0925)	0.621*** (0.0555)
Wine region				
Alentejo	0.0225 (0.0659)	0.0729 (0.0542)	0.0825 (0.0732)	0.0835 (0.0517)
Verdes	0.0926 (0.131)	−0.173 (0.156)	0.115 (0.135)	0.0233 (0.0945)
Douro	0.280*** (0.0456)	0.254*** (0.0768)	0.372*** (0.0893)	0.362*** (0.0487)
Producer type	−0.186* (0.0954)	−0.0277 (0.0943)	−0.0663 (0.0744)	−0.142** (0.0619)
Reserve	0.0884** (0.0432)	−0.0207 (0.0506)	−0.127* (0.0653)	−0.0702* (0.0384)
Constant	−2.208*** (0.233)	−0.763** (0.345)	−1.296* (0.713)	−1.727*** (0.373)
Observations		1,722		1,722
R ²	0.229	0.157	0.153	0.320

Table 7. Quantile regression and OLS results for the supermarket.

	Quantile regression			OLS
	25-quantile	50-quantile	75-quantile	
AlcCont	0.402*** (0.0519)	0.387*** (0.0370)	0.345*** (0.0634)	0.406*** (0.0285)
Age	0.0466*** (0.0144)	0.00839 (0.0164)	0.00637 (0.0271)	0.0381** (0.0172)
Colour	−0.118** (0.0571)	−0.107 (0.0789)	0.105 (0.137)	−0.0709 (0.0571)
Awards/medals	0.0767 (0.105)	0.156 (0.148)	0.276** (0.137)	0.124* (0.0738)
Wine region				
Alentejo	0.0831 (0.0634)	0.114 (0.0765)	0.0961 (0.130)	0.0495 (0.0647)
Verdes	0.699*** (0.148)	0.629*** (0.101)	0.505*** (0.176)	0.618*** (0.0795)
Douro	0.325*** (0.0730)	0.362*** (0.0746)	0.172 (0.110)	0.298*** (0.0718)
Producer type	−0.351*** (0.0640)	−0.351*** (0.0505)	−0.537*** (0.174)	−0.405*** (0.0662)
Reserve	0.266** (0.104)	0.271** (0.109)	0.292*** (0.104)	0.236*** (0.0661)
Constant	−4.054*** (0.685)	−3.456*** (0.442)	−2.467*** (0.734)	−3.625*** (0.352)
Observations		725		725
R ²	0.250	0.252	0.231	0.410

on the price. Finally, the cooperative producer type plays a negative effect on all segments of the price and an opposite effect is witnessed for Reserve wine.

Interquantile difference tests were performed to assess whether determinants of price varied across price segments within each channel. The results (see Annex, Table A1 and

Figure A1) show that, in the specialist retailer case, price determinants varied between quantiles. The greatest divergences occur for the differences between the 25th and 50th quantiles wherein most of the coefficients are significant. These findings provide empirical evidence of the hedonic price approach based upon price segments being heterogeneous in the specialist retailer case, whereas for supermarket the results seem to be homogeneous.

Comparison of the hedonic price determinants for the two distribution channels shows that alcohol content is the only variable to influence pricing in all quantiles of both market channels. Although in the specialist retailer's older wines were more expensive in all price ranges, in the supermarket age only increased price in the lowest priced ranges. Wine colour showed the opposite pattern: in the specialist retailer's range colour is a more important determinant of price and in the upper part of the price range.

In the case of the supermarket, awards or medals are only a determinant of the price of the more expensive wines, whereas in the case of the specialist retailer this variable is a positive determinant of price throughout the range.

Turning to the influence of the wine origin, the Douro region is the only one to influence price in the case of the wines sold by the specialist retailer, whereas Verdes region appears to be the most important region in the case of the large supermarket, being Douro a non-significant predictor for the more expensive wines. With regard to the producer type, we observe for the supermarket channel that the Portuguese wines receive an increasingly negative price premium, being the wines with the highest price ranges more affected by this specific producer type (cooperatives). In the case of the specialist retailer this effect is only observed at the lowest end of the price range. Finally, Reserve status has a positive impact on price in all estimated quantiles in the supermarket, whereas in the specialist retailer it only had a positive influence in the lowest price category (25 quantile).

5. Conclusions

Wine is a very complex product characterised by several attributes that can vary in time and space. There is a consensus from empirical research around the world that price is amongst the factors that can explain consumer choices. As well as considering the factors traditionally regarded as determinants of price, such as the objective characteristics described on bottle labels and sensory and reputational attributes, this paper has explored the potential role of distribution channel.

To do this we estimated a hedonic price function based on two databases of Portuguese wines for sale in a specialist retailer and a large supermarket chain. This allowed us to gain a deeper understanding of the offer structures of these two distribution channels during the observation period. As expected, the specialist retailer offered a wide range (quantity, vintages) of wine, including extremely expensive wines. The supermarket offered a more limited wine range of generally lower priced wines.

The estimated hedonic price functions point to two important findings.

Firstly, they show clearly that the determinants of wine price formation are different for these two distribution channels, confirming the results of Steiner (2004), Panzone (2011), Brentari et al. (2011), Brentari & Levaggi (2014), Di Vita et al. (2015) and Caracciolo et al. (2016). The age, awards/medals and the red colour are important price determinants in the specialist retailer, whereas the Reserve category and cooperative producer type play a stronger and more consistent influence on the supermarket wine prices. As reported in

several studies, the alcohol content determines the price of wine in both distribution channels. Specifically, in the specialist wine shop, the wine perceived as of better quality – which is converted in a mark-up on price – is vintage, red wine, premium wine and from the Douro region. Moreover, in the case of the supermarket distribution channel there is a positive impact on wine price if it is Reserve and from Verdes and/or Douro regions. A cooperative wine label works clearly in the opposite effect.

Secondly, the quantile regression revealed that the influence of the price determinants depends on the price segment. This outcome is consistent with studies by Di Vita et al. (2015) and Caracciolo et al. (2016) and suggests that the role of distribution channels in wine pricing deserves special attention as not all wineries would benefit from a single strategy to enhance the market value of wine.

These results may help the wine companies to place themselves in the market value chain, allowing their managers to define focused marketing strategies, according to the distribution channel used and the attributes that are more relevant in the different price segments. Specifically, to reach higher price segments, wine firms whose sales are concentrated in large supermarket chains should take into account the wines of the Reserve category and the awards received. On the other hand, selling wine in specialist retailers with higher value appears to be determined by the recognition of experts who act as quality signs to consumers, such as medals and awards. Therefore, firms should develop efforts to be present in wine events and competitions. Finally, the specialised channel is suitable to market aged red wines.

Future research should be extended to other countries and include other wine attributes in order to test whether there are different wine markets or a single market for wine. This question needs to be resolved in order to achieve a better match between supply and demand.

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Annex

Table A1. Interquantile differences.

Continente (Large supermarket)		
Alcohol content		
25-quantile and 75-quantile $F(1, 715) = 0.48$ Prob > $F = 0.4907$	25-quantile and 50-quantile $F(1,715) = 0.09$ Prob > $F = 0.7643$	50-quantile and 75-quantile $F(1,715) = 0.61$ Prob > $F = 0.4349$
Reserve		
25-quantile and 75-quantile $F(1,715) = 0.10$ Prob > $F = 0.7506$	25-quantile and 50-quantile $F(1,715) = 0.01$ Prob > $F = 0.9431$	50-quantile and 75-quantile $F(1,715) = 0.08$ Prob > $F = 0.7835$
Color		
25-quantile and 75-quantile $F(1,715) = 1.64$ Prob > $F = 0.2010$	25-quantile and 50-quantile $F(1,715) = 0.04$ Prob > $F = 0.8491$	50-quantile and 75-quantile $F(1,715) = 1.92$ Prob > $F = 0.1667$
Age		
25-quantile and 75-quantile $F(1,715) = 1.15$ Prob > $F = 0.2841$	25-quantile and 50-quantile** $F(1,715) = 4.85$ Prob > $F = 0.0279$	50-quantile and 75-quantile $F(1,715) = 0.00$ Prob > $F = 0.9497$
Douro		
25-quantile and 75-quantile $F(1, 715) = 2.27$ Prob > $F = 0.1320$	25-quantile and 50-quantile $F(1,715) = 0.15$ Prob > $F = 0.7005$	50-quantile and 75-quantile** $F(1,715) = 4.10$ Prob > $F = 0.0433$
Alentejo		
25-quantile and 75-quantile $F(1, 715) = 0.02$ Prob > $F = 0.8951$	25-quantile and 50-quantile $F(1,715) = 0.13$ Prob > $F = 0.7213$	50-quantile and 75-quantile $F(1,715) = 0.02$ Prob > $F = 0.8751$
Verdes		
25-quantile and 75-quantile $F(1, 715) = 1.41$ Prob > $F = 0.2354$	25-quantile and 50-quantile $F(1,715) = 0.26$ Prob > $F = 0.6117$	50-quantile and 75-quantile $F(1,715) = 0.90$ Prob > $F = 0.3420$
Producer type		
25-quantile and 75-quantile $F(1, 715) = 1.18$ Prob > $F = 0.2787$	25-quantile and 50-quantile $F(1,715) = 0.00$ Prob > $F = 0.9974$	50-quantile and 75-quantile $F(1,715) = 1.67$ Prob > $F = 0.1972$
Awards		
25-quantile and 75-quantile $F(1, 715) = 2.11$ Prob > $F = 0.1467$	25-quantile and 50-quantile $F(1,715) = 0.67$ Prob > $F = 0.4150$	50-quantile and 75-quantile $F(1,715) = 1.48$ Prob > $F = 0.2239$
Garrafeira (specialist retailer)		
Alcohol content		
25-quantile and 75-quantile $F(1, 1712) = 0.00$ Prob > $F = 0.9984$	25-quantile and 50-quantile*** $F(1,1712) = 7.12$ Prob > $F = 0.0077$	50-quantile and 75-quantile $F(1,1712) = 1.74$ Prob > $F = 0.1878$
Reserve		
25-quantile and 75-quantile*** $F(1, 1712) = 11.22$ Prob > $F = 0.0008$	25-quantile and 50-quantile*** $F(1,1712) = 7.20$ Prob > $F = 0.0074$	50-quantile and 75-quantile** $F(1,1712) = 4.16$ Prob > $F = 0.0415$
Colour		
25-quantile and 75-quantile $F(1, 1712) = 2.69$ Prob > $F = 0.1010$	25-quantile and 50-quantile $F(1,1712) = 2.50$ Prob > $F = 0.1137$	50-quantile and 75-quantile $F(1,1712) = 0.85$ Prob > $F = 0.3555$

(Continued)

Table A1. (Continued).

Age		
25-quantile and 75-quantile*** $F(1,1712) = 29.77$ Prob > $F = 0.0000$	25-quantile and 50-quantile*** $F(1,1712) = 28.25$ Prob > $F = 0.0000$	50-quantile and 75-quantile* $F(1,1712) = 2.85$ Prob > $F = 0.0918$
Douro		
25-quantile and 75-quantile $F(1, 1712) = 1.27$ Prob > $F = 0.2604$	25-quantile and 50-quantile $F(1,1712) = 0.31$ Prob > $F = 0.5798$	50-quantile and 75-quantile* $F(1,1712) = 3.52$ Prob > $F = 0.0606$
Alentejo		
25-quantile and 75-quantile $F(1, 1712) = 0.32$ Prob > $F = 0.5691$	25-quantile and 50-quantile $F(1,1712) = 0.64$ Prob > $F = 0.4247$	50-quantile and 75-quantile $F(1,1712) = 0.02$ Prob > $F = 0.9006$
Verdes		
25-quantile and 75-quantile $F(1, 1712) = 0.02$ Prob > $F = 0.8774$	25-quantile and 50-quantile** $F(1,1712) = 6.24$ Prob > $F = 0.0126$	50-quantile and 75-quantile** $F(1,1712) = 5.09$ Prob > $F = 0.0242$
Producer type		
25-quantile and 75-quantile $F(1, 1712) = 1.59$ Prob > $F = 0.2078$	25-quantile and 50-quantile** $F(1,1712) = 4.75$ Prob > $F = 0.0294$	50-quantile and 75-quantile $F(1,1712) = 0.36$ Prob > $F = 0.5479$
Awards		
25-quantile and 75-quantile** $F(1, 1712) = 10.72$ Prob > $F = 0.0011$	25-quantile and 50-quantile*** $F(1,1712) = 8.59$ Prob > $F = 0.0034$	50-quantile and 75-quantile $F(1,1712) = 0.13$ Prob > $F = 0.7163$

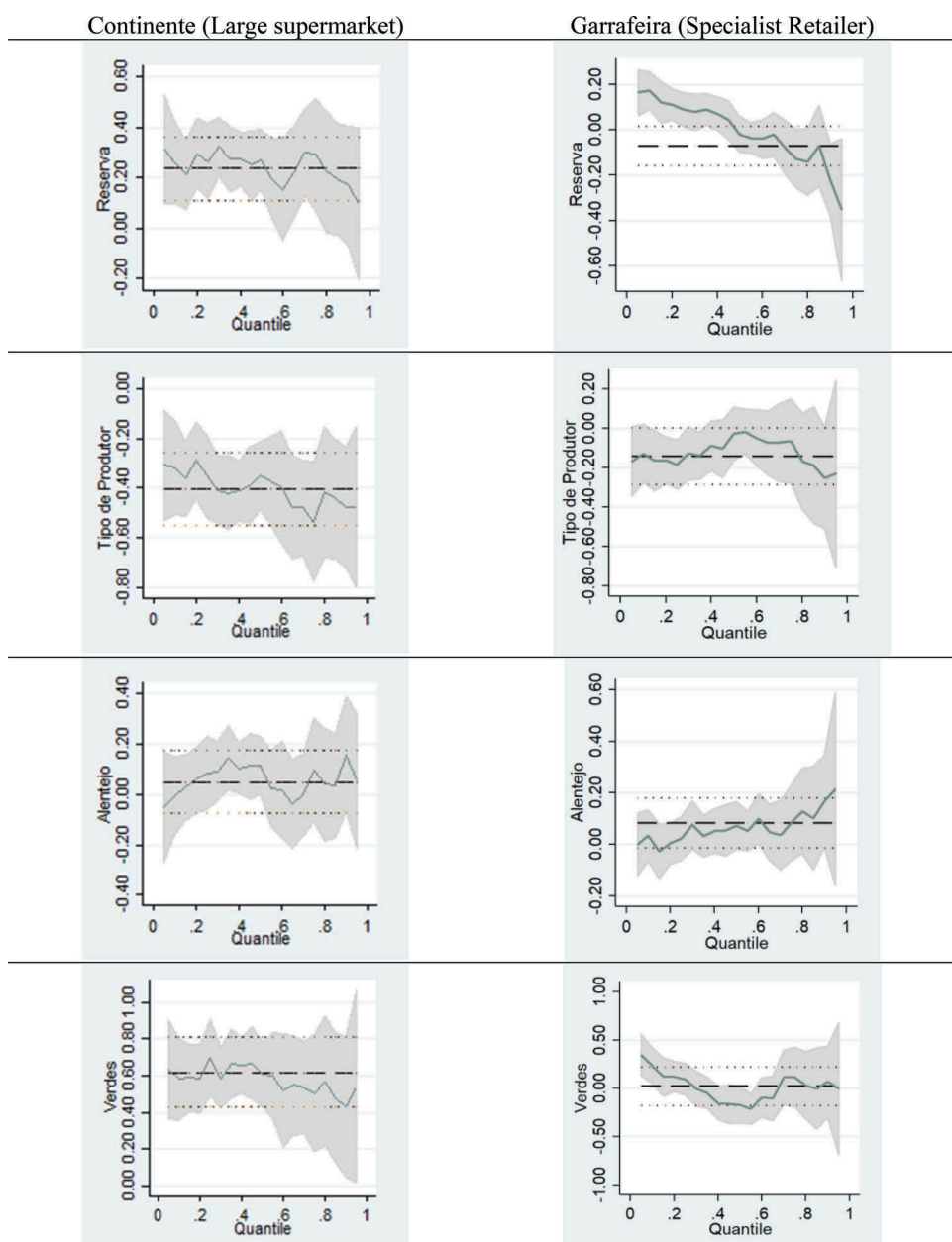


Figure A1. Estimated coefficients of the quantile regression and confidence interval for the explanatory variable-quantile from 0 to 1.

