Universidad Pública de Navarra
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Facultad de Ciencias Económicas y Empresariales

TRABAJO FIN DE GRADO EN
Administración y Dirección de Empresas

TÍTULO DEL TRABAJO
Gravity model for DOC Rioja wine exports

Módulo:
Economía

Pamplona-Iruña 13 de mayo de 2021

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I. RESUMEN

El mercado del vino ha experimentado una gran evolución durante las últimas décadas con la entrada de nuevos países productores y la expansión de la actividad internacional. Sin embargo, esta evolución no ha sido igual en todos los países. En concreto, en España juegan un papel muy importante las Denominaciones de Origen, garantizando la identidad y calidad de los vinos. Siendo una de las más importantes la Denominación de Origen Calificada Rioja, resulta por tanto relevante determinar cuáles son los factores que han contribuido a su expansión. Con este objetivo, se desarrolla un análisis econométrico a fin de construir un modelo de gravedad con el que establecer qué factores son potencialmente importantes.

I. ABSTRACT

The wine market has undergone a great evolution in recent decades with the entry of new producing countries and the expansion of international activity. However, this evolution has not been the same in all countries. Particularly, Geographical Indications play a very important role within the sector in Spain, guaranteeing the identity and quality of the wines. Being the "Denominación de Origen Calificada (DOC) Rioja" one of the most important of them, it is therefore relevant to determine the factors that have contributed to its expansion. To this end, an econometric analysis is carried out in order to construct a gravity model to establish which factors are potentially important.

II. KEYWORDS

Wine, Old World, New World, exports, gravity model, DOC Rioja.

INDEX

1. INTRODUCTION

Wine is one of the most representative products of Spain, both nationally and worldwide. Besides, the wine sector experienced a remarkable **expansion,** globally and in Spain, during the second half of the twentieth century, increasing its international activity favored by **globalization** and trade liberalization. Hence, export opportunities arose for Spanish producers, but also for those all around the world. This resulted in the incorporation of new wine-producer countries from different continents, competing with the traditional ones from Europe – France, Italy, and Spain. In sum, a dichotomy between the so-called Old World and New World emerged, prompting a much more **competitive** and interdependent context.

Due to these dynamics, the main factors affecting wine international trade flows might have been modified. Particularly, as it will be explained, not all the wines have evolved in the same way. In Spain, the most valuable wines are classified under different Geographical Indications or "Denominaciones de Origen" (DO), which ensure the identity and quality of those wines, thus triggering different selling patterns. Nowadays, there exist 75 DOs in Spain. In addition, DOs' quality wines are the main source of value added for Spanish wine exports. Among them, the **"Denominación de Origen Calificada (DOC) Rioja"** is one of the most important, currently amounting up to 40% of the total wine production in Spain.

Consequently, the analysis focuses on DOC Rioja exports. More precisely, the research aims at assessing which factors affecting international trade of wine are relevant for DOC Rioja exports, thus being able to construct a **gravity model** – a model for assessing the determinants of international trade flows. To this end, an econometric analysis is developed. Prior to this, some instrumental objectives should be accomplished. First, an analysis of literature is conducted in order to assess the most relevant variables. After that, the procurement of the necessary data is done. Finally, the use of Stata software is required to elaborate a panel data and run the regressions for the analysis. Hereby, it is noteworthy the lack of previous knowledge of this tool by the author, requiring for training and self-learning.

Regarding the **methodology**, data is taken for the 25-year period from 1995 to 2019. Moreover, the analysis focuses on DOC Rioja exports to its larger 25 destinations for each of these years, which are expected to be representative. Then, data for the different variables considered to be relevant based on the studied literature is searched for upon several databases, trying to build a complete picture. Once the data is obtained, an assessment of the variables is performed in order to check for heteroscedasticity and autocorrelation, and

accordingly choose the most appropriate tool. Finally, several linear regressions for panel data are conducted to accomplish the main objective of the research.

In order to do so, the subsequent structure is followed in the paper: first, an overview on the wine market is presented in section 2, depicting the global and the Spanish market, and introducing the case of DOs. Then, the empirical analysis is introduced in section 3, displaying the main factors affecting wine international trade, the data sources used to create the database, and the methodology for elaborating the gravity model. In section 4 the results from the model are presented and discussed. Finally, conclusions are made in section 5.

2. THE WINE MARKET: EVOLUTION IN THE WORLD AND IN SPAIN

Prior to start with the analysis of wine international trade flows, insights shall be gathered on how the market has evolved. To this end, this section presents the main characteristics and recent trends of the global market. In a similar way, the main features and trends in Spain and the case of DO exports are introduced. Most of the explanations contained within this section, as well as those summarized in the introduction, are based on the literature by Castillo, Villanueva, and García-Cortijo (2016); López and Compés (2018); Medina-Albadalejo and Martínez-Carrión (2012); and Fernández and Pinilla (2014).

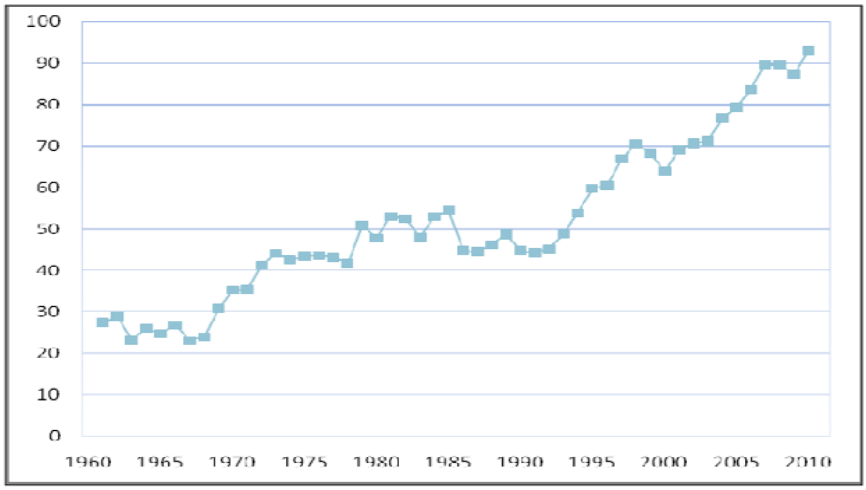
2.1 Global market: description and trends

The first point to be highlighted about the global wine market is its structure. It is composed of many different competing firms, from different countries, and each of them offering different types of wine, ranging from low-quality-low-price bulk wine to high-quality-high-price luxury wines (Castillo, Villanueva, & García-Cortijo, 2016). In this sense, its categorization is complex. On the one hand, it presents elements from **perfect competition**: there is a big number of firms, being many of them small, what also signifies the lack of economies of scale. Besides, the importance of comparative advantage is remarkable, especially in terms of climate and soil, which determine the countries where the wine sector can success – France, Italy, Spain, Chile, Australia, among others. On the other hand, product differentiation is key at brand level and at country level, especially in high-end segments, being an element of **monopolistic competition**. According to the mentioned authors, and as a consequence of this last factor, the wine sector presents an **intra-industrial trade**[1] structure.

[1] As defined by Krugman, Obstfeld, and Melitz (2018), this term refers to two-way international exchanges of similar goods, providing countries with access to a wider variety of goods within the same category.

Focusing now on recent evolution, the most remarkable trend in the global wine market is its **expansion** during the second half of the 20th Century, as presented in figure 1[2], favored by a context of globalization. This tendency represents a plot twist compared to the first half of the century, in which the two World Wars and the inter-war period, characterized by a paralysis of the markets and strong protectionism, had led to low levels of exports (Medina-Albadalejo & Martínez-Carrión, 2012). In contrast, during the second half, both imports and exports increased at a global level, thus increasing trade flows in terms of volume and even more in terms of value, converting international trade in the principal engine for wine-related activity (López & Compés, 2018). In fact, while in the 1980s only 14% of the liters sold were traded internationally, this percentage grew up to 30% in the 2010s (Castillo, Villanueva, & García-Cortijo, 2016). Another fact signifying the huge growth of wine international trade is that, even in an environment of **decreasing wine consumption** – it fell by around 15% from 1970 to 2010 – exports grew by 127% in the same period, resulting in a more competitive environment, with the Mediterranean countries and new producers – mainly Australia and Chile – increasing their sales (Medina-Albadalejo & Martínez-Carrión, 2012).

Figure 1: Evolution of global wine exports 1961-2010 (million hl)



Source: Medina-Albadalejo and Martínez-Carrión *(2012)* based on data from OIV.

It is particularly interesting the fact that this expansion of wine international trade occurred in a context of **overproduction** problems. The main producers kept growing, and the incorporation of new ones did not help in a time of increasing returns, technological improvements, and the mentioned falling consumption. In general, the extraordinary growth of wine international trade can be explained by different factors such as marketing strategies, trade liberalization, or new consumption habits, among others introduced in section 3.1.

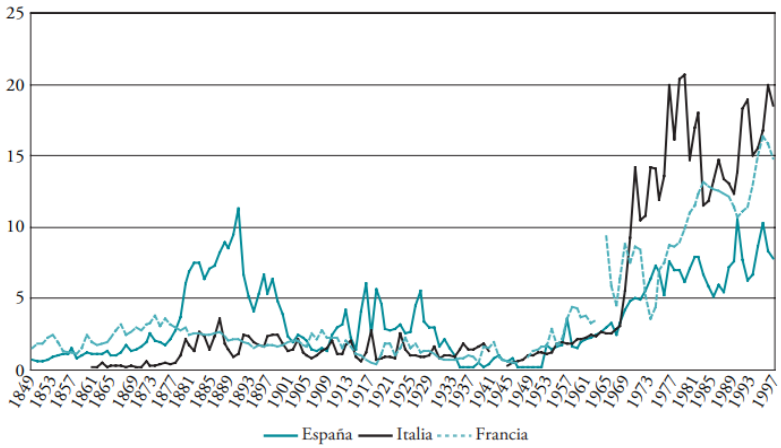
[2] This figure has been taken directly from other authors rather than self-elaborated due to the impossibility of accessing data for years prior to 1995.

Hereby, another important feature of the global wine market can be observed: the **dichotomy** between the "Old World" and the "New World". The former includes Germany, France, Italy, Spain, and Portugal; while the latter refers to Argentina, Chile, USA, South Africa, Australia, and New Zealand. This dichotomy is nowadays **less intense**, since during the globalization process the New-World countries grew in importance as it was mentioned before – New-World countries wine exports' participation on global wine exports increased from 1.3% in the 1960s to 29.4% in the 2000s (Medina-Albadalejo & Martínez-Carrión, 2012) – thus creating a new framework characterized by interdependence between all countries. (López & Compés, 2018) This change in the global wine market happened in two phases: a first one (1980s-1990s) characterized by the appearance of the New-World producers – USA and Australia the 1980s, Chile, Argentina, and South Africa in the 1990s – and the subsequent adaptation of the different agents to it; and a second stage (2000s-2010s) of consolidation of the new *status quo*. In sum, whereas in the 1980s 92% of wine volume exported was European, in the 2010s this proportion was down to 65%. However, despite of this fact, wine remains mainly as a European product, with 75% of the volume produced, consumed, and traded involving Europe (Castillo, Villanueva, & García-Cortijo, 2016).

Among the Old-World producers, the most outstanding ones have always been **France, Italy, and Spain.** These countries led the trend of the global market, experiencing a huge export growth from the 1950s on, especially from the 1970s, as shown in figure 2[3]. Actually, France's recovery in the 1970s was key for the explained expansion of international trade, being the second exporter – only behind Italy, favored by its early entry into the European Economic Community (EEC) – and the first importer of wine worldwide. In addition, France was specialized on high-value-added bottled wine, being able to present higher export prices, a characteristic that persists even nowadays thanks to its great prestige. (Medina-Albadalejo & Martínez-Carrión, 2012) In spite of this fact, an important trend among these three countries was the **growing weight of bulk wine** to the loss of bottled wine (Castillo, Villanueva, & García-Cortijo, 2016). Finally, the situation of Spain will be explained in section 2.2.

[3] As in figure 1, this graph has been taken directly from other authors rather than self-elaborated due to the impossibility of accessing data for years prior to 1995. On the other hand, data from 1995 until 2016 are presented later on in another figure.

Figure 2: Spanish, French, and Italian wine exports 1849-2000 (million hl)



Source: Fernández and Pinilla (2014) based on data from Anuario de Comercio Exterior de España, Sommario di Statistiche Storiche Italiane and Tableau du Commerce Exterieur de la France.

Regarding **New-World** countries, they were able to grow mainly from the 1980s on. Actually, this is not explained by an increase of own-consumption, since wine consumption per capita in those countries was lower than in Europe (Castillo, Villanueva, & García-Cortijo, 2016). Rather, their growth relied on a first stage of increasing demand for low-medium-quality wines from consumer-but-not-producer countries, and a second stage of demand for high-quality wines to New-World countries from both producers and non-producers. In consequence, these countries enjoy a good balance between exports in volume and exports in value, supported by exports of **mid-range wines**. What is more, during the 1990s New-World producers, especially Australia, Chile, USA, and South Africa, got to show relatively high prices together with an increasing market share in Europe, sustained by good marketing and the fact of being "easier to understand" for consumers. This last sentence illustrates the fact that New-World countries are allowed to classify their wines according to varieties instead of according to origin, thus being more suitable for non-expert consumers. In sum, the Old-World used to enjoy a comparative advantage, but the New-World has been able to gain competitiveness in the global market. (Medina-Albadalejo & Martínez-Carrión, 2012)

Finally, considering the composition of exports, **bottled wine** has consolidated especially in Europe and the Anglo-Saxon markets, showing an important geographical diversification. On the other hand, **bulk wine** has gained importance, as mentioned before, thanks mainly to high price elasticity and geographical closeness. However, it is remarkable a lapse taking place during the 2008 crisis, in which the preference for bottled wine was reinforced, after which bulk wine recovered its growth again. In addition, some countries such as Germany, USA, or United Kingdom, purchase bulk wine and then bottle it, something that has also

contributed to the rise of bulk wine exports. Consequently, there is a trend towards lower price per liter of wine exported. (Castillo, Villanueva, & García-Cortijo, 2016)

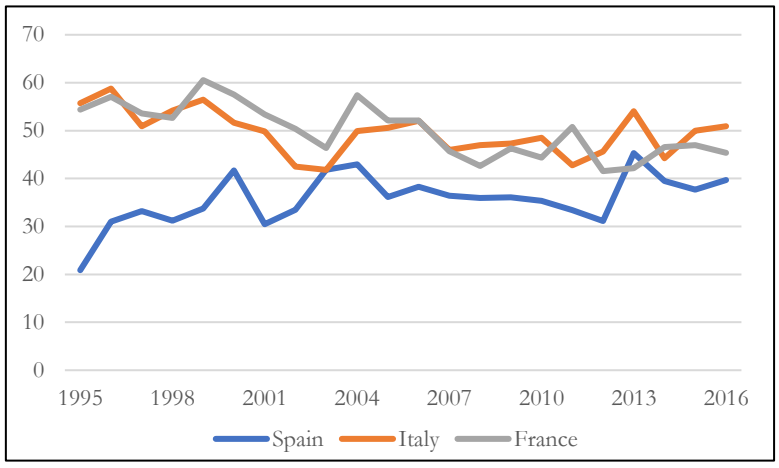
In conclusion, the global market of wine has experienced a globalization process that has led to a change in the dynamics occurring within it. The world has undergone a process of trade liberalization, backed up with agreements and associations such as GATT or WTO, thus enhancing exports (Barco Royo, 2018). New countries have joined to the production of wine, while at the same time there have been changes in demand. Concisely, a new environment for wine trade has arisen, in which international markets and competitiveness are essential.

2.2 Evolution of Spanish wine exports

2.2.1 General trends

Talking about Spain, the wine industry constitutes an important sector for its economy as shown by the following data provided by the International Organization for Vine and Wine (OIV, 2021): Spain is the first country worldwide in terms of vine-cultivated surface; the third in production, only behind Italy and France; and the first in volume exported. This last fact occurs thanks to being the biggest bulk wine exporter. In contrast, the same circumstance causes Spain to rank third in exports in value, with 2.9 billion euros, far behind France (9.3) and Italy (6.1).

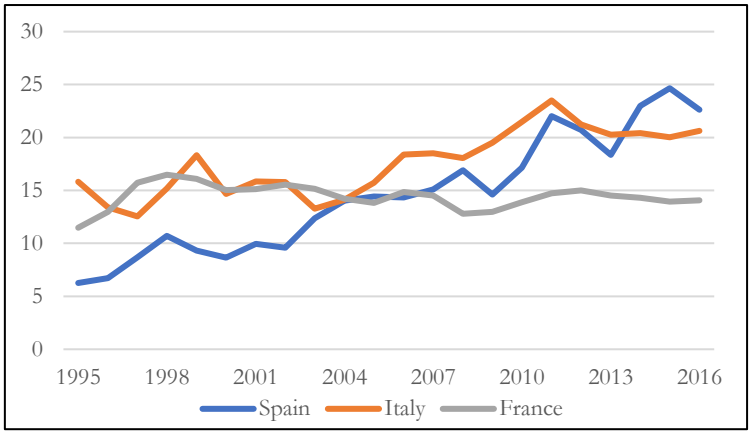
Figure 3: Wine production (million hl) in Italy, France, and Spain, 1995-2016



Source: Own elaboration based on data from International Organization of Vine and Wine *(OIV, 2021).*

The most remarkable trend regarding wine production is that of Spain **closing the gap** with France and Italy. It seems clear that, while Spain experiences a growing tendency, the other two countries are stagnated or even decreasing their production. However, all three countries suffer important year-by-year fluctuations, which could be due to wine's climate-dependance.

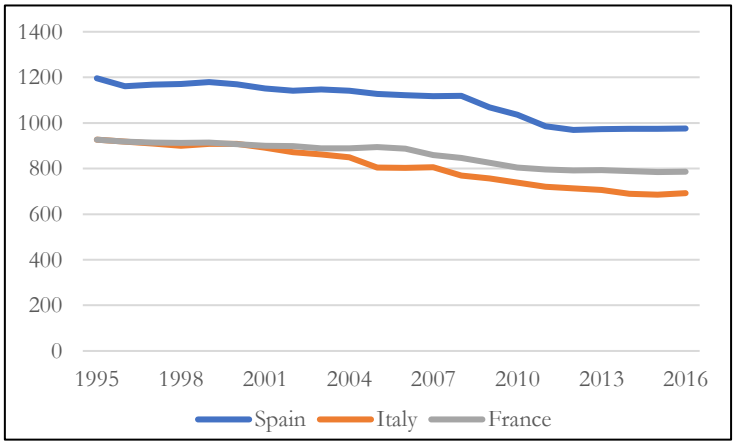
Figure 4: Wine exports (million hl) in Italy, France, and Spain, 1995-2016



Source: Own elaboration based on data from International Organization of Vine and Wine *(OIV, 2021)*.

Figure 4 shows how Spain has been able to **overcome** France and Italy in terms of volume exported describing an impressive evolution: in 1995 Spain exported around 6 million hectoliters of wine; already in year 2003, just eight years later, this number was doubled, exporting more than 12 million hectoliters. This trend has continued until nowadays, however, with some fluctuations probably due to the economic crisis suffered in 2008, year when Italy and France suffered a drop in exports – Spain's drop came in 2009 – followed by a recovery until 2011, and a further fall after that, when the tightest consequences of the crises emerged. In fact, only Spain was able to recover from 2013 to 2015, whereas Italy and, above all, France's wine exports, remained stagnated.

Figure 5: Wine-cultivated surface (1000 ha) in France, Italy, and Spain, 1995-2016



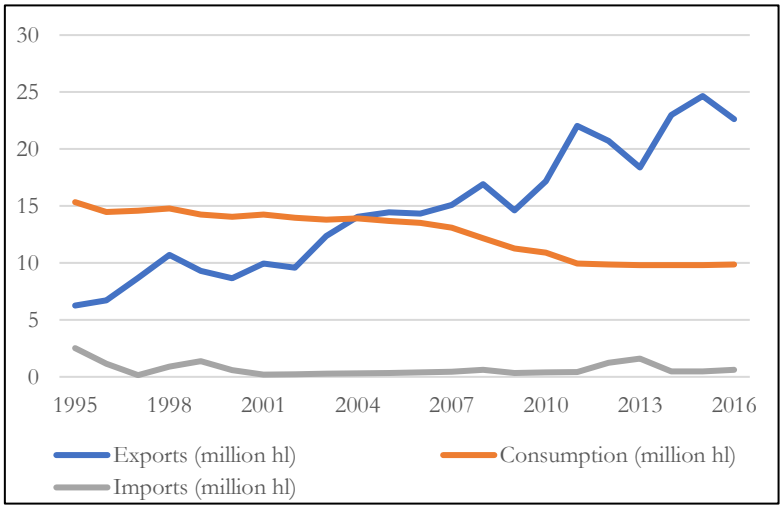
Source: Own elaboration based on data from International Organization of Vine and Wine *(OIV, 2021)*.

Finally, figure 5 represents the **falling surface** dedicated to wine cultivation. In relation with figure 3, and especially for Spain, which has shown a bigger increase in production than France and Italy, this tendency illustrates a higher productivity being achieved in the wine

sector, thanks mainly to mechanization processes. The fact of producing more, using less land, and with low imports and domestic consumption, as it will be presented in figure 6, could only mean one thing that has already been presented: international markets were gaining importance for Spanish wine. In the following lines this is explained in detail.

In general, the most notable trend in Spain, as remarked in the literature by López and Compés (2018), was the **intense growth of wine exports** both in volume and in value, allowing for a **positive trade balance** in this sector. Moreover, and in a similar way as the global market, Spain suffered a **falling wine consumption** in the period from 1970s to 2010s, what turned international markets into the biggest hope for the Spanish wine industry (López & Compés, 2018) – domestic wine consumption dropped by 55% in that period, while exports grew from 1.7 million hectoliters in the mid-1960s to 12.5 in the 2000s and 17.6 in 2010 (Medina-Albadalejo & Martínez-Carrión, 2012). The graph below (figure 6) illustrates how this trend evolved between 1995 and 2016. In addition, it provides a view on imports, showing their minimal relevance within the Spanish wine sector. As it can be observed, while exports have been multiplied by 3.5, consumption has decreased by around one third. On the other hand, imports have always remained at very low levels.

Figure 6: Wine exports, imports, and consumption in Spain (million hl), 1995-2016



Source: Own elaboration based on data from International Organization of Vine and Wine *(OIV, 2021)*.

Spanish exports growth was favored by its **specialization on low quality** wine, which has been in fact the biggest component of Spanish wine exports until the 2010s (Medina-Albadalejo & Martínez-Carrión, 2012). This trend had already started in the 1950s, with the country focusing on low expansive markets such as Western Europe, opposite to

France's previously explained specialization in high-value-added wines sold to more expansive markets such as the Anglo-Saxons. In fact, Spain failed with its strategy to approach these growing markets, selling cheap wines as imitations of French quality wines. However, Spain still kept a good position with **Sherry (Jerez) wines**, which accounted for around 50% of its exports in value. Even in the early 21st Century, Spain continued to be the biggest bulk wine exporter, targeting mainly traditional European markets – Italy and France – and Asian ones, especially China, which presented a growing demand for bulk wines without Geographical Indication (Medina-Albadalejo & Martínez-Carrión, 2012). In sum, even if Spanish exports have grown, they have done it less than French, with lower prices and, consequently, lower value (Fernández & Pinilla, 2014).

This growth of Spanish exports faced some **obstacles**. Already in the first half of the 20th century Spain had several problems in international markets: the growing demand from the UK made Spain **reduce the quality** of its wines, even selling falsifications of Sherry wines, damaging its reputation. In addition, France, which used to be an important market, had started to import wine from Algeria, a former colony with growing wine production; and other markets such as Argentina or Uruguay had imposed protectionist measures. Besides, the arrival of the **phylloxera** was a catastrophe for Spanish wine sector. Finally, after the recovery from this plague, **overproduction** problems appeared causing prices and rentability of wine activities to fall. (Fernández & Pinilla, 2014) But, focusing on the second half of the century, it was the **creation of the EEC** in 1957 what first harmed Spain – recall that the country did not enter until 1986. High tariffs plus the fact of important producers (France, Italy) being inside the EEC made Spain have to look for other markets, such as Eastern Europe or the Guinean Gulf, with lower incomes and which demanded cheap bulk wine. These markets at least allowed for Spanish exports to grow despite losing importance in traditional European markets. An additional problem was derived from yearly **fluctuations** within the growing trend of exports. First, because of demand variations due to economic and political crises in the 1970s; and second, because of wine production's aforementioned strong dependence on climate conditions. (Medina-Albadalejo & Martínez-Carrión, 2012)

So far, it can be said that the last decades of the 20th century were a challenge for Spanish wine exports. From 1970s, Old-World countries were posing a strong competition, and the addition of the **New-World** in the 1980s with more flexible policies in the wine sector hardened the situation. (Medina-Albadalejo & Martínez-Carrión, 2012) In fact, these countries' wines were easier to choose for non-expert consumers as mentioned in the

previous section, whereas Spanish ones, as well as French or Italian, in their seek for higher quality in the form of a reinforcement of "Denominaciones de Origen", became more difficult to understand (Castillo, Villanueva, & García-Cortijo, 2016).

On the other hand, the situation for Spain had changed with the **entry into the EEC** in 1986. Regulations, economic incentives for the readaptation of the sector, and greater visibility for the country allowed Spanish exports to grow and reorient to some extent towards better quality wines. But this topic will be introduced the next section, in which the situation of DO wines exports is presented.

Regarding the **destinations** of Spanish exports, they varied along time. As said before, the creation of the EEC made Spain shift towards Eastern Europe and the Guinean Gulf. However, after its entry in the EEC, there was a shift back towards European traditional markets. In addition to this, the GATT agreements together with the Common Agrarian Policy (CAP) favored the promotion and reconversion of the Spanish wine sector, being able to lower costs and be more competitive in terms of pricing (Castillo, Villanueva, & García-Cortijo, 2016). In sum, coming into the 21st century, 70% of Spanish wine exports continued to be destined to **Europe**. In this sense, France, Italy, and Portugal were the main ones in terms of volume, while Switzerland was the country losing more importance. Nonetheless, **USA** turned into one the most important markets for Spanish exports, and at the same time there was an intense demand growth from **Asian countries**, mainly Japan and China. (Medina-Albadalejo & Martínez-Carrión, 2012)

Finally, talking about the **composition** of Spanish exports, the specialization on **bulk wine** has already been highlighted. In fact, the mentioned authors remark that during the first decade of the 21st century the only segment experiencing an important growth was that of cheap, bottled table wine, followed by bulk wine, in spite of the improvement of DO wine exports since the 1980s. Bulk wine growth has also been encouraged due to the 2008 crisis, being able to increase its relative quota both in value and in volume (Medina-Albadalejo & Martínez-Carrión, 2012).

In conclusion, it can be said that Spanish wine sector performed relatively well during the second half of the 20th century and until nowadays, despite the numerous challenges. As previously noted, in a time of falling domestic consumption, exports grew in unprecedented ways: the participation of exports on total production increased from 20% in 2000 to 40% in 2009. In fact, already from 2004 on, exports have been higher than domestic consumption (see figure 6). (Medina-Albadalejo & Martínez-Carrión, 2012) In addition, Spain ranks

medium-to-high in terms of diversification of destinations; it is the best together with France in terms of adaptation to the demand; and it ranks medium in relative competitiveness, however, with a worrying reduction in important markets such as the UK, USA, Japan, and China (López & Compés, 2018). It is also troubling the low quality, low value added, and low price of its exports, what on the other hand has allowed for a growing volume exported, resulting in Spain turning nowadays into the first exporter in terms of volume.

2.2.2 "Denominación de Origen" wine: origin and evolution

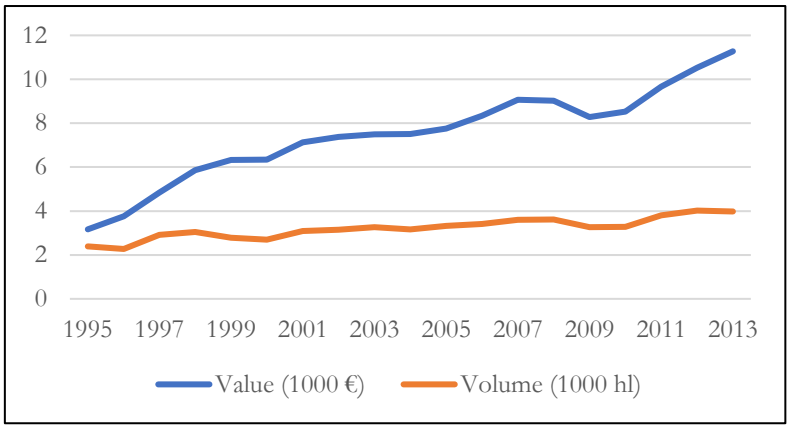
As mentioned before, bulk wine is the main component of Spanish wine exports. However, in the **1980s**, DO wines as well as table and bottled wines started to gain importance, favored by the entry in the EEC and the subsequent reorientation towards better quality wines (Medina-Albadalejo & Martínez-Carrión, 2012). This trend was enhanced by a change of demand in the direction of less consumption but higher quality (Fernández & Pinilla, 2014).

According to the aforementioned literature by Fernández and Pinilla (2014), the "Denominaciones de Origen" started to be created in 1930s, being the first one "Jerez" in 1933, followed by "Málaga" or "Rioja", among others. The problem was that, unlike France, in Spain there was **no strict quality control**, which led to the emergence of lower quality DO wines, so there was no clear differentiation between high and low-quality wines.

Following with the ideas of these authors, producing under a DO provided important export opportunities, what incentivized their creation: in 1963 there were already **16 DOs**, they covered around 55% of the total surface, and their wines amounted to 50% of total Spanish wine exports. Within DO wines, already in the 1990s, Rioja accounted for 40% of consumption of all DO wines.

As stated by Medina-Albadalejo and Martínez-Carrión (2012), in this last decade of the 20th century and the beginning of the 21st, DO wines had stopped increasing their sales relative to other types of wine; however, in absolute terms, their volume exported still grew from 1995 to 2013 and their value was multiplied by 3 in the same period (see figure 7). This converted DO wine exports into the main revenue source, within a good trend for quality wines, which amounted to 23% of exports in volume and 49% in value in the period 2000-2010. Nonetheless, these authors note that the aforementioned dynamics were stopped by the 2008 crisis, after which the consumption patterns changed in the direction of cheaper, bulk and table wines. Despite of this shock, some Spanish DO wines, more precisely "Rías Baixas", were still able to gain recognition in strong markets such as the USA. (Medina-Albadalejo & Martínez-Carrión, 2012)

Figure 7: Spanish DOC wine exports in volume vs in value, 1995-2013



Source: Own elaboration based on data from OEMV *(2014)*.

Finally, according to these authors, the growth of DO wines is directly related with the European orientation of Spanish exports. Countries within this market are demanding now more quality and are willing to pay higher prices, except the big producers – France and Italy. This is the case of the UK, the Netherlands, and Germany, as well the USA in the American market. Likewise, these wines have found markets in emergent economies such as the BRIC (Brazil, Russia, India, China), especially in China and Russia.

3. EMPIRICAL ANALYSIS

In this section, in order to pose the analysis and get insights about the behavior of Spanish DOC Rioja wine exports, and for the purpose of reaching enough accuracy, several relevant variables considered to affect wine international trade are introduced. These factors have been deduced from the aforementioned literature. At the end, when the model is developed, the results will illustrate which of these variables are actually statistically significant and, if so, whether they trigger a positive or a negative effect on wine trade flows.

3.1 International trade of wine: main determinants

Hereby, the main variables are described, grouped into economic, cultural and historical, and geographical. Regarding the sources used to obtain data for each of them, they are presented in table 1 within section 3.2.

3.1.1 Economic

a) ***GDPit* and *GDPjt***. The relevance of GDP – *real* GDP for the model – lies in the fact that it represents income, which is a key factor affecting export and, above all, import decisions. In fact, these variables are expected to have a positive *ceteris paribus mean causal effect* on trade flows – represented by *Xijt* – implying higher values of them will lead to higher values of *Xijt*.

b) **Wine export price (*Pijt*)**. It is another important aspect determining purchase and sale decisions. In this case, it should represent the price at which country *i,* that is, the exporting country, namely Spain, sells wine to country *j,* the importing country, in year *t.* The *ceteris paribus mean causal effect* that shall be expected form this variable is not clear: on the one hand, higher export prices might lead to lower trade flows since other countries would demand less; however, on the other hand, higher export prices represent an incentive for Spain to sell more abroad.

c) **Wine domestic price (*DPit*)**. This variable is in close relation with export price. If domestic price is lower than export price, there will exist a bigger incentive to export. Conversely, if domestic price is higher, this motivation is not that strong. In sum, a negative *ceteris paribus mean causal effect* would be natural for *DPit*.

d) **Nominal exchange rate (*ERijt*)**. It refers to the exchange rate between the currency of country *i* and the currency of country *j* in year *t.* In general, it will be relevant for destinations outside the Eurozone, some of which are becoming important for Spanish exports as explained in previous sections, but also for Eurozone countries in the period before the introduction of the Euro. In principle, a higher exchange rate will mean "*more of country j's currency*" for 1 unit of country i's currency. Consequently, a negative *ceteris paribus mean causal effect* of this variable might be expected, implying that higher exchange rates will lead to lower trade flows, given that the importing country would have to pay more for 1 unit of country i's currency.

e) **Production in origin vs in destination (*Qit* vs *Qjt*).** Wine production in origin is an important determinant of exports as it has been mentioned in the previous explanation. Higher production in origin represents an incentive for exporting, and even more if domestic consumption is decreasing. On the other hand, higher production in destination might cause the country to need less imports. However, recall that the wine sector presents an intra-trade industry, so that higher production may not necessarily be related to low imports. In conclusion, a positive *ceteris paribus mean causal effect* may result from *Qit*, whereas the one expected for *Qjt* is more uncertain.

f) **Consumption in origin vs in destination (*Cit* vs *Cjt*).** This variable plays a similar role to that of production but acting in an opposite way. Hence, higher consumption in origin reduces the incentive for exporting, while higher consumption in destination causes the country to demand more imports. In sum, a negative *ceteris paribus mean causal effect* shall be expected for *Cit*, whereas a positive one would arise for *Cjt*.

g) **Trade agreements (*Aijt*).** Whether countries are subject to a trade agreement or under the rules of a trade organization looks more like a political factor, however, with straight economic implications. When it comes to the model, for simplicity, this variable will be presented as a dummy taking value 1 if both country *i* and country *j* belong within a trade agreement or association in year *t* and taking value 0 otherwise. In consequence, a positive *ceteris paribus mean causal effect* is expected, implying that if an agreement exists, bigger values of *Xijt* will take place.

h) **Tariffs (*Tijt*).** Although related to trade agreements, in this case it refers to tariffs themselves. Hence, this variable will represent actual tariffs imposed by country *j* to country *i* in year *t* and affecting the wine trade. The *ceteris paribus mean causal effect* expected for this variable is negative. However, in the last decades, there has been a trend towards liberalization of trade, therefore tariffs are expected to be reduced in many of the analyzed countries.

Other economic-related factors affecting international trade of wine are, among others, the different marketing strategies applied by the country in terms of pricing, distribution, and differentiation; existing transaction costs; or the incentives and instruments to facilitate trade provided by institutions such as ICEX, ICO, or the Chamber of Commerce.

3.1.2 Cultural and historical

a) Hereby, an important factor is **Country risk (*CRjt*)**. Actually, this concept may include political, social, economic, and/or cultural components. Its values are normally presented in an eight-letter scale as follows: A1 (very low), A2, A3, A4, B, C, D, and E (extreme). For a good representation of the reality, in principle, a higher country's *j* risk in year *t* should be translated into lower trade flows, thus showing a negative *ceteris paribus mean causal effect.*

b) Additional cultural factors that should be taken into account might be whether the countries share the same **language** and/or **religion**, whether they have similar **consumption patterns**, or in general, whether **cultural affinities** are significant. For instance, the fact of wine being associated with good health and western lifestyles might be a determinant of its export possibilities to some countries. Also, the demand for higher quality wine instead of bulk wine might be affected by the culture or lifestyle. However, these factors are difficult to measure. (Castillo, Villanueva, & García-Cortijo, 2016)

Finally, as explained by Medina-Albadalejo and Martínez-Carrión (2012), an internationalization process is occurring within the wine sector, leading to an expansion of consumption habits to emergent countries which are now economically able to purchase this product. In this sense, the global context surrounding international relations may also play its role, as well as the experience and know-how regarding export operations that the country or the sector presents, which may provide the country with a comparative advantage.

3.1.3 Geographical

a) A central element for international trade is **Physical distance (*Dij*)**. It is so important since it has implications in others such as transport and transaction costs, or cultural affinity. In the model it will be measured in *kilometers*, more precisely, the kilometers separating the capital city of each country involved. This variable is expected to have a negative *ceteris paribus mean causal effect,* implying higher values of it would lead to lower values of *Xij*.
b) In relation to distance, another important factor is **transport costs**. To measure this variable, it should be taken into count the fact that the analysis focuses on DOC wine, which is mainly bottled, rather than bulk wine. Therefore, the main consideration should be how costly is it to ship bottled wine from country *i* to country *j* in year *t*. In general, transport costs are a barrier for international trade; however, they have been decreasing thanks to technological advances. For the purpose of our model, and given its close relation with distance, this variable will be consequently omitted.

This section should also include the appearance of new producers and consumers, as well as new areas of distribution in different parts of the world, as it was shown to be relevant in the wine sector in the time of the New-World rise. Moreover, location, and in relation to it, access to transport facilities such as airports or harbors might be also relevant. Finally, as mentioned before, country-risk shall be considered as presenting a geographical component, so that it could be included here too.

3.2 Database and variables

For the purpose of conducting an econometric analysis, a panel data should be created including the countries, years, and variables. To this end, data was gathered about some of these factors and others that are considered relevant for the study of DOC Rioja wine exports from Spain to the rest of the world. The main sources of information which have been used are presented in the table below:

Table 1: Sources of information

SOURCE	DATABASE	CITATION
CEPII Research and expertise on the world economy	"Gravity" database	(CEPII, 2021)
Grupo de criadores y exportadores de vinos de Rioja	Estadísticas de exportación	*(Grupo de criadores y exportadores de vinos de Rioja, 1995-2011)*
Grupo de empresas vinícolas de Rioja	Resumen anual de estadísticas	(Grupo de empresas vinícolas de Rioja, 2012-2019)
DataComex "Estadísticas del comercio exterior español"	DataComex	(Ministerio de Industria, Comercio y Turismo, 2021)
Gobierno de La Rioja	Agrarian Statistics	(Gobierno de La Rioja, 2019)
OEMV "Observatorio Español del Mercado del Vino"	Reports	(OEMV, 2014)
OIV International Organization of Vine and Wine	Statistics	(OIV, 2021)
The World Bank, Databank	Global Economic Monitor	(The World Bank, 2020)
	World Development Indicators	(The World Bank, 2021)
WTO World Trade Organization	Tariff Download Facility	(WTO, 2021)

Based on them, a database has been prepared, containing a time series from 1995 to 2019 for 36 different countries – in fact, the top-25 destinations of DOC Rioja wine exports for each year within the mentioned time period. The main reason for working with those countries is that, when looking for DOC Rioja exports statistics, data for the whole range of destinations could only be obtained from year 2012 to 2019; in contrast, data for the top-25 destinations was available for the entire time period considered in the analysis. In addition, with this selection it is ensured that the most representative destinations are included, providing also a wide-enough variety, ranging from United Kingdom, Germany, or Switzerland to United States, Japan, or China, to name a few – the whole list of countries is available in Appendix 1.

Regarding variables, the main ones presented before shall be included – excluding those for which appropriate data could not be found – as well as others provided by CEPII "Gravity" database and which are thought to be relevant. In sum, the panel data consists of 900 observations and 22 variables, presented in the table below with their original nomenclature.

Table 2: Variables of the panel data

	VARIABLE	DESCRIPTION	SOURCE
1	Year	Years from 1995 to 2019	*(CEPII, 2021)*
2	Contig	Dummy, 1 = Contiguity	
3	Dist_cap	Distance between capitals, in km	
4	comlang_off	Dummy, 1 = Common official or primary language	
5	Comrelig	Common religion index, values between 0 and 1	
6	col_dep_ever	Dummy, 1 = Pair ever in colonial or dependency relationship	
7	pop_o	Origin Population, total in thousands	
8	pop_d	Destination Population, total in thousands	
9	gatt_d	Dummy, 1 = Destination GATT membership	
10	wto_d	Dummy, 1 = Destination WTO membership	
11	eu_d	Dummy, 1 = Destination is an EU member	
12	wine_prod_o	Origin wine production, in 1000 hl	*(OIV, 2021)*
13	wine_prod_d	Destination wine production, in 1000 hl	
14	wine_cons_o	Origin wine consumption, in 1000 hl	
15	wine_cons_d	Destination wine consumption, in 1000 hl	
16	wine_price_o	Wine price in La Rioja, in EUR per L	*(Gobierno de La Rioja, 2019)*
17	wine_export_price	Wine export price, in EUR per L (until 2013), in EUR per KG (from 2014)	Until 2013: *(OEMV, 2014)* From 2014: self-calculation based on DataComex *(Ministerio de Industria, Comercio y Turismo, 2021)*
18	gdp_o	Origin GDP (constant 2010 US$)	*(The World Bank, 2021)*
19	gdp_d	Destination GDP (constant 2010 US$)	

20	Tariffs	Tariffs imposed to wine[4], in %. For simplicity only bound[5] average Ad Valorem duties are considered	*(WTO, 2021)* based on data from the Consolidated Tariff Schedules database (CTS).
21	rioja_exports	DOC Rioja wine exports, in 1000 hl	For years 1995-2011: *(Grupo de criadores y exportadores de vinos de Rioja, 1995-2011)* *For years 2012-2019: (Grupo de empresas vinícolas de Rioja, 2012-2019)*
22	exch_rate_euro	Destination exchange rate, "new LCU (extended backward) per EUR"	Self-calculation based on data from The World Bank *(2020)*

In general, the majority of the variables provides data for the complete time period and for every territory. Hereby, however, additional remarks about some variables are needed:

- Data regarding wine production and consumption both in origin and in destination could only be obtained for years between 1995 and 2016, which are the ones provided by OIV in its statistics site. Besides, these data are missing for some countries.

- The price of wine in origin refers in this case to the price received for 1 liter of wine in La Rioja. Data about domestic prices for the whole DOC Rioja, which includes some surfaces in Navarra and Rioja Alavesa, could not be found. However, since La Rioja accounts for around 70% of all wine produced within the DOC Rioja *(Consejo Regulador, 2019)*, and the three areas are geographically close and under the same DOC rules, these prices have been regarded as representative.

- Regarding the export price of wine, it includes data from different databases, as shown in the previous table. Data from OEMV refers to export prices from 1995 to 2013, expressed in euros per liter, and for "still" DO wines in general, with no individualized data for each DO being specified. Then, from 2014, information was taken from DataComex about DO exports in value (euros) and in volume (kilos), and price was calculated from that data just by dividing exports in value by exports in volume, so that obtaining export price represented in euros per kilo.

- The variable **exch_rate_euro** was created through a transformation of two previously existing variables: **exchange_rate_o** and **exchange_rate_d.** These variables referred to the amount of each country's local currency per 1$ – nowadays' local currency is considered,

[4] Wine in this case refers to: *"wine of fresh grapes, including fortified wines, and grape must whose fermentation has been arrested by the addition of alcohol, in containers of <= 2 l (excluding sparkling wine)"* as defined by the 6-digits TARIC code 220421.
[5] Bound tariffs represent *"the maximum Most-Favored-Nation tariff level for a given commodity line"*. (The World Bank, 2010)

extended backwards. With the newly computed variable, these two variables were transformed into one providing data on each country's local currency per 1€. More precisely, $\frac{\text{LCUj/1\$}}{\text{LCUi/1\$}}$ was computed, being LCUi the local currency of the exporting country, that is the Euro in Spain, and therefore LCUj/LCUi was obtained or, what is the same, LCUj/€.

- For simplicity, the variable "**Tariffs**" represents only bound average *Ad Valorem* duties, as mentioned in table 2. However, some countries do not pose AV tariffs, but rather other barriers. According to WTO (2021), this is the case of Afghanistan, Canada, the European Union, Georgia, Haiti, Japan, Kazakhstan, Kyrgyz Republic, Malaysia, the Republic of Moldova, Papua New Guinea, Samoa, the Kingdom of Saudi Arabia, Singapore, Solomon Islands, Switzerland, Tajikistan, Thailand, Ukraine, USA, and Yemen. Please, find the full table containing this information in Appendix 2. The main reason for using this measure is that it provides uniform data for every country, something that would not be possible if actual tariffs were considered. In addition, this variable is expected to be relevant since it represents the maximum level of tariffs that a country could impose, thus giving an idea of the existing risk derived from the fact that a country may rise its tariffs up to that level. Therefore, destinations with lower bound average tariffs should be the most appealing ones.

- Since Spain is part of GATT, WTO, and EU, the dummy variables referring to the membership of the destinations to these groups will be the ones considered in the model. Initially, the database included also those representing Spain's membership, but they always take value 1 for Spain.

- The variables for population of origin and destination are considered as another measure for the size of the countries, as done in augmented gravity models. In addition, they will serve to compute per capita values if needed.

3.3 The gravity model

For the analysis of DOC Rioja wine exports from Spain to the rest of the world, a gravity model will be elaborated, being a very useful tool in order to assess the most determinant factors affecting interregional and/ or international trade flows. The simplest form of this approach explains the trade flows between two countries in terms of the GDP of both countries and the physical distance between them. In this sense, the main underlying idea behind this method is the following: *trade flows between two countries will be bigger the larger these countries are and the smaller the physical distance between them is.* The equation characterizing this concept could be written as follows:

$$Xijt = \frac{GDPit * GDPjt}{Dij}$$

where *Xijt* represents the trade flows between country *i* and country *j* in year *t,* positively depending on *GDPit* and *GDPjt,* which are the Gross Domestic Products of country *i* – exporting country – and country *j* – importing country – *r*espectively in year *t*, and depending negatively on *Dij,* which is the physical distance between country *i* and country *j* – this variable does not need a time dimension, it takes a constant value during the different years instead. Other forms of the gravity model such us the "**Augmented Gravity Model**" might use additional variables to measure the size of the countries, including population and/or GDP per capita (Castillo, Villanueva, & García-Cortijo, 2016).

Regarding our model, it is elaborated using Stata software. The main objective is to assess the relevance and effects that the different variables present for DOC Rioja wine exports, thus constructing a **gravity model** for this variable. For this purpose, several regressions with various combinations of variables are performed, and its results are analyzed to evaluate which mixture is the most accurate one. More precisely, since panel data are being used, the Stata function to approach the model is **"linear regressions with panel data"**.

Prior to conducting the regressions, some variables are transformed, namely, by computing their natural logarithms (ln). This is done with three main objectives: 1) to provide for stability of the regressors; 2) to avoid the presence of extreme observations; and 3) to have every variable measured in the same unit. Hence, this is the case of GDP both from origin and destination, which give rise to ln_gdp_o and ln_gdp_d, respectively; distance, obtaining ln_dist_cap; or population both from origin and destination, resulting in ln_pop_o and ln_pop_d, among others. This explanation is included in order to get familiarized with the terminology that will be used when presenting the table of results.

Then, to start with, since the basis of the model is the gravity equation, the first regression explains DOC Rioja wine exports in terms of distance, Spain's GDP and importing country GDP. Hereby, the first step is to choose between a fixed-effects and random-effects model. For this purpose, the **Hausman test** compares the difference between the coefficients obtained with a fixed-effects model and with a random-effects model – recall, a difference for distance is not included since fixed effects cannot be computed for this variable. The null hypothesis of this test (Ho) is that those estimators do not differ significantly. If the null is rejected, it means that estimators actually differ, and a fixed-effects model is more efficient. In this case, as shown in the table below, the null was rejected, and thus fixed effects would

be more appropriate. However, due to using panel data, a fixed-effects model would not work well since the variable distance is constant for the whole time series included in the panel. Consequently, and given the relevance of distance for a gravity model, a random-effects model is used.

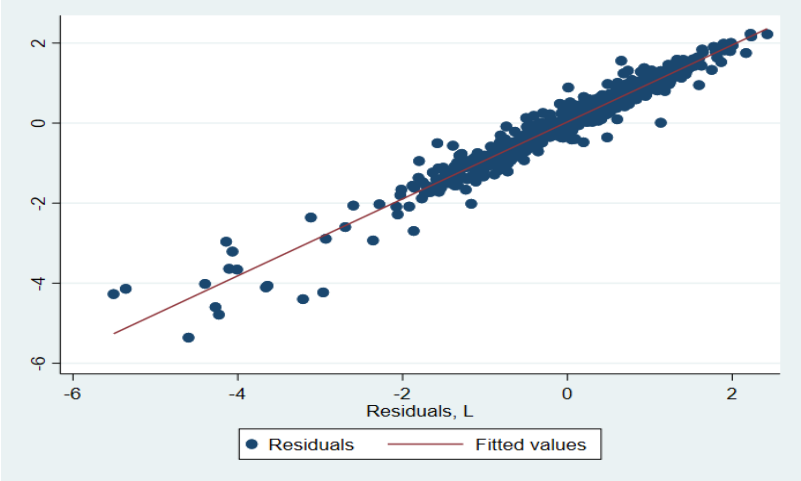
Table 3: Hausman test result

	Coefficients		
	Fixed	Random	Difference (F – R)
ln_gdp_o	-1.132052	-0.3130702	-0.8189818
ln_gdp_d	1.610912	0.8824462	0.7284655
Test Ho: difference in coefficients not systematic			
chi2 = 30.32			
Prob > chi2 = 0.0000 < 5% → reject Ho			

Source: self-computed with Stata

Two other aspects should be considered for the estimation of the model: autocorrelation and heteroscedasticity. For finding out whether **autocorrelation** takes place, the fixed-effects regression is performed again, and the residuals are predicted after that. Then, by means of a scatterplot relating residuals in *year t* and residuals in *year t-1* it can be observed if first order autocorrelation exists. As shown in the graph below, there exists an evident positive autocorrelation, as also signified by the 0.0436 value of the Durbin-Watson statistic. Recall that, when using the Durbin-Watson test, a value close to 0 or to 4 indicates correlation, while only a value close to 2 indicates that no correlation exists.

Figure 8: First order autocorrelation (t, t-1) scatterplot



Source: self-computed with Stata

Regarding **heteroscedasticity**, the Breusch-Pagan test can be used to check if it takes place. For that purpose, and following with the first regression attempt, DOC Rioja exports are regressed depending on GDP of the exporting country, GDP of the importing country, and distance between countries. After that, the test is conducted, providing the result presented in the table below. As it can be observed, the null hypothesis (Ho) is that the variance of the variables is constant, that is, homoscedasticity. In this case, since the p-value is lower than 5%, the null is rejected and therefore the conclusion is that heteroscedasticity exists.

Table 4: Breusch-Pagan test for heteroscedasticity

Test Ho: constant variance
Variables: fitted values of ln_rioja_exports
chi2 = 19.70
Prob > chi2 = 0.0000 < 5%

Source: self-computed with Stata

In sum, based on the insights gained in the previous discussion, a random-effects model will be estimated, assessing its coefficients by means of **Generalized Least Squares** (GLS), which is a suitable approach when autocorrelation and heteroscedasticity are present.

4. DISCUSSION OF RESULTS

The following table introduces a summary of the results obtained from the 11 regressions conducted combining 12 variables. For each variable and regression, the estimated coefficient and its p-value are presented, showing whether the variable triggers a positive or a negative effect on DOC Rioja wine exports (ln_rioja_exports), whether this effect is statistically significant or not and, if so, whether it is significant at a 10%, at a 5% or at a 1% significance level[6].

For a better visualization, those variables whose coefficients are significant and show the effect that was expected for them are highlighted in light red. On the other hand, variables which present a coefficient different to the expected one are highlighted in grey. In addition, the R-square coefficient for each model is presented in order to give an idea of how representative each of the conducted models is. A discussion of these results is conducted in the lines following the table.

[6] Coefficients being significant at a 10% significance level will be accompanied by a * symbol; those being significant at 5% will be accompanied by two ** symbols; and those being significant even at 1% will be followed by three *** symbols.

Table 5: Summary of results. Dependent variable ln_rioja_exports

	Regression									
Variable	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**9**	**10**	**11**
ln_gdp_o	-0.313 (0.070) *	-	-0.812 (0.019) **	-0.851 (0.014) **	-0.369 (0.042) **	-0.827 (0.089) *	-0.246 (0.135)	-0.252 (0.166)	-0.931 (0.151)	0.444 (0.461)
ln_gdp_d	0.882 (0.000) ***	-	1.634 (0.000) ***	1.702 (0.000) ***	0.933 (0.000) ***	0.814 (0.000) ***	0.741 (0.000) ***	0.908 (0.000) ***	0.711 (0.000 ***	0.662 (0.000) ***
ln_dist_cap	-1.065 (0.000) ***	-1.187 (0.000) ***	-0.203 (0.482)	-0.372 (0.251)	-1.222 (0.000) ***	-1.115 (0.000) ***	-1.083 (0.000) ***	-0.893 (0.002) ***	-0.855 (0.004) ***	-0.494 (0.577)
ln_pop_o	-	0.841 (0.012) **	0.109 (0.881)	0.032 (0.965)	-	-	-	-	-	-
ln_pop_d	-	0.451 (0.000) ***	-1.129 (0.000) ***	-1.138 (0.000) ***	-	-	-	-	-	-
comlang_off	-	-	-	0.681 (0.240)	0.622 (0.293)	-	-	-	-	-
wto_d	-	-	-	-	-	1.585 (0.000) ***	1.546 (0.000) ***	1.699 (0.000) ***	1.484 (0.000) ***	1.639 (0.000) ***
ln_wine_price_o	-	-	-	-	-	-	0.179 (0.001) ***	0.206 (0.000) ***	0.153 (0.033) **	-0.121 (0.440)
ln_exch_rate_euro	-	-	-	-	-	-	-	-0.077 (0.214)	-	-
ln_wine_cons_pc_d	-	-	-	-	-	-	-	-	0.704 (0.364)	0.178 (0.634)
ln_wine_cons_pc_o	-	-	-	-	-	-	-	-	-0.215 (0.172)	-0.132 (0.369)
ln_tariffs	-	-	-	-	-	-	-	-	-	-0.777 (0.078) *
R-square	**0.451**	**0.329**	**0.429**	**0.443**	**0.441**	**0.433**	**0.434**	**0.411**	**0.457**	**0.321**

First of all, as it can be observed in the table, the **procedure** was the following: first, a basic gravity model was estimated, including GDP of both origin and destination and the distance between countries; then, a second model similar to this was computed, but using population instead of GDP as a measure for the size of the countries; after that, both models were joined; and finally, different variables were combined in the model in order to check for their effects and significance.

So, focusing now on the results, the main conclusion is that the original gravity model worked in a different way than expected for all the regressions. While the coefficient for **GDP** of the destination country was positive and significant at 1%, confirming the initial hypothesis of the gravity model, the GDP of Spain caused an opposite effect to the one expected, being its coefficient negative and significant. A possible explanation for this outcome is that, when the GDP of Spain increases, people have more disposable income and thus increase domestic consumption. This would lead in the end to lower exports since the domestic market would be absorbing the supply. Regarding **distance**, its result is the one expected: a negative and significant coefficient at 1%, thus meaning that a longer distance between Spain and the destination country causes DOC Rioja wine exports to be lower.

Moreover, when conducting the model using **population** variables instead of GDP as a measure of the countries' size (regression 2), it is observed that the initial hypothesis of the gravity model is confirmed: the greater the size of both countries – represented by bigger populations – the greater the exports of DOC Rioja wine; and the greater the **distance** between the countries, the lower the exports. More precisely, taking into account that it is a regression of a variable in its logarithmic form depending on the logarithmic form of the regressors, the interpretation of that model could be as follows: a 1% increase in Spain's population leads to a 0.841% increase in DOC Rioja exports; a 1% increase in destination's population generates a 0.451% increase in exports; and a 1% increase in distance results in a 1.187% decrease in exports. In this sense, a model using logarithms both in the dependent variable and in the regressors provides insights on the *elasticity* of DOC Rioja wine exports related with the regressors included.

Another relevant remark is that, when joining the two models (regression 3), both distance and Spain's population, despite providing their expected effects – negative for distance and positive for population –, they lost their significance whereas Spain and destination's GDP remained significant and with the signs mentioned before. In addition, importing country's population started to show a negative effect, but being still significant at 1%. Apparently, no feasible explanation exists for this outcome. It might happen that a larger population in those

countries enhances their domestic consumption, but anyway it shall also increase their imports. Regarding the representativeness of the three commented models, the best score was attained with the original gravity model, providing a **R-square** coefficient of 0.451, or what is the same, 45.1% of changes in DOC Rioja exports being explained by changes in Spain's GDP, destination's GDP, and distance between countries. The model using population showed only a 0.329 R-square, while this last model combining the two previous ones resulted in a R-square of 0.429. Consequently, once this was discovered, the model including **population was not used anymore** after regression 4 since: 1) it tries to explain the same as the one with GDP but provides a lower representativeness, 2) it prevents distance from being significant, and 3) it gives strange results in terms of destination's population, thus not representing the reality accurately enough.

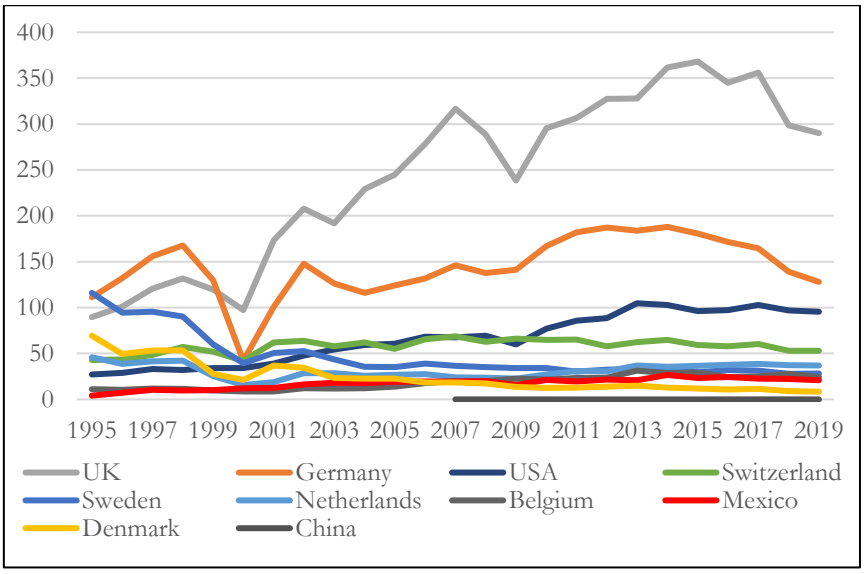
Following with the next regressions, variables related with cultural affinities were included in the model. Hereby, the first factor took into consideration was the existence of a **common official language** (comlang_off), which is the one that appears in the table of results, more precisely in regressions 4 and 5. This variable showed the expected effect, namely, positive, meaning that common language enhances trade flows between two countries. Nevertheless, its importance seemed not to be very high, since its coefficient was not significant in none of the tried models. In sum, and as signified by their R-square, these attempts did not improve representativeness in comparison with the original gravity model, but they did improve it if compared with the models using population instead of GDP. As an additional remark, other cultural variables such as having to some extent a common religion (comrelig) or the existence of a former colonial dependency (col_dep_ever) were also considered but not included due to not significant results. In consequence, common language was regarded as representative of this group of variables and was the only one shown in the table.

Next, and in a similar way, variables representing the membership to trade organizations or agreements were considered. For this group, the table presents the one showing whether the destination country belongs to **WTO** (wto_d). Hence, regression 6 provided the same results as those in the previous models for both GDP and for distance and showed that the importing country belonging to WTO contributes in a positive way to DOC Rioja wine exports. In fact, it not only triggers a positive effect, but also a relevant one, being its coefficient significant even at a 1% significance level in every model in which it was included.

The same could not be said about other two variables which were not included in the table: importing country belonging to GATT (gatt_d) or to the EU (eu_d), which deemed a negative and not significant coefficient. Both appreciations are difficult to explain as the

expected result was the opposite. However, it might happen that EU countries have a preference for French or Italian wines. In fact, as observed in the data from *"Grupo de criadores y exportadores de vinos de Rioja" (1995-2011)* and *"Grupo de empresas vinícolas de Rioja" (2012-2019)*, two out of the four biggest destinations for DOC Rioja wine exports, namely the United States of America and Switzerland, are not part of the EU, and a third one, namely United Kingdom, was still the first one in 2019 despite already knowing about the Brexit. Thus, the only country among the four biggest destinations which is still part of the EU is Germany. What is more, five out of the ten most important destinations during the analyzed period are nowadays outside the EU. The figure below illustrates this information:

Figure 9: Top-10 destinations for DOC Rioja wine exports



Source: own elaboration based on data from "Grupo de criadores y exportadores de vinos de Rioja" (1995-2011) and "Grupo de empresas vinícolas de Rioja" (2012-2019)

Following with the discussion of results, the next variables that were introduced in the model were those related with prices: price of wine in Spain (ln_wine_price_o) and exchange rate between the Euro and the importing country's currency (ln_exch_rate_euro). Hereby, export price of wine was not included due to lack of accuracy in the data derived from those reasons mentioned in section 3.2. Regarding the price of wine in Spain (regression 8), actually, the **price in La Rioja**, it presented a positive effect opposite to what was expected. In addition, its coefficient was significant at 1% or 5% in all the regressions in which it was included, except in the last one which will be commented at the end. A possible explanation for this result is that higher market prices in origin may encourage production, which will in turn, and under a circumstance of falling domestic consumption, trigger higher exports. Focusing now on the **exchange rate** (regression 9), it showed a negative effect, implying that an appreciation of the Euro relative to the other country's currency represents an impediment

for exports by making them more expensive. Nevertheless, the coefficient for this variable was not significant. In addition, an important fact took place in these models: the effect of Spain's GDP, even though remaining negative, was no longer significant after the introduction of these variables. Moreover, the representativeness of the models could not improve the one offered by previous attempts, showing a R-square of 0.411 in the model with both price in Spain and exchange rate.

In regression 10 two important variables were introduced: **wine consumption per capita in Spain** (ln_wine_cons_pc_o) and **in the importing country** (ln_wine_cons_pc_d). And with them, the most representative model was achieved, providing a R-square of 0.457, and thus implying that 45.7% of changes in DOC Rioja wine exports are explained by factors included in this model, namely, GDPs of Spain and destination country, distance between countries, WTO membership, price of wine in La Rioja, and the two newly added consumption variables. Likewise, both consumption per capita in Spain and in destination showed the expected effects: a negative effect for domestic wine consumption and a positive one for wine consumption in the importing country. Nevertheless, and in spite of providing the best model in terms of representativeness, none of these new variables resulted to be significant. In addition, as it happened in every regression including price of wine in La Rioja, the GDP of Spain was not significant.

Finally, **tariffs** (ln_tariffs) were added to the previous model in regression 11. When analyzing international trade flows, this variable is always expected to be relevant. And, in fact, that is the result that was obtained in this model. Tariffs presented a negative effect whose coefficient was significant at 10%, thus meaning that higher tariffs induce lower exports. Recall that this variable was defined as representing average bound *Ad Valorem* tariffs, which are only a maximum limit to tariffs. In consequence, it could be deduced that, in principle, a measure of actual tariffs would be even more significant. Other relevant remarks about this model are that: 1) the effect of GDP of Spain turned positive despite remaining not significant; 2) distance's coefficient, even though being still negative, was no longer significant; and 3) price of wine in La Rioja turned positive but also lost its significance. Opposite to them, WTO membership kept showing a positive and very significant coefficient, what seems to be logical with the introduction of tariffs. In this sense, it is interesting how the introduction of tariffs caused important factors such as distance or price of wine in origin become less relevant, while it enforced the importance of belonging to trade organizations. In sum, however, this model was the least representative among those shown in the table, providing a R-square of 0.321.

5. CONCLUSIONS

After having conducted the research, some concluding remarks can be drawn from the achieved findings. First of all, the complexity of the wine industry has been illustrated. It was observed how elements both from perfect competition – many small firms, lack of economies of scale, comparative advantage – and monopolistic competition – product differentiation – are present, giving rise to an **intra-industrial trade** structure characterized by two-way international exchanges of wine.

Focusing on the assessment of the main trends within the global and the Spanish market, which represents the first instrumental objective of this paper, the most important one is the unprecedented evolution of the wine sector. In fact, it is of great relevance the expansion of **international markets**, which have turned into the major engine for wine producers in a context of falling consumption and increasing production; however, at the same time this fact has heated the competence. In this sense, the globalization process with the entrance of the New-World producers meant a plot-twist in the dynamics within the sector, getting to change the *status quo*. In fact, it created the dichotomy between the Old World and the New World, being the latter able to compete in the mid-range wine segment and even show relatively high prices during some periods.

Regarding Spain, it is among the most important countries in the wine sector, in close competition with France and Italy, being the three most important wine producers and exporters worldwide. Hereby, it is noteworthy the positive recent dynamics experienced by **Spain** relative to these countries: from 1995 to 2016, Spain has been able to close the gap with them in terms of production; and it overcame Italy in the early 2000s and France in the 2010s regarding exports in volume. Moreover, Spanish wine exports surpassed domestic consumption back in 2004, providing again insights on the importance of international trade in a time of falling consumption, in a similar way as it was observed in the global markets. On the other hand, however, Spain still ranks behind France and Italy in exports in value given its specialization in low-quality, low-value-added, and thus low-priced wines. Nevertheless, this trend might improve with the growing importance of DO wines, which are the main source of value added for Spanish wine exports.

Talking about the methodology, several points shall be highlighted. First, focusing on the remaining **instrumental objectives**, the most relevant factors affecting the international trade of wine could be extracted from the analyzed literature, thus being able to build a complete picture in sections 3.1 and 3.2. Nonetheless, more difficulties appeared when

retrieving data for these variables in order to construct the panel data for the econometric analysis. Finally, knowledge about Stata software was self-acquired in order to develop this analysis in an appropriate manner.

Regarding the **main objective** of constructing a gravity model for DOC Rioja wine exports, the most representative model obtained got to explain 45.7% of the changes in DOC Rioja wine exports. This low value might be due to different reasons: 1) the aforementioned difficulties for gathering data probably caused some variables not to be defined in the most accurate way; 2) due to the previous fact, some factors such as export price or transport costs, which could have been important determinants, were not included in the regressions; 3) other factors including marketing strategies, consumers' knowledge, or countries' experience in international trade are difficult to measure in numerical values, whilst they may represent relevant aspects influencing trade flows. Adding these variables would have probably allowed to achieve a more representative model. Besides, the fact of including only the top-25 destinations for DOC Rioja exports – it actually exports to around 120 countries according to "Consejo Regulador DOC Rioja" (2019) – and considering just the 25-year period between 1995 and 2019 is another limiting factor when it comes to the representativeness of the models.

Nevertheless, important insights could be gained from the **results**. First of all, the point of Spain's GDP causing a negative and significant effect on DOC Rioja exports, in opposition to the positive effect that was expected from the gravity model hypothesis – larger GDP of both countries involved results in higher trade flows while larger distance leads to lower trade flows. Also, it could be proved that this hypothesis held true when using population instead of GDP as measure for the size of the countries. Other relevant results were that variables related with cultural affinity presented positive but not significant effects on trade flows; or that the exchange rate between the Euro and the importing country's currency caused a negative but not significant effect. In addition, wine consumption per capita in Spain and in the importing country presented negative and positive effects on DOC Rioja exports, respectively; however none of them was significant. On the other hand, it was found that, in a context of globalization, belonging to trade organizations such as WTO is of great importance in enhancing trade, while the introduction of tariffs plays an important role in preventing exports of DOC Rioja wine. In fact, the introduction of tariffs caused other important variables such as distance or Spain's GDP to lose its relevance within the model.

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7. APPENDIX

Appendix 1. List of countries

	COUNTRY	YEARS WITHIN TOP-25 DESTINATIONS
1	ANDORRA	1995-2011
2	ARGENTINA	1996
3	AUSTRALIA	2008 and 2011-2019
4	AUSTRIA	1995-2019
5	BELGIUM	1995-2019
6	BRAZIL	1995, 1997-2003 and 2008-2019
7	CANADA	1995-2019
8	CHINA	2007-2019
9	COLOMBIA	2012, 2016-2017 and 2019
10	CUBA	1995-1996
11	DENMARK	1995-2019
12	DOMINICAN REPUBLIC	1995-2004 and 2006-2019
13	FINLAND	1995-2019
14	FRANCE	1995-2019
15	*FREE PORTS*	*1995-2006 and 2009*
16	GERMANY	1995-2019
17	ICELAND	1995-1996, 1998-2005, 2007, 2013-2018
18	IRELAND	1995-2019
19	ITALY	2001 and 2003-2006
20	JAPAN	1995-2019
21	LATVIA	2016-2019
22	LITHUANIA	2009-2015 and 2018-2019
23	LUXEMBOURG	1995-2005, 2007 and 2010
24	MEXICO	1995-2019
25	NETHERLANDS	1995-2019
26	NORWAY	1995-2019

27	PANAMA	2016-2018
28	PERU	1999-2000
29	POLAND	2002-2003 and 2005-2019
30	PUERTO RICO	1995-2015
31	RUSSIA	1997-1998 and 2004-2019
32	SWEDEN	1995-2019
33	SWITZERLAND	1995-2019
34	TAIWAN	1997
35	UNITED KINGDOM	1995-2019
36	USA	1995-2019
37	VENEZUELA	1995-2002 and 2004-2006

Appendix 2. Bound tariffs (WTO, 2021)

Reporter	**Number of AV duties**	**Average of AV Duties**	**Number of Non-AV Duty**	**List of Non-AV Duties (for HS 6-digit codes only)**
Afghanistan	0	-	1	[Prohibited]
Albania	1	20.0	0	
Angola	1	55.0	0	
Antigua and Barbuda	1	113.0	0	
Argentina	1	35.0	0	
Armenia	1	15.0	0	
Australia	4	14.3	0	
Bahrain, Kingdom of	1	200.0	0	
Bangladesh	1	200.0	0	
Barbados	1	100.0	0	
Belize	1	100.0	0	
Benin	1	60.0	0	

Bolivia, Plurinational State of	1	40.0	0	
Botswana	3	73.0	0	
Brazil	1	55.0	0	
Brunei Darussalam	-	-	-	
Burkina Faso	1	100.0	0	
Burundi	1	100.0	0	
Cabo Verde	1	35.0	0	
Cambodia	1	40.0	0	
Cameroon	1	80.0	0	
Canada	0	-	11	[1.1$/ltr + 15%] [10.33¢/ltr] [11.31¢/ltr] [12.29¢/ltr] [13.28¢/ltr] [14.25¢/ltr] [15.24¢/ltr] [16.22¢/ltr] [17.20¢/ltr] [3.74¢/ltr] [9.35¢/ltr]
Central African Republic	1	30.0	0	
Chad	1	80.0	0	
Chile	10	25.0	0	
China	1	14.0	0	
Colombia	1	70.0	0	
Congo	1	30.0	0	
Costa Rica	1	40.0	0	
Côte d'Ivoire	1	15.0	0	
Cuba	1	40.0	0	
Democratic Republic of the Congo	1	100.0	0	
Djibouti	2	125.0	0	
Dominica	1	100.0	0	
Dominican Republic	1	40.0	0	
Ecuador	1	20.0	0	
Egypt	1	3000.0	0	

El Salvador	1	40.0	0	
Eswatini	3	73.0	0	
European Union	0	-	51	[1.75 €/% vol/hl] [13.1 €/hl] [14.8 €/hl] [15.4 €/hl] [15.8 €/hl] [18.6 €/hl] [20.9 €/hl] [32 €/hl]
Fiji	1	40.0	0	
Gabon	2	60.0	0	
The Gambia	1	110.0	0	
Georgia	0	-	1	[0.5 euro/lt]
Ghana	1	99.0	0	
Grenada	1	30.0	0	
Guatemala	1	35.0	0	
Guinea	1	40.0	0	
Guinea-Bissau	1	40.0	0	
Guyana	1	100.0	0	
Haiti	0	-	2	[Gourdes 1.35/Litre ou 40%] [Gourdes 2.10/Litre ou 42%]
Honduras	1	20.0	0	
Hong Kong, China	1	0.0	0	
Iceland	25	2.0	0	
India	1	150.0	0	
Indonesia	3	123.3	0	
Israel	1	148.0	0	
Jamaica	1	100.0	0	
Japan	0	-	2	[112yen/l] [15% or 125yen/l, whichever is the less, subject to a minimum customs duty of 67 yen/l]
Jordan	1	200.0	0	
Kazakhstan	25	12.5	26	[13 or 0.5 €/L whichever is the lower]
Kenya	1	100.0	0	

Korea, Republic of	3	30.0	0	
Kuwait, the State of	1	100.0	0	
Kyrgyz Republic	0	-	1	[0.15 US$ per litre or 10 percent, whichever is low]
Lao People's Democratic Republic	1	10.0	0	
Lesotho	1	200.0	0	
Liberia	1	30.0	0	
Macao, China	1	0.0	0	
Madagascar	1	30.0	0	
Malawi	1	125.0	0	
Malaysia	0	-	2	[1,200.00 RM per dal] [450.00 RM per dal]
Maldives	1	300.0	0	
Mali	1	60.0	0	
Mauritania	1	75.0	0	
Mauritius	1	122.0	0	
Mexico	4	38.3	0	
Moldova, Republic of	0	-	1	[0,5 Euro/l]
Mongolia	1	20.0	0	
Montenegro	53	48.9	0	
Morocco	11	34.0	0	
Mozambique	1	100.0	0	
Myanmar	1	385.0	0	
Namibia	3	73.0	0	
Nepal	1	100.0	0	
New Zealand	3	25.0	0	
Nicaragua	1	40.0	0	
Niger	1	200.0	0	

Nigeria	1	150.0	0	
North Macedonia	1	50.0	0	
Norway	1	0.0	0	
Oman	1	200.0	0	
Pakistan		-		
Panama	1	15.0	0	
Papua New Guinea	0	-	1	[6.00K/litre]
Paraguay	1	15.0	0	
Peru	1	30.0	0	
Philippines	1	45.0	0	
Qatar	1	200.0	0	
Russian Federation	51	12.5	0	
Rwanda	1	80.0	0	
Saint Kitts and Nevis	1	50.0	0	
Saint Lucia	1	100.0	0	
Saint Vincent and the Grenadines	1	100.0	0	
Samoa	0	-	1	[30% or SAT 2 per litre, whichever is the higher]
Saudi Arabia, Kingdom of	0	-	1	[Prohibited]
Senegal	1	30.0	0	
Seychelles	1	25.0	0	
Sierra Leone	1	40.0	0	
Singapore	0	-	2	[$70.00/LITRE OF ALCOHOL] [$9.50/LITRE]
Solomon Islands	0	-	1	[$15.00/l]
South Africa	3	73.0	0	
Sri Lanka	1	50.0	0	
Suriname	1	20.0	0	

Switzerland	0	-	7	[2.42 Fr./l] [2.45 Fr./l] [25.00 Fr./100 kg brut] [34.00 Fr./100 kg brut] [5.10 Fr./l] [50.00 Fr./100 kg brut]
Chinese Taipei	1	10.0	0	
Tajikistan	0	-	1	[0.5 € per L]
Tanzania	1	120.0	0	
Thailand	0	-	2	[54%, 18 B/Lt] [60%, 20 B/Lt]
Togo	1	80.0	0	
Tonga	1	20.0	0	
Trinidad and Tobago	1	100.0	0	
Tunisia	51	100.0	0	
Turkey	51	102.0	0	
Uganda	1	80.0	0	
Ukraine	0	-	1	[0.3 EURO/l]
United Arab Emirates	1	200.0	0	
United States of America	0	-	5	[16.9¢/liter] [19.8¢/liter] [5.3¢/liter] [6.3¢/liter]
Uruguay	3	35.0	0	
Vanuatu	1	40.0	0	
Venezuela, Bolivarian Republic of	1	40.0	0	
Viet Nam	4	50.0	0	
Yemen	0	-	1	[Prohibited]
Zambia	1	125.0	0	
Zimbabwe	1	150.0	0	