Port wine exports: a gravity model approach

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Abstract

Purpose – The purpose of this paper is to empirically examine the macroeconomic determinants of Port wine exports, taking into account the diversity and various quality levels associated with this product.

Design/methodology/approach – Port wine is a fortified wine only produced in Portugal. In the period 2006-2014, an extended gravity model is applied to data on the exports of the top 20 importing countries, accounting for 94 per cent of total exports. The authors base their empirical strategy on the Hausman–Taylor estimator (1971), overcoming endogeneity and accounting for time invariant variables. They estimate the impact of several factors on the total trade of Port wine, namely: gross domestic product (GDP), GDP per capita, tariffs, exchange rates, distance from original supplier, mutual language familiarity, landlockedness, wine consumption per capita and presence of Portuguese emigrants, all measured in volume and value terms, and for each of the four categories (Standard, High Standard, Vintage and Aged).

Findings – The findings show that the quantity and value of total Port wine exports are positively determined by overall GDP per capita, the presence of a Portuguese emigrant community (which implies that to some degree a common language and culture are shared), while exports are negatively influenced by landlockedness. In contrast to the traditional gravity model, distance from the source of supply does not appear to be a significant determinant, a fact explained by the specific and singular nature of Port wine and by the long tradition of this product in international markets. In addition, the results revealed specific determinants for specific product categories – such as GDP for aged Port and wine consumption per capita for high standard, vintage and aged Port, suggesting that Portugal needs to increase its exports of high-quality Port wine to markets that exhibit a tendency towards increased wine consumption per capita and are coming to be considered large and fast-growing economies.

Originality/value – This paper extends the literature, by respecifying the typical gravity model for aggregate goods to permit the analysis of wine exports. There has been relatively little application of this model to assess the determinants of the wine trade, and when it has been used, generally it has been in studies focusing on aggregate wine trade between countries. This paper seeks to fill this gap by focusing on the determinants of exports of a specific wine – Port wine, which is an internationally recognised product, with a clear internal product differentiation according to distinct quality levels – and in this regard provides new insights into the international patterns of trade in wine.

Keywords Gravity model, Competitiveness, Panel data, Export determinants, Port wine

Paper type Research paper

JEL classification – C23, F10, F14, F41

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1. Introduction

Recent decades have been characterised by an intense globalisation process and by changing patterns of international trade and a growth in the number of key players involved. Several developments have converged to increase global international trade (Obstfeld, 2016):

- Eastern Europe and Asia have moved to market driven economies open to international trade and investment after the collapse of the Communist bloc;
- China's lowering of barriers to imports and exports and its authorisation of more firms to engage in trade; and
- other emerging markets, such as countries in Latin America and India, becoming more open to trade.

These shifts have characterised both developed and developing regions, encouraging firms to look for sales opportunities beyond their own borders and traditional export markets (Surugiu and Surugiu, 2015). The importance of exports to the economic growth of countries (as well as to firms) has given rise to emerging markets for new and differentiated products. Consumers are now offered a wider range of products and services, with monopolistic competition constituting the market structure for many of these items.

The wine industry is a specific yet typical example of globalisation, displaying a remarkable growth rate in volume of exports relative to world wine production levels (Anderson and Nelgen, 2011). Increasing competition, emergence of new producers and exporters and new consuming countries (Castillo *et al.*, 2016) have made the wine market increasingly globalised and competitive. With the fall in transport and communication costs, suppliers have found a profitable market opportunity, while, on the demand side, consumption has been boosted by the spread in the taste for wine (Anderson *et al.*, 2016), with monopolistic competition being the typical trading environment. In turn, this has raised both challenges and opportunities for traditional producing countries and traditional wine regions, not least of all in Europe, which have adopted a market strategy based on the principle of "less wine, but higher quality" (Castillo *et al.*, 2016).

These changes in the international wine trade are related to modifications in world patterns of consumption and production. From 2000 to 2014, with the exception of Germany (+3 per cent) and the UK (+9 per cent), wine consumption fell by 16.6 per cent in Europe (Coface, 2015), especially in Spain (−34 per cent), Italy (−26 per cent) and France (−17 per cent). In the future, policy measures on drinking and driving in favour of drinks with lower percentages of alcohol will most probably continue to reinforce this tendency.

However, contrary to European trends, world wine consumption increased by 6 per cent in the same period, a development that was only interrupted by the 2008 global financial crisis. The growth in global consumption of wine has been driven by the USA (+46 per cent), China (+50 per cent) and Australia (+38 per cent). Regarding the future, Coface (2015, p. 3) argues that for a given country's wine consumption to increase over the next decade, in addition to changes in social and cultural habits, at least one of the following conditions needs to be fulfilled: population increase, growing urbanisation or growth in economic activity – Asia being the region that most likely to achieve all three objectives.

In Portugal, the wine industry constitutes a priority domain for the strategy of economic specialisation. Wine as a product has the potential to acquire higher added value, to contribute to export growth and to penetrate more dynamic market segments. A remarkable example of an internationalised product with this potential is the fortified wine[1] (*vin de liqueur* in European Union parlance) produced under quite specific natural, historical and

cultural conditions in the Douro Wine Region in the North of Portugal. Port – or Port wine – of different categories (standard, high standard, vintage and aged[2]) has been sold on the world market for over 250 years, with almost 85 per cent of its production being exported to more than one hundred countries, albeit with a high concentration in a small number of markets (Brito, 2006, Rebelo and Correia, 2008; Correia *et al.*, 2015).

The new challenges faced by the wine stakeholders require additional research to understand and internalise the opportunities that emerge from a better knowledge of the markets. One way to overcome this issue is through the analysis of the main export determinants, and this constitutes the main goal of the present article, that is, to contribute to a new and a better understanding of Port wine's export determinants by category/quality[3]; as far as we are able to establish, this is the first attempt to apply a gravity model to this iconic sector.

In our research, a gravity model was applied to balanced panel data from 2006 to 2014 on Port wine exports to the top 20 importing countries. Port wine is a heterogeneous product that reaches the market in the form of different categories of products with distinct levels of quality; the gravity model allows us to analyse the influence of product quality on the export process.

The paper is organised as follows. Section 2 presents a review of the literature. Section 3 provides the procedure for modelling Port wine exports using the gravity equation framework. Section 4 presents the results from the empirical analysis. Section concludes and explores key policy implications.

2. Literature review

2.1 The gravity model framework

Economic theories have long tried to explain the factors that most affect trade between countries. Ricardo's (1817) theory of comparative advantage contends that trade patterns are the result of labour productivity differences between countries. Subsequently, analysts sought to extend comparative advantage theory: for instance, Heckscher (1919) developed the factor proportions model to show how a country's comparative advantage resides in concentrating on trading those goods that make relatively intensive use of its more abundant factors. Moreover, with the development of new trade theories, scale economies emerged as an explanation for existing trade patterns. Krugman (1979) complemented extant models by allowing for intra-industry trade under conditions of monopolistic competition and product differentiation.

Two other sources of trade theory are the Linder hypothesis (a theory that foregrounds quality) and the gravity model, which allows additional structural and institutional factors to be taken into account to explain the extent of trade (Paas, 2000). Linder (1961) first noted the role of quality in determining the direction of trade, arguing that richer countries spent a larger proportion of their income on high-quality goods; the Linder hypothesis further asserts that "the more similar the demand structures of two countries, the more intensive, potentially, is the trade between these two countries" (Linder, 1961, p. 94).

The gravity model uses the analogy of Newton's Law of Universal Gravitation to describe patterns of international trade. The gravity model was applied for the first time by Tinbergen (1962) and Pöyhönen (1963) to study trends in global trade in the 1960s. In its basic equation, the trade flow between two countries depends directly on their economic sizes (masses) and inversely on the physical distance between them.

Linnemann (1966) extended the model by adding new variables, such the countries' respective populations, resource endowments, membership of preferential trading groups, historical background and cultural characteristics. Further variables used to extend the

model includes common language (Geraci and Prewo, 1977), exchange rates (Bergstrand, 1985, 1989), adjacency (McCallum, 1995), policy barriers – usually in the form of tariff and nontariff barriers (Anderson and van Wincoop, 2004) and landlockness[4] (Silva and Tenreyro, 2006).

For several years, the gravity model was taken to reflect an empirical fact; however, as time went on, trade theorists realised that gravity-related equations can be derived using a variety of modelling frameworks (Head and Mayer, 2014): constant elasticity of substitution (CES); product differentiation with imperfect competition (Anderson, 1979; Bergstrand, 1985); Ricardian models (Eaton and Kortum, 2002); Heckscher–Ohlin models (Deardorff, 1998); and the assumption of heterogeneous firms (Chaney, 2008; Helpman *et al.*, 2008). Moreover, over the years, significant improvement has been achieved in extending the theoretical background for the gravity-related equations and improving its empirical estimation (De Benedictis and Taglioni, 2011).

As Piermartini and Yotov (2016, p. 5) conclude:

> Despite the numerous applications of the gravity model and despite the great progress in the empirical gravity literature, many of the gravity estimates in the existing literature still suffer biases and even inconsistency.

Furthermore, gravity estimations have mostly been performed with aggregate (country-level) bilateral trade flows, with fewer studies being undertaken using data disaggregated by commodity (Cirera *et al.*, 2016).

2.2 Applications of the gravity model to the wine trade

Some empirical studies have used a commodity-specific gravity model to evaluate trade flows between a pair of trade partners. For example, Koo *et al.* (1994) deployed a specific gravity model to examine the meat trade. Later, Koo *et al.* (2006) applied a gravity model to international agricultural trade using cross-section data for 1999, concluding that preferential trade arrangements for agricultural commodities improved global welfare by increasing agricultural trade volume between member countries and, to a lesser degree, between non-member countries.

The gravity model has been also used specifically for wine to investigate the determinants of bilateral trade flows between European Union (EU) countries. Dascal *et al.* (2002) analysed the main factors affecting wine trade flows from 1989 to 1997 between the first twelve EU members. The results revealed that the wine trade was positively influenced by increases in GDP per capita, the depreciation of EU national currencies and the scale of wine production. Pinilla and Serrano (2008) research on the long-term determinants of Spanish still wine exports between 1871 and 1935, showed that it was exported to countries with large growing markets that were close both culturally and geographically to Spain. When Seccia *et al.* (2009) examined the magnitude of trade flows for high quality wine from Italy to its main importing countries, they found that GDP per capita of receiving countries and the quality of wine they imported both positively influence trade[5]. Focusing on the EU-27 from 1998 to 2011, the evaluation of the impact of communication costs on wine exports conducted by Fertő *et al.* (2013) supported the validity of standard gravity model variables such as market size, trade costs, common language and colonial links. In the study undertaken by Lombardi *et al.* (2016) of bilateral trade in bottled and bulk wine between three traditional, old world wine-producing European countries (France, Italy and Spain), exports of each category of wine proved to be influenced by distinct factors: those of bulk wine were penalised four times more than bottled wine by the physical distance between exporter and importer; mutual language familiarity was statistically significant with a

coefficient close to one for exports of bottled wine, while not statistically significant for bulk wine.

Another group of empirical studies focus on multiple countries worldwide. Dal Bianco *et al.* (2016) analysed the role of tariff and non-tariff barriers on the main exporters and importers in the global wine trade from 1997 to 2010 and found a negative impact for most technical barriers, with tariffs a declining component. Examining the global wine market over a longer period 1988-2012, Castillo *et al.* (2016) estimated the determinants of bottled and bulk wine exports for the principal exporting countries (Argentina, Australia, Chile, France, Italy, New Zealand, Portugal, South Africa and Spain) and the major importing countries (Belgium, Canada, China, Denmark, Germany, Japan, The Netherlands, Russia, Sweden, Switzerland, the UK, the USA, Norway and Finland). Their results suggested that higher incomes, lower prices, cultural and geographical affinities and trade agreements all promote wine exports.

More recently, applying a CES model of monopolistic competition, Dal Bianco *et al.* (2017) assessed Argentine wine exports to 23 major importing countries worldwide over the period 1997-2010. Their results showed that export flows of this New World wine can be explained by importing countries' economic scale and trade policies. Tariffs have had a considerable negative impact on trade (−0.454), suggesting that the "greatest efforts should be made in trade policy, at both national and supranational level".

As the literature on the international demand for wine is not very extensive and it has generally been assumed that wine is a homogeneous product and analysis has focused on trade between countries, a key aspect that commonly has been neglected is the specificity of different wines. It is in this respect, in particular, that the present paper fills a gap by applying a gravity model for different categories of Port wine exports, thereby contributing to new and more product-specific avenues of research applied to the wine industry. Effectively, there is not only one market for wine, but many different ones that depend on price, tastes and brands, with consumers selecting their purchases according to the type of wine, its "colour" (i.e. red, white, rosé, etc.), region of production and the varieties of grape used. This is why what has been thought of as "the" wine market must be addressed as a bundle of monopolistic and competitive markets, and not a single, undifferentiated one.

3. Model

Our empirical model assumes CES preferences and goods that are differentiated by region of origin (Anderson, 1979). Moreover, it broadly follows Bergstrand (1989) who saw the gravity model to reflect, in a reduced form, the partial equilibrium between demand and supply under monopolistic competition. The demand equation was obtained by maximizing CES utility function, subject to an income restriction. The resulting demand curves relate trade flows to national income, per capita income and prices. Additionally, the supply equation resulting from the firm's profit maximisation in exporting countries is allocated according to the constant elasticity of transformation (CET). The underlying specification defines bilateral international trade as:

$$X_{i,j} = \beta_0 (Y_i)^{\beta_1} (Y_i/L_i)^{\beta_2} (Y_j)^{\beta_3} (Y_j/L_j)^{\beta_4} (D_{ij})^{\beta_5} \ (A_{ij})^{\beta_6} u_{i,j} \quad (1)$$

where X_{ij} is the aggregate value of bilateral trade from i (the exporting country) to j (the importing country); $Y_{i(j)}$ is the nominal GDP in $i(j)$; and $L_{i(j)}$ is the population in $i(j)$; D_{ij} is the distance between i and j; A_{ij} is a set of other factors either promoting or deterring trade between i and j; and u_{ij} represents a log-normally distributed error term. Estimates of β_1, β_2, β_3 and β_4 are typically positive; estimates of β_5 are negative.

Besides distance, usually used as a proxy for transport costs, other factors captured in A_{ij} include: linguistic barriers, colonial links, landlockness, adjacency, exchange rates and policy barriers usually proxied by tariff and non-tariff barriers.

The gravity equation used in this paper is given by [Equation (2)]:

$$ln\ Exp_{s,j,t} = \beta_0 + \beta_1 lnY_{j,t} + \beta_2 lnypc_{j,t} + \beta_3 AVE_{j,t} + \beta_4 ER_{j,t} + \beta_5 lnWC_{j,t} + \beta_6 lnEmg_{j,t} + \beta_7 lnDist_j + \beta_8 Lang_j + \beta_9 Ll_j + \alpha_j + u_{j,t} \quad (2)$$

where $Exp_{s,j,t}$ represents Port wine export flows by quality s (S = standard; HS = high standard; V = vintage; A = aged and T = total) expressed, alternatively, in hectolitres and in thousands of euros, from Portugal to country j in year t; $Y_{j,t}$ is country j's GDP in year t; $ypc_{j,t}$ is the GDP per capita of country j in year t; $AVE_{j,t}$ is the custom protection of Port wine (*ad valorem* equivalent tariff) imposed by country j in year t; $ER_{j,t}$ is the nominal exchange rate of country j's currency vis-a-vis the euro in year t; $WC_{j,t}$ is the per capita wine consumption in country j in year t; $Emg_{j,t}$ is the number of Portuguese emigrants in country j in year t; $Dist_j$, is the distance between the capital of Portugal and those of the importing countries. Finally, $Lang_j$ is a dummy variable which equals one if Portugal and country j share a common language and is zero otherwise; Ll_j is a dummy variable taking the value 1 if country j is landlocked and 0 otherwise; α_j is an effect associated with a country that might be correlated with explanatory variables and u_{jt} is the standard classical error that is assumed to be uncorrelated with the explanatory variables and is independent and identically distributed, IID (0, σ_u^2).

GDP represents the size of importing countries of Port wine and it is expected that the relation between exports and GDP be positive, as a bigger country would potentially import more Port wine. As economic theory on gravity model implies, higher income per capita in the importing countries ensures a greater ability to purchase products, and therefore, a positive impact on Port wine exports is expected. Tariffs represent impediments to trade and, thus, are expected to underpin a negative relationship with Port wine exports. Regarding the exchange rate, the earlier research in the general literature reports mixed results for the impact of exchange rate on exports (Karemera *et al.*, 2011). Wine consumption per capita on the importing country is predicted to have a positive relation with Port wine exports. It is also predicted that there will be a positive relationship between the size of the Portuguese emigrant community and Port wine exports due to their cultural links with the home country. A large distance will have a negative impact on the trade between two countries; thus, greater distance is expected to have negative effect on Port wine exports. The factor of language will yield similar evidence to variables related to historical factors, common background or culture, which is why it is assumed that the *Lang* dummy variable would have a positive sign. As transportation costs are higher for a landlocked country, it is expected that this has a negative effect on Port wine exports.

As the econometric analysis only focuses on Portugal's Port wine exports, the functional form of the model has two specific features. The first eliminates the need to account for the exporter's GDP and per capita GDP, and in the second, the supply of wine can be controlled using time-fixed effects.

Moreover, the model includes explanatory variables that vary over time, time-invariant variables (distance, language and landlockedness) and some that are correlated with individual effects. In this regard, the Hausman–Taylor estimator[6] (Hausman and Taylor, 1981; Baltagi *et al.*, 2003) was deemed an appropriate tool, as it allows both "between" and "within" variations of strictly exogenous variables to be used. More specifically, the

individual means of exogenous regressors are used as instruments for the time-invariant regressors that are correlated with individual effects (Baltagi, 2001). The choice of strictly exogenous regressors is statistically testable. Thus, the Hausman–Taylor estimator has three advantages: first, it provides parameter estimates of time-invariant variables that a fixed effects model cannot supply, even when consistent; second, as opposed to the traditional random effects model, it eliminates bias in parameter estimates stemming from endogenous unobserved effects; and finally, as individual effects contain all factors specific to destination countries, it is unlikely that explanatory variables would not be correlated with them, making it more efficient than a fixed effects model.

4. Empirical analysis

4.1 Data

The empirically gravity Equation (2) was estimated for annual Port wine exports to Portugal's principal wine trade partners over the period 2006-2014. The database consisted of balanced panel data comprising exports to the 20 main destination countries, over 9 years, with a total of 180 observations performed. The export data (from the *Instituto dos Vinhos do Douro e Porto* – IVDP) are disaggregated into four categories. They consist of the real euro value[7] and volume (in hectolitres) of Port wine exports to each of the 20 importing countries.

In 2014, although Port wine was exported to 120 countries, the top 20 importing countries received 95.4 per cent of total Port wine exports (see Table AI). The structure of Port wine export value by destination was markedly different for each category in 2014 (see Table AII): more specifically, France was the first-largest importer (34.9 per cent) of standard Port by value, the UK had the highest share of high standard and vintage Port (41.1 and 37 per cent, respectively), and the USA exhibited the highest share (25 per cent) of aged Port exports. It is worth noting that vintage and aged categories have a large share in terms of value, although they are less relevant in terms of quantity (Figure A1). In addition, the four categories exhibit different shares in total Port wine exports to these 20 countries for the period of 2006-2014 (see Figure A2).

Annual data on real GDP, real GDP per capita and population were taken from the World Bank's World Development Indicators (WDI). GDP for each country has been converted into euros. As a measure of the import tariff applied, we used the total *ad valorem* equivalent tariffs, at the six-digit level (code 220421) of the Harmonised System (HS), as provided by the International Trade Centre's Market Access Map. Nominal exchange rates are annual averages of daily observations and were taken from the website "fxtop.com". Wine consumption statistics expressed as annual per capita consumption of wine in litres were obtained from International Organisation of Vine and Wine (OIV). Data for the current dimensions of the Portuguese emigrant community in particular countries was taken from *Observatório da Emigração* (The Immigration Observatory) and was complemented with data from Organisation for Economic Cooperation and Development (OECD) and the United Nations (UN). From the GeoDist database from *Centre d'Etudes Prospectives et d'Informations Internationales*, we obtained data for the kilometre distance between Lisbon and the capital of the importing country; a dummy variable equal to 1 was applied both to countries sharing the same official language and to landlocked countries.

Further details of all the data used in the empirical analysis are outlined in Table I.

In Table AIII shows the main descriptive statistics of the variables used in the gravity *equation.*

Variable	Description	Source
$ExpT_{jt}$	Volume of total Port wine exports from Portugal to country j in year t in hectolitres	IVDP (www.ivdp.pt)
$ExpTE_{jt}$	Value of total Port wine exports from Portugal to country j in year in thousands of euros at constant prices (deflator of exports)	IVDP; Bank of Portugal
$ExpS_{jt}$	Volume of standard Port wine exports from Portugal to country j in year t in hectolitres	IVDP
$ExpHS_{jt}$	Volume of high standard Port wine exports from Portugal to country j in year t in hectolitres	IVDP
$ExpV_{jt}$	Volume of vintage Port wine exports from Portugal to country j in year t in hectolitres	IVDP
$ExpA_{jt}$	Volume of aged Port wine exports from Portugal to country j in year t in hectolitres	IVDP
$ExpES_{jt}$	Value of standard Port wine exports from Portugal to country j in year t in thousands of euros at constant prices	IVDP; Bank of Portugal
$ExpEHS_{jt}$	Value of high standard Port wine exports from Portugal to country j in year t in thousands of euros at constant prices	IVDP; Bank of Portugal
$ExpEV_{jt}$	Value of vintage Port wine exports from Portugal to country j in year t in thousands of euros at constant prices	IVDP; Bank of Portugal
$ExpEA_{jt}$	Value of aged Port wine exports from Portugal to country j in year t in thousands of euros at constant prices	IVDP; Bank of Portugal
Y_{jt}	Country j's GDP in year t in real terms in thousands of euros, converted into euros with nominal exchange rates from fxtop.com	World Bank WDI; fxtop.com
ypc_{jt}	Country j's GDP per capita in year t in euros, converted into euros with nominal exchange rates from fxtop.com	World Bank WDI; fxtop.com
AVE_{jt}	Total ad valorem equivalent tariff implemented by country j in year t	International Trade Centre (www.macmap.org)
ER_{jt}	Nominal exchange rate of country j's currency vis-à-vis the euros in year t	fxtop.com
WC_{jt}	Wine consumption (litres) per capita in country j in year t	OIV (www.oiv.int); World Bank WDI
Emg_{jt}	Portuguese emigrant community (stock) in country j in year t	Observatório da Emigração (www.observatorioemigracao.secomunidades.pt); United Nations; OECD
$Dist_j$	Distance of country j from Portugal in kilometres	CEPII
$Lang_j$	Dummy variable that takes the value of 1 if Portugal and country j have a common language and zero otherwise	CEPII
Ll_j	Dummy variable that takes the value 1 if country j is landlocked and zero otherwise	CEPII (www.cepii.fr)

Notes: IVDP = Instituto dos Vinhos do Douro e do Porto; WDI = World Development Indicators; OIV = International Organisation of Vine and Wine; OECD = Organisation for Economic Co-operation and Development; CEPII = Centre d'Etudes Prospectives et d'Information International

Table I.
Variables: definitions and sources

4.2 Results

In Table II, the results of the Hausman–Taylor estimator[8] are presented for dependent variables 1 – 5 by volume, namely: "total", "standard", "high standard", "vintage" and "aged", and the same five categories by value (variables 6-10). Time effects are globally significant and, thus, were included in all regressions via the dummies D2007 – D2014. The estimators are robust, with heteroscedasticity and serial correlation corrected using conventional methods. Sargan–Hansen tests showed that over-identifying restrictions could not be rejected, thereby validating the use of the exogenous variables as instruments for the time invariant regressors.

To test if there are differences between the results for each category of Port wine and total Port wine exports, the Wald test for linear restrictions was applied. The Wald test statistic – between the individual coefficients for each quality of Port and total Port wine exports – identifies the following statistical differences: vintage and aged (in volume) and high standard, vintage and aged (in value). These differences attest to the insufficiency of results based only on total Port wine exports, confirming the usefulness of estimating sub-samples disaggregated by quality-related sub-category.

The GDP of the importing countries is statistically significant for aged Port wine, achieving a value of export elasticity close to 1.0. This result means that the size of the destination market has a positive influence on the exports of high quality Port wine. For the remaining qualities of Port wine and total Port wine exports, the variable GDP is not statistically significant. These results suggest a clear preference by countries with higher income levels for superior quality wines. In 2014, the largest importer of this type of wine was the USA (see Table AII) with a share of 25.2 per cent, which could explain some specificities of the results. With the exception of aged Port wine exports by value, the GDP per capita of importing countries has, in general, a significant effect on Port wine exports, a finding that is consistent with most previous studies of wine exports (Dascal *et al.*, 2002; Seccia *et al.*, 2009; Castillo *et al.*, 2016; Dal Bianco *et al.*, 2017).

As regards tariffs, the coefficients are not statistically significant, which indicates that custom duties appear to have no influence on Port wine exports for all quality categories. This result contrasts with the negative and statistically significant impact of this variable for the wine sector in general (Dal Bianco *et al.*, 2016). Moreover, the lack of statistical significance of the exchange rate suggests that euro appreciation and/or depreciation does not significantly affect exports. Both results attest to the highly specific nature of Port wine compared with wine in general, with the former displaying much less sensitivity to these effects.

As expected, the per capita consumption of wine in destination markets has a positive and significant impact on the three higher quality categories of Port wine exports, with particular effects on vintage Port, suggesting that Port, as a fortified dessert wine, can be considered as complementary to – rather than directly competitive with – still wines. Countries with a more marked habit of wine consumption, such as Germany, the UK and the USA, are likely to demand the superior qualities of Port.

The size of the Portuguese emigrant community in importing countries has a positive and significant impact on total and high standard Port exports, both in volume and value, revealing a strong preference for home-country products. This result is in line with the literature (Rauch, 1999; Girma and Yu, 2002; Blanes, 2005), in which the immigrant connection has been shown to influence aggregate bilateral trade flows.

The variable of geographical distance is not statistically significant, indicating that transport costs have a limited role in Port wine exports. As the world has become ever more globalised, transport costs have decreased and the strategies of economic agents are less

Table II.
Determinants of Port wine exports by quality, 2006-2014 (Hausman–Taylor estimator)

			Volume		
	(1)	(2)	(3)	(4)	(5)
Variables	Total	Standard	High standard	Vintage	Aged
LnY	−0.788 (0.626)	−1.082 (0.701)	0.158 (0.636)	0.747 (0.656)	0.981* (0.586)
Lnypc	3.927*** (0.753)	4.469*** (0.837)	2.498*** (0.842)	2.596** (1.041)	1.310* (0.793)
AVE	0.624 (0.365)	0.535 (0.392)	0.739 (0.579)	−1.049 (0.908)	0.963 (0.601)
ER	0.005 (0.003)	0.005 (0.003)	0.001 (0.005)	0.014* (0.007)	0.008* (0.005)
LnWC	−0.108 (0.228)	−0.328 (0.245)	0.660* (0.347)	1.837*** (0.528)	0.789** (0.354)
LnEmg	0.268** (0.111)	0.068 (0.120)	0.398** (0.159)	0.236 (0.229)	0.066 (0.159)
LnDist	−0.166 (1.336)	−0.625 (1.608)	0.374 (0.992)	1.042 (1.349)	−0.385 (0.880)
Lang	5.466* (2.983)	6.849* (3.590)	3.975* (2.332)	7.066** (3.364)	3.998* (2.136)
Ll	−6.334** (3.125)	−6.523* (3.708)	−4.996** (2.507)	−3.605 (3.105)	−1.009 (2.241)
D 2007	0.264*** (0.062)	0.285*** (0.067)	0.164* (0.098)	0.142 (0.153)	0.249** (0.101)
D 2008	0.378*** (0.076)	0.441*** (0.082)	0.264** (0.117)	0.235 (0.183)	0.368*** (0.121)
D 2009	0.303*** (0.072)	0.386*** (0.077)	0.006 (0.110)	0.222 (0.173)	0.078 (0.114)
D 2010	0.139** (0.063)	0.180*** (0.068)	−0.019 (0.097)	−0.256* (0.152)	0.110 (0.100)
D 2011	0.286*** (0.068)	0.354*** (0.074)	0.047 (0.104)	−0.250 (0.161)	0.125 (0.107)
D 2012	0.025 (0.066)	0.080 (0.072)	−0.070 (0.098)	−0.502*** (0.153)	0.075 (0.101)
D 2013	0.082 (0.068)	0.133* (0.074)	−0.008 (0.100)	0.000 (0.156)	0.059 (0.103)
D 2014	0.054 (0.071)	0.116 (0.077)	−0.161 (0.103)	−0.493*** (0.160)	0.104 (0.105)
Constant	−15.169 (11.424)	−9.060 (13.565)	−29.622*** (9.704)	−52.350*** (13.764)	−26.913*** (8.928)
Sargan-Hansen test for the validity of instruments	4.890 [0.299]	5.184 [0.269]	6.374 [0.173]	8.849 [0.115]	2.883 [0.578]
Wald test		5.72 [0.995]	24.27 [0.112]	57.69 [0.000]	25.33 [0.088]
Observations	180	180	180	180	180

(*continued*)

Notes: Robust standard errors are given in parentheses *, ** and *** indicate that coefficients are significant at the 10, 5 and 1% levels, respectively. Figures in [.] indicate *p*-values. D2007 = 1 if year = 2007 and zero otherwise; D2008 = 1 if year = 2008 and zero otherwise; D2009 = 1 if year = 2009 and zero otherwise; D2010 = 1 if year = 2010 and zero otherwise; D2011 = 1 if year = 2011 and zero otherwise; D2012 = 1 if year = 2012 and zero otherwise; D2013 = 1 if year = 2013 and zero otherwise; D2014 = 1 if year = 2014 and zero otherwise

	Value				
Variables	(6) Total	(7) Standard	(8) High standard	(9) Vintage	(10) Aged
LnY	0.371 (0.467)	−0.083 (0.593)	0.230 (0.571)	0.921 (0.663)	1.062** (0.529)
Lnypc	2.478*** (0.595)	3.439*** (0.725)	2.183*** (0.760)	2.695*** (1.021)	1.106 (0.716)
AVE	0.441 (0.354)	0.234 (0.374)	0.600 (0.533)	−0.232 (0.848)	0.668 (0.544)
ER	0.001 (0.003)	−0.000 (0.003)	0.001 (0.004)	0.016** (0.007)	0.012*** (0.004)
LnWC	0.177 (0.217)	−0.338 (0.232)	0.782** (0.318)	1.842*** (0.498)	0.863*** (0.320)
LnEmg	0.243** (0.103)	0.044 (0.113)	0.366** (0.146)	0.181 (0.220)	0.174 (0.144)
LnDist	−0.265 (0.786)	−0.915 (1.145)	0.487 (0.883)	0.859 (1.372)	−0.048 (0.793)
Lang	4.733*** (1.790)	6.635*** (2.564)	3.721* (2.089)	7.580** (3.359)	3.390* (1.927)
Ll	−3.226* (1.950)	−3.849 (2.740)	−4.462** (2.237)	−3.035 (3.169)	−0.665 (2.020)
D 2007	0.225*** (0.060)	0.253*** (0.064)	0.126 (0.090)	0.196 (0.143)	0.200** (0.092)
D 2008	0.278*** (0.073)	0.375*** (0.078)	0.199* (0.108)	0.208 (0.172)	0.252** (0.109)
D 2009	0.258*** (0.068)	0.383*** (0.073)	0.023 (0.101)	0.286* (0.162)	0.063 (0.103)
D 2010	0.077 (0.060)	0.134** (0.064)	−0.005 (0.089)	−0.305** (0.142)	0.048 (0.091)
D 2011	0.143** (0.064)	0.236*** (0.069)	−0.021 (0.095)	−0.207 (0.151)	0.051 (0.096)
D 2012	−0.123** (0.062)	−0.065 (0.067)	−0.161* (0.090)	−0.523*** (0.144)	−0.078 (0.091)
D 2013	0.001 (0.063)	0.010 (0.068)	−0.010 (0.092)	0.078 (0.146)	0.015 (0.093)
D 2014	−0.040 (0.065)	0.008 (0.071)	−0.174* (0.094)	−0.346** (0.150)	0.069 (0.095)
Constant	−24.502*** (7.292)	−17.297* (10.042)	−29.168*** (8.705)	−54.288*** (13.715)	−29.955*** (8.054)
Sargan-Hansen test for the validity of instruments	4.940 [0.294]	4.041 [0.401]	7.240 [0.124]	8.896 [0.113]	4.522 [0.340]
Wald test		12.24 [0.785]	26.56 [0.065]	58.81 [0.000]	25.38 [0.087]
Observations	180	180	180	180	180

Table II.

influenced by distance than before. According to Wang *et al.* (2011), shipping costs have been decreasing over a number of years suggesting that because of modern means of communication and transport, for all practical purposes, physical distances have shortened.

For the specific case of wine, Dal Bianco *et al.* (2016, p. 19) contend that:

> The physical distance has a limited impact on the global wine trade. This result is hardly surprising because exported wine is highly priced and has relatively long storability. [. . .] We conclude that transport costs have a limited role in determining trade patterns. Our explanation for this result is that product differentiation plays an important role in the bottled wine trade because imported wines are imperfect substitutes, distant importers do not replace imports from distant markets with wines sold by closer partners.

This is especially true for Port wine, as it is only produced in Portugal, and therefore, the brand effect or regional reputation tend to compensate for the distance between countries. The trade implications of the geographical designation have been analysed by Agostino and Trivieri (2014): for the three largest European wine producers (France, Italy and Spain), from 1995 to 2009, there was a positive relationship between wine origin, traded values and market share.

Sharing the same language has favoured Port wine exports for all categories, both in volume and value, corroborating the general findings of applied gravity models. For example, Castillo et al (2016) found similar results in their study of the international market for bottled wine for the period 1988-2012. The cultural affinities between Portugal and Brazil and between Portugal and Angola, based on shared history, has positive effects on Port wine exports, primarily because of reductions in transactions costs through the enhancement of business or enterprise connections and knowledge about the relevant countries and their political and economic contexts. These relationships can be translated into positive export dynamics by national authorities and players in the wine value chain.

As is to be expected, landlockedness has a negative impact on total Port wine exports, both in terms of volume and value. However, with regard to the various qualities of Port wine, the coefficients are not statistically significant for vintage and aged categories, which suggests that landlockedness does not restrict exports of higher quality Port wines[9].

5. Conclusions, implications, limitations and future research recommendations

5.1 Main conclusions and implications

The great diversity of quality wines in the international market suggests that in analysing the determinants of wine exports, the product's various sub-categories and levels of quality should always be taken into account. This paper has attempted to address this previously neglected aspect by analysing the determinants of Port wine exports differentiated by category/quality for the period of 2006-2014 – a time that, incidentally, includes the global financial crisis of 2008-2009 and its enduring consequences, as well as the subsequent euro area sovereign debt crises.

An extended version of a gravity model was estimated using the Hausman–Taylor estimator, overcoming endogeneity and accounting for time invariant variables. The results reveal that international demand for Port wine is determined by the per capita wealth of countries, positioning Port wine as a luxury good (i.e. displaying an income elasticity greater than one). Cultural affinity, expressed both through the existence of Portuguese emigrant communities and/or a shared language, plays a fundamental role in the international trade of Port wine. In this context, priority should be given to strategies that rely on the consolidation and expansion of these familiar markets, designing methods of product

valorisation based on Port wine's association with certain regions, cultural heritage and other regional products. It transpires that landlockedness is a barrier to the Port wine trade, but the related business implications are only applicable to two countries (Switzerland and Luxemburg) both of which have a very small share of Port wine imports.

The specific determinants by categories are GDP for aged Port and wine consumption per capita for high standard, vintage and aged Port. An important implication of these particular results is that Portugal should increase its exports of high quality Port wine to markets that show a tendency towards increasing wine consumption per capita and to large and fast-growing economies. These results are important, as, despite Port wine being sold around the world, its core markets are located in Europe and North America, where communities of Portuguese descent are numerous and demand is firmly established. Nevertheless, these mature markets show a tendency to shrink, as referred in our Introduction; thus, in the future, export dynamics will need to be based on new demand in response to the trend towards greater global consumption and the strengthening of market shares in emerging countries, particularly in Asia.

5.2 Limitations and future research

The present research and the results reported on here refer to major Port wine importing countries, and this undoubtedly constitutes a limitation. It would therefore be interesting in future research to extend this type of analysis to other countries that, while currently not major importers, offer new opportunities for exporting Port wine. These opportunities not only exist in European markets but also in emerging markets with growing populations, high per capita income and a growing demand for luxury "unique sensation" food products – of which Port wine is a clear example, because of its long history, its global reputation and, more recently, because of growing knowledge of the Alto Douro wine region, a UNESCO world heritage site.

Port wine is only produced in Portugal, and in this sense, it is unique in the world. Nevertheless, it competes in the liqueur wine market, an issue the present article does not explicitly address, but that should be empirically analysed in future applications, which could, for example, examine consumption trends of this kind of drink, as well as of alcoholic drinks in general.

In future analysis, it would also be useful to analyse the effect on Port wine exports of variables other than those considered in the model used in this research, to assess the individual and collective effect of such factors in contributing to overall demand for Port wine, to guide future investments and marketing strategies on the part of Port wine exporters, in response to our growing knowledge of the preferences and tastes of overseas consumers. Additionally, it would be beneficial to investigate the role of agreements and preferential trade arrangements between Portugal and importing countries, including rules of origin and other non-tariff barriers or investment effects linked to trade regimes. Complementary to the introduction of these new variables, other econometric methodologies may be applied, namely, the Poisson–Pseudo Maximum Likelihood and semiparametric approaches to panel data.

Notes

1. In the liqueur wine market (Port, Sherry, Marsala, Madeira and Samos), Port wine dominates, followed by Sherry. In 2000, Port wine represented 67 per cent by volume and 78 per cent of the value of exports of the principal liqueur wines. By 2014, the corresponding proportions had risen to 77 and 83 per cent, respectively, mainly at the expense of second-placed Sherry, which, in the

same period, saw export volume falling from 31 to 18 per cent and value from 20 to 13 per cent (Comext database; epp.eurostat.ec.europa.eu/newxtweb/).

2. Standard (tawny, ruby, white and rosé), high standard (late bottled vintage, reserves and crusted), vintage (vintage Port) and aged (10, 20, 30 or more than 40 years old and year of harvest). There are other categories, as presented by the Instituto dos Vinhos do Douro e Porto (IVDP; www.ivdp.pt).
3. In a recent paper on Cognac exports, Bouët *et al.* (2017) conclude that the structure by quality of exports is a fascinating subject that deserves greater consideration.
4. The term "landlockedness" describes a country that has no direct access to the sea.
5. Köhr *et al.* (2017), applying firm-level data collected via a quantitative survey of wineries engaged in exports in the Romagna wine producing region of Italy, concluded that competitiveness in international markets is closely linked to wine quality.
6. This approach has been used in other papers dedicated to gravity models (Serlenga and Shin, 2007; Belke and Spies, 2008).
7. The nominal value of exports (IVDP) was deflated using the Portuguese export price deflator (base = 2011), made available by the Bank of Portugal.
8. Although the theoretical groundwork emphasises the Hausman-Taylor estimator, other data panel models were estimated and tested empirically. The results for different estimation techniques are presented in Table AIV for total exports. The results for each of the four qualities of wine are available on request from the authors. Columns 1 – 4 relate to export volume, while columns 5-8 refer to export values. The first and fifth columns report pooled ordinary least squares (OLS) estimation, and the second and sixth columns present random effects estimator results. The third, fourth, seventh and eighth columns report fixed effects and the Hausman and Taylor (1981) estimator results, respectively. Time effects are included in all estimators, except pooled OLS. Eventual heteroscedasticity and serial correlation in all regressions were corrected using a clustered robust estimator. The outcomes of the Hausman and Breusch-Pagan LM tests applied to the panel data indicate that the pooled OLS and the random effects model could be rejected, which supports the use of a fixed effects model. However, this model would not provide estimations for the time invariant variables and, for this reason, the Hausman-Taylor estimator was deemed more appropriate.
9. To be sure about the robustness of the results, that is, if there is correlation between explanatory variables, we applied the Coefficient Eta that is recommended for the computation of the correlation between the dummy variables (Lang, Ll) and the quantitative variables ($0 < \text{Eta} < 1$); χ^2 (Lang, Ll) and Pearson Coefficient (remaining variables). Additionally, we re-estimated the model starting with the basic equation of the gravity model (distance and GDP per capita) and extending it by adding other variables one by one. In general, the sign and significance did not change, indicating that the results were robust. These computations are available upon request to the authors.

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Appendix 1

Country	2006 Value	2006 Share (%)	2007 Value	2007 Share (%)	2008 Value	2008 Share (%)	2009 Value	2009 Share (%)	2010 Value	2010 Share (%)	2011 Value	2011 Share (%)	2012 Value	2012 Share (%)	2013 Value	2013 Share (%)	2014 Value	2014 Share (%)
France	92.1	25.9	93.3	25.7	89.9	27.5	94.5	28.6	89.5	26.9	80.0	26.4	77.1	25.7	78.8	25.4	77.1	24.9
United Kingdom	53.2	15.0	52.7	14.6	41.0	12.5	45.8	13.9	44.5	13.4	41.5	13.7	45.1	15.1	49.7	16.0	45.5	14.7
Netherlands	51.5	14.5	54.0	14.9	50.0	15.3	43.9	13.3	46.1	13.9	43.0	14.2	43.6	14.6	42.2	13.6	42.7	13.8
Belgium	43.8	12.3	44.3	12.2	41.7	12.8	42.5	12.9	41.6	12.5	35.5	11.7	34.8	11.6	32.6	10.5	35.1	11.3
United States	37.1	10.4	31.3	8.6	25.7	7.9	24.2	7.3	25.4	7.6	26.6	8.8	27.6	9.2	29.6	9.5	31.9	10.3
Canada	18.1	5.1	19.4	5.4	15.6	4.8	15.4	4.6	17.0	5.1	14.8	4.9	14.0	4.7	15.1	4.8	12.4	4.0
Germany	11.4	3.2	14.5	4.0	17.1	5.2	17.6	5.3	13.7	4.1	11.9	3.9	11.3	3.8	12.4	4.0	12.2	3.9
Denmark	7.5	2.1	8.0	2.2	6.3	1.9	8.2	2.5	14.3	4.3	8.8	2.9	6.2	2.1	7.1	2.3	9.8	3.2
Spain	6.3	1.8	7.4	2.0	5.6	1.7	6.1	1.8	5.6	1.7	5.2	1.7	4.7	1.6	4.6	1.5	5.2	1.7
Brazil	3.7	1.0	4.3	1.2	4.6	1.4	4.6	1.4	5.3	1.6	5.4	1.8	4.1	1.4	3.8	1.2	3.9	1.3
Switzerland	4.4	1.2	4.6	1.3	4.4	1.3	3.9	1.2	3.7	1.1	3.8	1.3	3.5	1.2	3.6	1.2	3.7	1.2
Italy	4.3	1.2	4.2	1.2	3.4	1.0	3.1	1.0	3.2	1.0	2.7	0.9	2.3	0.8	2.6	0.8	2.8	0.9
Russian Federation	0.8	0.2	1.4	0.4	0.9	0.3	0.7	0.2	1.1	0.3	1.5	0.5	1.8	0.6	2.5	0.8	2.4	0.8
Poland	0.6	0.2	1.0	0.3	1.0	0.3	0.9	0.3	1.2	0.4	1.7	0.6	2.2	0.7	2.4	0.8	2.4	0.8
Sweden	2.1	0.6	2.3	0.6	2.0	0.6	2.1	0.6	2.1	0.6	1.9	0.6	1.8	0.6	3.4	1.1	1.8	0.6
Japan	1.8	0.5	2.0	0.5	1.7	0.5	1.7	0.5	1.6	0.5	1.9	0.6	1.8	0.6	1.6	0.5	1.4	0.5
Angola	0.4	0.1	0.7	0.2	0.8	0.3	0.8	0.2	0.5	0.2	0.8	0.3	1.0	0.3	1.1	0.3	1.4	0.4
Ireland	3.0	0.8	2.3	0.6	2.3	0.7	2.1	0.6	2.2	0.7	2.1	0.7	1.7	0.6	1.4	0.5	1.3	0.4
Norway	1.2	0.3	1.4	0.4	1.1	0.3	1.5	0.5	1.0	0.3	1.1	0.4	1.1	0.4	1.2	0.4	1.3	0.4
Luxembourg	1.2	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.2	0.4	0.9	0.3	1.0	0.3	1.0	0.3	1.1	0.4
Total	344.8	97.0	350.0	96.6	316.0	96.7	320.8	97.0	321.0	96.6	291.1	96.0	286.6	95.8	296.5	95.4	295.4	95.4
World	*355.3*	*100.0*	*362.2*	*100.0*	*326.7*	*100.0*	*330.6*	*100.0*	*332.2*	*100.0*	*303.2*	*100.0*	*299.3*	*100.0*	*310.7*	*100.0*	*309.7*	*100.0*

Table AI. Total Port wine exports to main importing countries (1000000 EUR), 2006-2014

Table AII.
Port wine exports by quality to main importing countries, 2014

Standard			High Standard			Vintage			Aged		
Country	1000 EUR	Share (%)	Country	1000 EUR	Share (%)	Country	1000 EUR	Share (%)	Country	1000 EUR	Share (%)
France	63,639.2	34.9	United Kingdom	23,775.5	41.7	United Kingdom	3,815.5	37.7	United States	14,110.7	25.2
Netherlands	31,812.3	17.4	United States	8,723.6	15.3	Denmark	1,632.0	16.1	France	7,649.4	13.7
Belgium	29,325.1	16.1	France	4,221.0	7.4	United States	1,482.2	14.6	Netherlands	6,620.5	11.8
United Kingdom	11,403.6	6.2	Canada	4,009.3	7.0	France	552.1	5.5	United Kingdom	5,943.7	10.6
Germany	8,393.8	4.6	Netherlands	3,382.6	5.9	Netherlands	348.9	3.4	Canada	5,803.3	10.4
United States	7,160.2	3.9	Denmark	2,416.9	4.2	Canada	345.1	3.4	Denmark	2,919.3	5.2
Spain	4,444.4	2.4	Belgium	2,363.2	4.1	Germany	269.7	2.7	Belgium	2,714.4	4.8
Brazil	2,827.1	1.5	Germany	1,660.4	2.9	Belgium	192.7	1.9	Germany	1,690.8	3.0
Denmark	2,689.9	1.5	Norway	706.5	1.2	Switzerland	170.5	1.7	Switzerland	926.0	1.7
Switzerland	2,360.6	1.3	Sweden	567.7	1.0	Sweden	136.9	1.4	Russian Fed.	492.5	0.9
Italy	2,354.6	1.3	Brazil	541.5	0.9	Angola	121.5	1.2	Spain	411.7	0.7
Poland	2,138.4	1.2	Ireland	419.0	0.7	Norway	89.7	0.9	Brazil	393.8	0.7
Canada	2,114.9	1.2	Spain	283.1	0.5	Russian Fed.	81.5	0.8	Angola	322.5	0.6
Russian Fed.	1,495.7	0.8	Russian Fed.	268.0	0.5	Brazil	63.6	0.6	Sweden	269.6	0.5
Japan	1,207.6	0.7	Switzerland	242.4	0.4	Japan	52.0	0.5	Norway	229.7	0.4
Sweden	836.1	0.5	Italy	214.0	0.4	Ireland	41.6	0.4	Italy	197.4	0.4
Luxembourg	788.1	0.4	Angola	148.0	0.3	Spain	31.3	0.3	Luxembourg	196.6	0.4
Angola	779.2	0.4	Luxembourg	97.5	0.2	Italy	28.4	0.3	Japan	114.1	0.2
Ireland	757.5	0.4	Poland	60.3	0.1	Luxembourg	21.1	0.2	Poland	113.0	0.2
Norway	236.2	0.1	Japan	13.3	0.0	Poland	14.2	0.1	Ireland	95.0	0.2
Total	176,764.5	96.9	Total	54,113.7	94.8	Total	9,490.5	93.7	Total	51,214.1	91.5
World	182,497.5	100.0	World	57,056.3	100.0	World	10,124.2	100.0	World	55,995.5	100.0

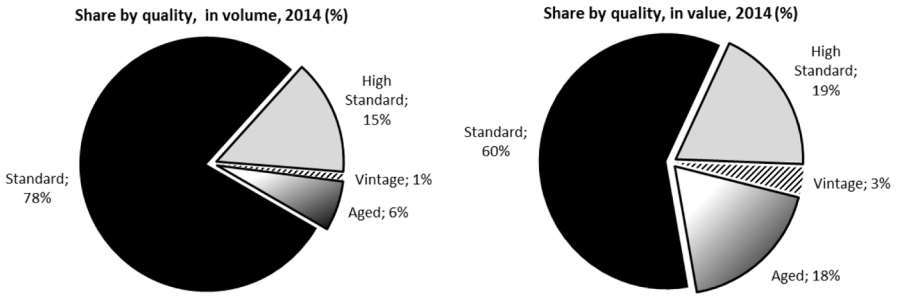

Figure A1. Share of Port wine exports by quality, volume and value, in 2014

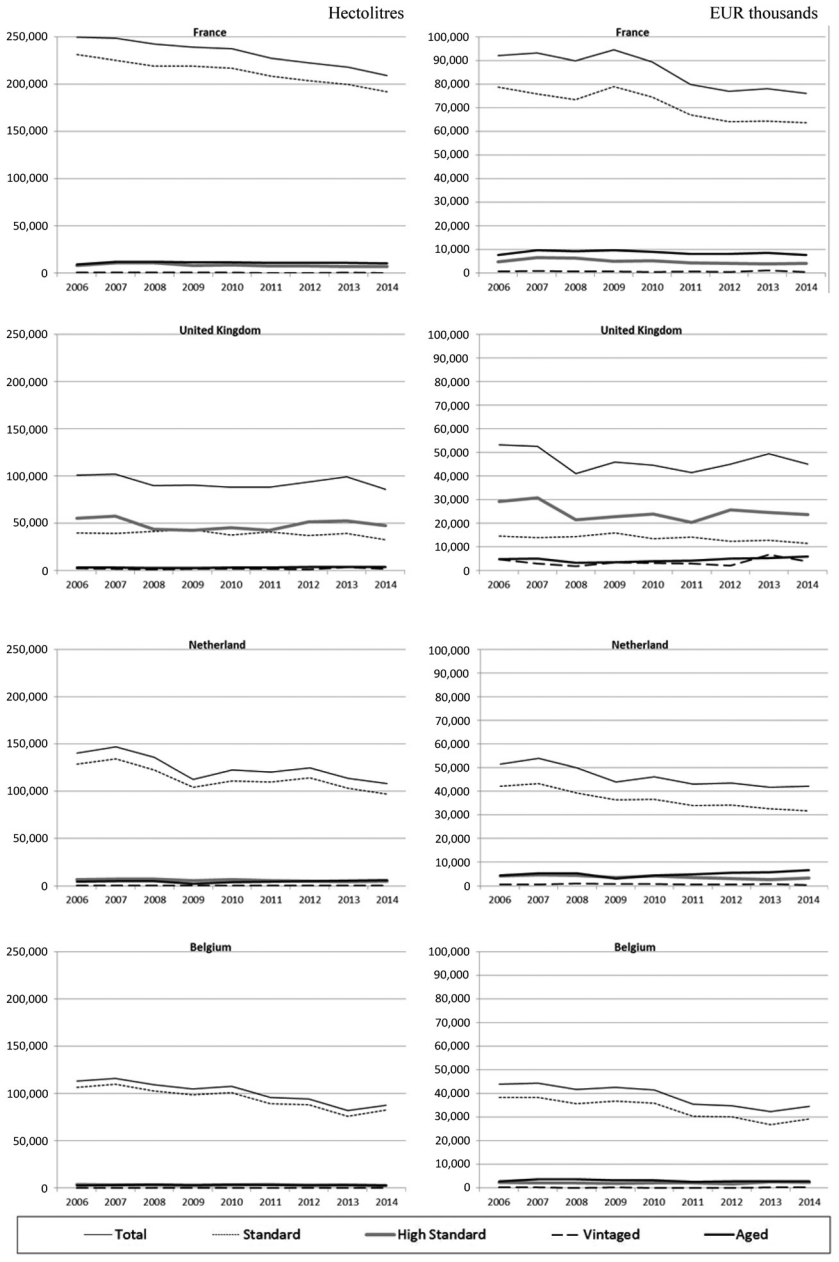

Figure A2.
Port wine exports to selected countries, 2006-2014

(*continued*)

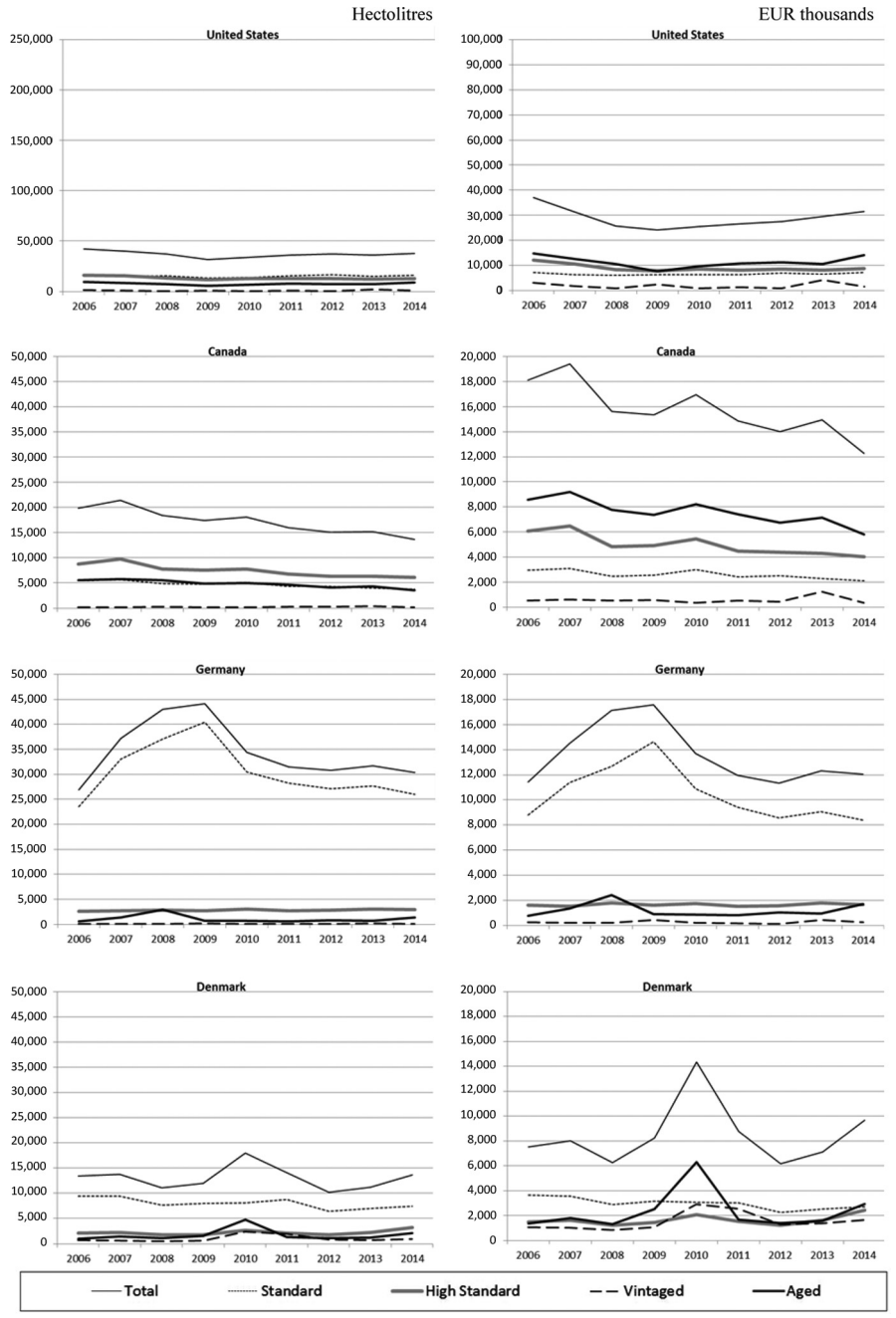

Figure A2.

Variable	Unit	Mean	SD	Minimum	Maximum	Observations
expt	hectolitres	35,453.2	58,319.7	833.2	249,569.9	180
exps	hectolitres	28,300.9	52,502.1	336.4	231,335.7	180
exphs	hectolitres	4,895.9	10,783.8	18.1	57,467.8	180
expv	hectolitres	283.9	526.5	1.3	3,275.7	180
expa	hectolitres	1,972.5	2,978.5	19.6	11,833.8	180
expte	EUR thousands	15,646.8	22,222.5	426.3	94,529.6	180
expes	EUR thousands	9,900.0	17,476.6	201.8	79,052.1	180
expehs	EUR thousands	2,856.7	5,592.2	13.3	30,887.7	180
expev	EUR thousands	524.0	950.0	2.7	6,734.2	180
expea	EUR thousands	2,366.1	3,349.2	39.5	14,751.8	180
y	EUR thousands	1,340,000,000.0	2,240,000,000.0	27,100,000.0	11,100,000,000.0	180
ypc	EUR	27,752.9	14,927.8	14,641.9	65,493.1	180
ave	percentage	5.7	10.3	0	35.0	180
er	local currency vs EUR	16.7	37.5	0.7	161.3	180
wc	litres	20.8	14.5	0.0	54.4	180
emg	number of persons	86,325.7	134,400.4	106	613,689	180
dist	kilometres	3,325.3	2,514.4	500.9	11,156.4	180
lang	same:1; dif:0	–	–	0	1	180
ll	ll:1; otherwise:0	–	–	0	1	180

Table AIII.
Descriptive statistics

Appendix 2

Table AIV. Determinants of total Port wine exports, 2006-2014

	Volume			
Variables	(1) OLS	(2) RE	(3) FE	(4) HT
LnY	0.070 (0.245)	0.545** (0.258)	−1.729 (1.831)	−0.788 (0.626)
Lnypc	−0.368 (0.394)	1.791*** (0.505)	4.976* (2.574)	3.927*** (0.753)
AVE	−3.099 (2.050)	0.734*** (0.211)	0.564*** (0.151)	0.624 (0.365)
ER	−0.003 (0.004)	0.005* (0.003)	0.006 (0.004)	0.005 (0.003)
LnWC	0.180 (0.389)	0.089 (0.261)	−0.156 (0.374)	−0.108 (0.228)
LnEmg	0.455** (0.165)	0.149 (0.124)	0.299** (0.137)	0.268** (0.111)
LnDist	0.144 (0.713)	−0.973* (0.576)		−0.166 (1.336)
Lang	−1.568 (1.386)	3.999*** (1.431)		5.466* (2.983)
Ll	−2.126*** (0.739)	−2.261** (0.894)		−6.334** (3.125)
Constant	6.132 (5.882)	−13.971** (6.128)	−8.273 (12.968)	−15.169 (11.424)
Time effects	No	Yes	Yes	Yes
Time effects' significance	0.10 [0.998]	20.42 [0.005]	4.61 [0.000]	
Hausman test			21.62 [0.003]	
Breusch-Pagan LM test		583.12 [0.000]		
Observations	180	180	180	180
R-squared	0.674	0.447	0.408	

(continued)

Notes: OLS = ordinary least squares; RE = random effects; FE = fixed effects; HT = Hausman-Taylor; Robust standard errors are given in parentheses; *, **and; *** indicate that coefficients are significant at the 10, 5 and 1% levels, respectively. Figures in [] indicate *p*-values

Table AIV.

Variables	Value (5) OLS	(6) RE	(7) FE	(8) HT
LnY	0.057 (0.215)	0.598** (0.240)	−0.187 (1.482)	0.371 (0.467)
Lnypc	−0.151 (0.292)	1.552*** (0.324)	3.299 (1.975)	2.478*** (0.595)
AVE	−1.365 (1.324)	0.484*** (0.185)	0.375** (0.143)	0.441 (0.354)
ER	−0.003 (0.003)	0.003 (0.004)	0.002 (0.004)	0.001 (0.003)
LnWC	0.206 (0.351)	0.279 (0.233)	0.150 (0.357)	0.177 (0.217)
LnEmg	0.433*** (0.140)	0.172 (0.125)	0.326** (0.150)	0.243** (0.103)
LnDist	0.334 (0.556)	−0.463 (0.473)		−0.265 (0.786)
Lang	−1.754 (1.176)	3.405*** (1.285)		4.733*** (1.790)
Ll	−2.230*** (0.668)	−2.071*** (0.755)		−3.226* (1.950)
Constant	2.199 (4.835)	−17.856*** (4.421)	−24.112* (11.868)	−24.502*** (7.292)
Time effects	No	Yes	Yes	Yes
Time effects' significance	0.15 [0.994]	23.11 [0.002]	4.70 [0.000]	
Hausman test			13.31 [0.065]	
Breusch-Pagan LM test		590.99 [0.000]		
Observations	180	180	180	180
R-squared	0.716	0.543	0.397	