

# The European wine export cycle

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## Abstract

Europe is the world's largest wine-producing and wine-exporting region. In recent decades, fostered by the liberalization of international trade, the European wine industry has witnessed an acceleration in its exports, but this increase has been far from steady. It has fluctuated considerably in the short term, where periods of rapid growth have alternated with slow or negative growth. In this context, it is of particular relevance to know the temporal dynamics of the fluctuations in wine exports and to discover whether there are cyclical co-movements with the European wine export cycle. This paper analyzes the cyclical synchronization of wine exports for the ten main European wine-producing countries with the aggregate European wine export cycle since the inception of the European Economic Community. The main objective is to investigate whether there has been a “European” wine export cycle over the last six decades. The cycles of wine exports are obtained using detrending techniques, and Spearman's rank correlations and concordance indices are calculated to analyze the synchronization and interaction between cycles. The results for the exports, by value, revealed a strong degree of synchronization over the whole period for the majority of the countries, with a tendency to grow over time.

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## 1. Introduction

Over recent decades, the wine industry has experienced rapid globalization, with an impressive growth in the volume of exports as a percentage of world wine production (Anderson and Nelgen, 2011). The growth of the international wine trade has been fostered by the trade liberalization process. This is an outcome of the abolition of trade barriers through the establishment of integrated economic areas, of which the most relevant to the wine trade are the European Union (EU), the North America Free Trade Agreement (NAFTA), Mercado Común del Sur (MERCOSUR), and the Zealand Closer Economic Agreement (ZCERTA). The role of the World Trade Organization (WTO) in working towards a

general and progressive reduction of tariffs and more effective regulation of non-tariff barriers contributes to the expansion of the wine trade (Mariani et al., 2012).

The EU is the world's largest wine-producing and wine-exporting region. According to the data available in the Anderson and Pinilla (2017) database, since the inception of the European Economic Community (EEC) until 2016 the EU accounted, on average, for about 67% of the wine produced across the world, and represented 71% of the world's export markets. Motivated by the importance of the European wine industry over a long period of time, this paper analyzes and compares the wine export cycles from the ten most important wine-producing countries in the EU - Austria, Bulgaria, France, Germany, Greece, Hungary, Italy, Portugal, Romania,

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and Spain<sup>1</sup> - and considers how these cycles are synchronized with the European aggregate wine export cycle, for volume and value, in the 1957–2016 period. The cycles of wine exports are obtained using de-trending techniques, and Spearman's rank correlations and concordance indices are calculated to analyze the synchronization and interaction between cycles.

The main objective of the research conducted in this paper is to analyze whether (or not) there exists a “European” wine export cycle. This question is especially relevant for the trade policy applied to the wine sector. Divergent export trajectories pose difficulties in reconciling the very different interests of EU member states in negotiations of free trade agreements. A high degree of synchronization between national wine export cycles may reduce the effects of asymmetric shocks and make it easier for the EU to take action in order to reduce or eliminate trade barriers for the wine sector.

To explore the existence of a European export cycle and to examine how it has evolved over time, we apply the business cycle synchronization approach to the wine exports. The empirical research of business cycles has received particular attention since the pioneering work of Burns and Mitchell (1946). Through the contribution of these authors, it has become possible to define and characterize a business cycle. Subsequently, and building on this work, many studies have been produced concerning the dating, measuring, and synchronization of business cycles.

Within the broad literature that explores the topic of business cycle synchronization, from the middle of the 1990s a vast number of authors have investigated the existence of a European business cycle, with diverse conclusions depending on the data, the period, and the methods chosen.<sup>2</sup> Whereas several studies find evidence for a common European cycle (Massmann and Mitchell, 2004; Altavilla, 2004; Perez et al., 2007; Darvas and Szapáry, 2008), others cast doubt on its existence (Camacho et al., 2006; Mink et al., 2007).

For the wine sector, there is a substantial amount of literature that analyzes the world wine trade applying different perspectives and methods: (i) the gravity model is used to study the determinants of wine trade (Dascal et al., 2002; Castillo et al., 2016; Dal Bianco et al., 2016, Lombardi et al., 2016; Dal Bianco et al., 2017, Gouveia et al., 2018); (ii) the comparative advantage in international trade is applied to assess the export competitiveness of wine (Van Rooyen et al., 2011; Anderson, 2013; Anderson and Wittwer, 2013; Balogh and Jám bor, 2017); and (iii) the historical perspective is employed to analyze the dynamics of wine trade (Anderson, 2001; Ayuda et al., 2018).

As concerns the research about the identification of the cycles (and trends) in the wine industry, the book of Anderson (2015a), providing an economic and statistical analysis of the Australian wine sector's distinct cycles since the 1840s, has to be highlighted. Based in this study, Anderson (2015b)

discusses in detail what lessons of the past boom-bust cycles can be drawn to help Australia's wine industry return to a growth trajectory sustainable and less vulnerable to adverse shocks. In these works, the wine cycles were based in a comprehensive set of data of production, consumption, and trade over 17 decades and informed by several charts and tables, not comprising de-trending or econometric approaches. The few papers that involve the modelling of the trends and cycles of the wine trade include the regression analysis carried out by Labys and Cohen (2006) for the world wine market shares, and the application by Rebelo and Correia (2008) and Correia et al. (2015) of cycle–trend decomposition methods for Port wine time series.

This brief literature review shows that few studies examine the export cycles in the wine industry and that no one has expanded the knowledge about the cyclical synchronization of European wine exports, giving our paper an innovative contribution in this sense. Moreover, the identification of the characteristics of the European wine export cycle and the respective degree of synchronization may play an important role in anticipating fluctuations in wine exports, and could be an important tool for supporting the decision-making process of public and private organizations in the wine industry.

The remainder of this paper is organized as follows. After the introduction, the second section presents an overview of the global wine dynamics and of the European integration process. Section 3 analyzes the evolution of wine exports in the EU. Section 4 provides a description of the methods used in the empirical study and a discussion of the results. Section 5 concludes the paper, presenting the main results and policy recommendations.

## 2. Global wine dynamics and the European integration process

This section looks at some aspects of wine exports in the EU using as the main source the annual time series of the database recently published by Anderson and Pinilla (2017). We focus our analysis on the ten most important wine-producing countries in the EU (the EU10), which total of exports account for more than 95% of the EU wine exports: Austria, Bulgaria, France, Germany, Greece, Hungary, Italy, Portugal, Romania, and Spain. We start by providing an overview of the global wine production and exports in the period 1957–2016, emphasizing also the evolution of these variables in the “Old World” and the “New World”. Although different classifications of countries have been used, the Old World corresponds largely to the Western and Southern Europe, and in this study coincides with the EU10. Regarding the New World wine producers, we use the classification of Castillo et al. (2016) which split them into two groups: the Anglo-Saxon New World (NW\_AS) where the United States, Australia, South Africa, and New Zealand are included; and the Latin New World (NW\_L) with Argentina, Chile, Uruguay, and Brazil.

In the period considered (1957–2016) there was an overall increase in terms of volume of world wine production (Fig. 1).

<sup>1</sup> According to Anderson and Pinilla (2017), in the EU28 production ranking for 2016 Italy stood in the first position, then France, Spain, Germany, Portugal, Romania, Greece, Austria, Hungary, and Bulgaria.

<sup>2</sup> See, for example, De Haan et al. (2008) for a survey.

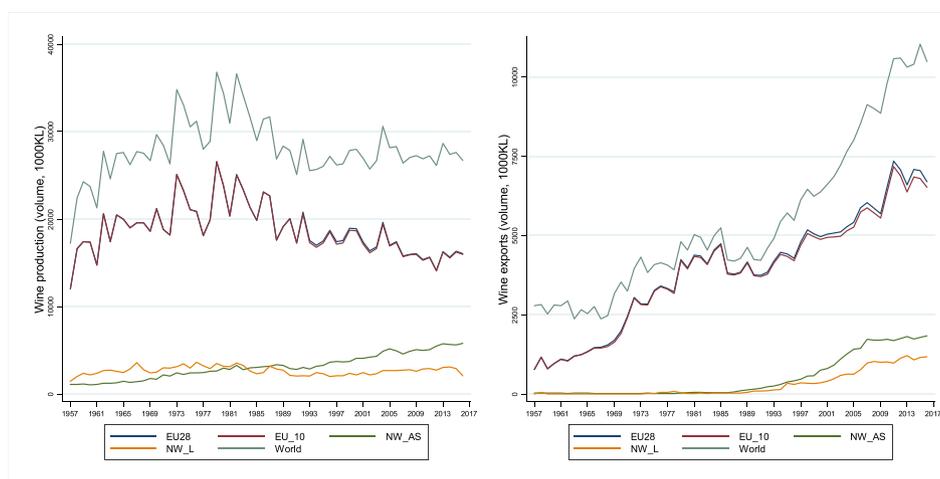


Fig. 1. Wine production and exports, by volume, 1957–2016.

In the 1970s and 1980s, the production levels were high in the world due to the contribution of the Old World. Subsequently, there was a reduction in the European countries production and an increase in the production of the New World countries belonging to the Anglo-Saxon group (NW\_AS). Thus, the share of global wine production of EU10 decreased from 70% in 1957 to around 60% in 2016, which contrasts with the evolution of the total share of the New World countries of 15–30% in the same period, with the Anglo-Saxon group accounting for over 20% of production in 2016 (Figure A1 in Appendix A).

In regards to the international trade of wine, the volume of wine exports increased significantly after the end of the 1980s when the countries of the New World, especially the Anglo-Saxon countries, began to take a growing role. In fact, European countries recorded a considerable increase in their share of global wine exports until the late 1980s, but then they lost international market share to the countries of the New World (Figure A1 in Appendix A).

The global wine export dynamics also contains the increasing phenomenon of re-export, i.e. exporting wine from one country where it previously imported. There are two

groups of re-export countries. The first group includes the re-export countries without domestic production of wine or with a production lower than their exports. In the EU, re-exports from this group of countries began to grow steadily in the 1990s, representing more than 3% of EU28 wine exports in 2015, with the United Kingdom, Netherlands, and Denmark being the most prominent countries. The second group includes the re-export countries that are large producing countries. [Mariani et al. \(2012\)](#) stress that Germany is probably the largest re-exporter of wine (according to official data for 2011) and that the statistics of world exports overestimate the true volume of wine traded internationally by 6% at the very least.

To present the wine export performance in the ten most important wine-producing countries in the EU, [Table 1](#) displays the average over the whole period of four indicators for each country: the share of wine exports among the EU10 wine exports, by volume and by value, wine exports as a percentage of the country's wine production, and wine exports as a percentage of the country's exports of merchandise.

The analysis of wine exports for the ten countries since the Treaty of Rome reveals the dominance of Italy, France, and Spain, which together represented 75.6% and 78% of the

Table 1  
Indicators of wine exports for ten EU countries, 1957–2016.

Country	Volume		Value	
	Share of wine exports among EU10 wine exports (%)	Wine exports as a share of the country's wine production (%)	Share of wine exports among EU10 wine exports (%)	Wine exports as a share of the country's merchandise exports (%)
Austria	0.6	11.8	0.6	0.1
Bulgaria	4.8	47.8	3.9	2.0
France	25.9	18.0	46.3	1.7
Germany	4.5	22.5	5.7	0.1
Greece	2.0	13.9	0.9	0.9
Hungary	3.4	27.4	2.9	1.1
Italy	31.0	23.0	21.3	1.0
Portugal	7.5	28.2	6.5	4.3
Romania	1.6	7.1	1.6	0.7
Spain	18.7	23.6	10.4	1.8
<b>EU10</b>	<b>100.0</b>	<b>21.4</b>	<b>100.0</b>	<b>0.8</b>

EU10 exports in volume and value, respectively, on average over the whole period. The wine exports from the EU10 represented, on average, 21.4% of the total wine production of the countries, but Bulgaria, Portugal, and Hungary exported more than 25% of their production. For the aggregate of the ten countries, wine exports represented, on average, less than 1% of their total exports of goods over the whole period. Portugal had the largest share of total exports of goods with, on average, 4.3%, followed by Bulgaria, Spain, and France, with percentages of 2%, 1.8%, and 1.7%, respectively.

These ten countries have been part of the EU since at least 2007, but the European integration process has gone through different phases since its inception in 1957, becoming both wider (from six to the present 28 Member States) and deeper (changing from a customs union to a monetary union). Thus, it is important to assess whether the trade agreements between the member states have influenced their wine export dynamics. We describe the main developments in the EU for the wine sector, with relation to the wine Common Market Organization (CMO), over six sub-periods: 1) 1957–1967; 2) 1968–1978; 3) 1979–1986; 4) 1987–1998; 5) 1999–2007; and 6) 2008–2016.

The first sub-period covers the first years of the EEC. Among the initial six members of the EEC, only three countries of the EU10, Germany, France, and Italy, are founding members but they accounted for 61.4% and 73.3% of EU10 wine exports in terms of volume and value, respectively. They adopted different pre-EEC wine policies: France's wine market was highly regulated and the French tariffs were higher than the Italian ones ([Newsletter on the Common Agricultural Policy, 1969](#)). Thus, the process of European integration required an integrated wine policy at the European level, which only happened later.

The second sub-period (1968–1978) covers the beginning of the customs union in the EEC and the pre-European Monetary System (EMS) period, with the breakdown of the Bretton Woods system and the subsequent period of generalized floating. The CMO for the wine sector was established in 1962 and the European Commission established a regulation in 1970 to complement it (Commission Regulation No 817/1970). At production level, rules were established, namely control of planting development, rules concerning oenological practices and processes, and specific provisions for quality wines produced in specified regions. Regarding trade, the regulation defined a price and intervention regime and a regime for trade with third countries, with common customs tariff, tax compensation, and export refunds.

The third sub-period (1979–1986) was marked by great stability of the functioning of the EMS, and includes the implementation of the Single European Market. Greece acceded to the EEC in 1981, while Spain and Portugal joined in 1986. During this sub-period some measures were taken to forbid new planting for still wine to reduce oversupply, which diminished the volume of wine production. At the same time, campaigns were launched to increase consumption, given that overall wine consumption in the EU had decreased since 1980.

The fourth sub-period (1987–1998) corresponds to the implementation of several proposals made in the Delors Report. In 1995 Austria joined the EU. Since the 1990s, the competition and imports from New World have grown, enlarged tariffs decrease following the agreements from Uruguay Round of the General Agreement on Tariffs and Trade (GATT) and the inception of WTO.

The fifth sub-period (1999–2007) covers the early years of the European Monetary Union (EMU) until the financial crisis. In 1999, major changes were introduced in wine CMO, such as removing the price regime and simplifying the distillation measures. The Eastern enlargement of the EU, which integrated several wine-producing countries into the EU (Hungary in 2004 and Bulgaria and Romania in 2007), accelerated conditions for reforms. Furthermore, in the discussion about the next CMO reform occurred in 2006, several players (EU wine industry, merchant organizations and the European Commission) agreed and obtained more power in their demand for less market intervention.

The last sub-period (2008–2016) embraces the financial and economic global crises and the subsequent sovereign debt crisis in Europe. Regarding the CMO reforms in 2008 and 2013 and their impact on wine trade, it is appropriate to highlight that additional measures were introduced, namely, the broad package of financial support for production and for marketing, being particularly relevant the “promotion in third countries” (Regulation N°1308/2013 of the European Parliament and of the Council). These measures assume more relevance, since the EU10, as shown in Figure A1 in [Appendix A](#), continuously lost its share of global wine production and, in a more pronounced way, of world wine exports.

### 3. Dynamics of wine exports in EU: some facts

To assess whether the European integration process changed the wine exports dynamic of the EU10, we analyze the wine exports growth rates for the six aforementioned sub-periods and compare them with the respective GDP and merchandise exports growth rates. It is important to note that, for value, the series that was used to calculate the growth rate refers to annual wine export data expressed in thousands of US Dollars at 2015 constant prices, over the 1960–2016 period. To convert the nominal prices into real prices, the consumer price index was employed as a deflator. Because some data were not available, we did not include Bulgaria, Hungary, and Romania, so the wine exports growth rates in value refers only to the other seven countries (the EU7). [Table 2](#) and [Table 3](#) show the average annual growth rates in wine exports for the six sub-periods, in volume and in value, respectively.

The first sub-period (1957–1967) is the one with the highest average GDP growth. The GDP growth rates were higher than the growth rates for merchandise exports, but both average growth rates were above 10% (Figure A2, in [Appendix A](#)). Given the favourable economic environment, almost all the countries, with exception of Austria (and Germany for value), recorded a positive average annual growth rate for wine exports. The highest increases, for volume, were

Table 2  
Growth in wine exports for ten EU countries (%), by volume, for sub-periods.

	1957–1967	1968–1978	1979–1986	1987–1998	1999–2007	2008–2016
Austria	−9.2	31.0	−27.7	<b>13.6</b>	<b>9.2</b>	<b>−3.1</b>
Bulgaria	15.4	3.4	−3.9	−2.2	<b>1.9</b>	<b>−12.9</b>
France	<b>6.2</b>	<b>7.9</b>	<b>6.8</b>	<b>1.9</b>	<b>−0.8</b>	<b>0.9</b>
Germany	<b>3.2</b>	<b>19.7</b>	<b>6.3</b>	<b>−1.5</b>	<b>5.1</b>	<b>0.1</b>
Greece	7.8	0.5	<b>0.6</b>	<b>−1.4</b>	<b>−5.7</b>	<b>1.0</b>
Hungary	12.1	9.0	−2.4	−4.1	<b>−3.0</b>	<b>0.5</b>
Italy	<b>3.7</b>	<b>16.3</b>	<b>−6.8</b>	<b>3.5</b>	<b>1.3</b>	<b>1.3</b>
Portugal	3.4	−5.4	<b>1.0</b>	<b>3.3</b>	<b>7.6</b>	<b>−0.4</b>
Romania	—	4.6	−6.8	5.3	<b>−8.1</b>	<b>−0.8</b>
Spain	6.0	3.7	<b>−2.3</b>	<b>7.7</b>	<b>6.7</b>	<b>4.9</b>
<b>EU7 (mean)</b>	<b>3.0</b>	<b>10.5</b>	<b>−3.2</b>	<b>3.9</b>	<b>3.3</b>	<b>0.7</b>

Note: The data regarding the member states of the ECC/EU is marked in bold.

Table 3  
Growth in wine exports for seven EU countries (%), by value, for sub-periods.

	1957–1967	1968–1978	1979–1986	1987–1998	1999–2007	2008–2016
Austria	−11.6	35.7	−26.7	<b>11.1</b>	<b>14.5</b>	<b>−2.0</b>
France	<b>6.0</b>	<b>11.1</b>	<b>−1.5</b>	<b>3.5</b>	<b>3.0</b>	<b>−2.3</b>
Germany	<b>−3.0</b>	<b>23.0</b>	<b>1.0</b>	<b>1.7</b>	<b>8.9</b>	<b>−2.3</b>
Greece	17.5	3.3	<b>−15.1</b>	<b>−7.3</b>	<b>−2.2</b>	<b>−0.7</b>
Italy	<b>4.9</b>	<b>11.6</b>	<b>−14.5</b>	<b>4.4</b>	<b>7.1</b>	<b>0.2</b>
Portugal	7.1	−3.8	<b>−15.0</b>	<b>−2.0</b>	<b>2.7</b>	<b>−1.7</b>
Spain	3.8	2.9	<b>−10.0</b>	<b>4.3</b>	<b>4.5</b>	<b>−0.4</b>
<b>EU7 (mean)</b>	<b>3.5</b>	<b>12.0</b>	<b>−11.7</b>	<b>2.2</b>	<b>5.5</b>	<b>−1.3</b>

Note: The data regarding the member states of the ECC/EU is marked in bold.

obtained by Bulgaria and Hungary and, for value, by Greece and Portugal. Thus, it was not the ECC countries (France, Germany, and Italy) that presented the highest rates of growth in wine exports.

In the sub-period 1968–1978, there was the highest average increase in merchandise exports (18%) and all countries recorded growth rates for merchandise exports higher than GDP growth rates, with the exception of Portugal (Figure A2, in the Appendix A). Similarly, all the countries increased their wine exports (both by volume and value), except Portugal. Austria and the three countries of EEC had very high wine exports growth rates (for volume and value).

The economic situation was less favourable in the sub-period of 1979–1986. Merchandise export growth rates were higher than GDP growth rates in all countries (except for France and Italy), and this was particularly evident in Greece, Spain, and Portugal (the three countries entering the EEC in this sub-period). In terms of volume, only France, Germany, Portugal, and Greece, all ECC countries, registered positive growth rates for wine exports. In terms of value and probably due to the less favourable economic environment, all countries registered negative growth rates for wine exports, with the exception of Germany. Austria presented the largest decrease in wine exports (in volume and value) due to the glycol scandal, which deeply affected Austrian wine exports after 1985.

There was an economic recovery in the fourth sub-period (1987–1998), when the average growth of merchandise exports was higher than the respective GDP growth. In terms of

volume, almost all the countries, except Bulgaria, Germany, Greece, and Hungary, registered positive growth rates for wine exports. It should be noted that Bulgaria also had negative growth rates in GDP and merchandise exports (Figure A2, in Appendix A). In terms of value, all the countries, except Greece and Portugal, recorded positive growth rates for wine exports. Unlike the previous sub-period, Austria showed the highest growth rates of wine exports (in volume and value) in this sub-period, which covers the Austria's entry into the EU in 1995 and coincides with the end of the glycol scandal. As documented by Stöckl (2006), in reaction to the glycol scandal, structural changes in the Austrian wine industry's practices were introduced, namely the move from production of cheap sweet wines in large quantities to better quality standards at higher prices.

From the beginning of the EMU to the financial crisis, economic expansion intensified with average growth rates of GDP and exports of goods exceeding 10%. All countries had an increase in wine exports in value, with the exception of Greece, which also exhibited a negative wine growth rate in volume, as did Romania, Hungary, and France. All the other countries, with the exception of Portugal and Spain, showed higher wine export growth rates in value than in volume, which could be related to the growing trend in demand for wines of a higher quality and which are more expensive.

The last sub-period (2008–2016) is a period of economic crisis: all of the countries registered negative GDP growth rates and only four of them showed positive growth rates for goods exports: Bulgaria, Greece, Spain, and Romania

(Figure A2, in the [Appendix 1](#)). Over this most recent period, the volume of wine exports increased in six of the EU10, while the value of wine exports decreased in all the countries, except Italy. Comparing the growth rates of wine exports in terms of volume and value in EU7, we conclude that the average growth rate is positive in volume and negative in value.

Summing up, from the results of this section it is not possible to establish a direct correspondence between the evolution of wine exports in the different countries and the main historical milestones of the integration. However, the process of European economic integration has coincided with an increase in wine exports as a share of the countries' wine production. Furthermore, by both volume and value, Spain, Italy, and France lead the wine exports in the EU. Spain is the country that loses the most weight when we go from analyzing exports by volume to analyzing exports by value. Conversely, France improves its relative position for the value of exports. It is important to highlight that there was an increase in wine exports in value greater than the respective growth of exports in volume in the three sub-periods with greater increase in exports of goods, which suggests that a global economy more favourable to international trade favours price adjustments in wine greater than the respective adjustments of quantities.

#### 4. Synchronization of wine export cycles

In this section, we present and analyze the dynamic pattern of the wine export cycles of the most important wine-producing EU countries and their synchronization with the European aggregate cycle. The original data used are the same as those mentioned above and come from the [Anderson and Pinilla \(2017\)](#) database.

##### 4.1. Methods

The methodology followed to estimate the cyclical synchronization is based on the decomposition of the wine exports logarithm time series into trend and cycle components. In the definition of the cyclical component we adopt the deviation-cycle concept proposed by [Lucas \(1977\)](#), i.e. the fluctuations of a series (in logs) around the underlying stochastic trend. To extract the cyclical component, and since it may depend on the de-trending procedure ([Canova, 2007](#)), in order to allow us to check the robustness of our results, we use two of the most widely applied techniques: the [Hodrick and Prescott \(1997\)](#) filter, hereafter referred to as the HP filter, and the [Baxter-King \(1999\)](#) band-pass filter, hereafter referred to as the BK filter.<sup>3</sup>

In brief, the HP filter assumes that, for a time series ( $y_t$ ), a stochastic and smooth trend ( $g_t$ ) can be determined by minimizing the changes in the trend over time and the stationary cyclical component ( $c_t$ ) is obtained, by definition, making the

difference:  $c_t = y_t - g_t$ . The computation of  $g_t$  comprises the choice of a parameter  $\lambda$ , which determines the respective smoothness. When  $\lambda = 0$ , there are no cyclical fluctuations ( $y_t = g_t$ ), as  $\lambda$  increases the trend become smoother and for  $\lambda \rightarrow \infty$ , it becomes a linear trend. In this paper, we set  $\lambda = 6.25$ , which is a customary value among business cycle researchers using annual data ([Ravn and Uhlig, 2002](#)). The BK filter belongs to the class of band-pass filters that are intended to eliminate both high and low frequency oscillations in the data, which is an advantage given that the majority of the other filters leave or exaggerate the amount of variability present at high frequencies ([Canova, 2007](#)). Moreover, the band-pass filters are attractive because they preserve the fluctuations in a specific range for its duration, making the notion of business cycle operational. Following the suggestion of [Baxter and King \(1999\)](#), we have configured the BK filter to extract fluctuations lasting between one-and-a-half and eight years.

The results obtained from the application of both filters are qualitatively similar. For this reason, and because the BK filter is preferable from a theoretical point of view ([Stock and Watson, 1998](#)), for the sake of brevity the focus in the following analysis will be on the outputs generated using the BK filter.<sup>4</sup> Figure A3 and Figure A4 in the [Appendix A](#) display the cycles of the wine exports by volume and by value, extracted by the BK filter, with solid and dotted lines representing the cycles of each individual country and the EU aggregates, respectively.<sup>5</sup> Visual inspection of the graphs reveals a great heterogeneity of situations, mainly in terms of the amplitude of the cycles for volume, a lower cyclical dispersion for the exports by value, and, in general, a decreasing amplitude of the fluctuations after the 1980s. The exceptions are Bulgaria, Hungary, and Portugal, which exhibit a cyclical volatility more pronounced in their volume of wine export in that period. Moreover, we can observe an apparently greater association with the aggregate cycle for the wine export cycles for value than those for volume. However, we cannot objectively conclude anything about the magnitude of the (a)symmetry of the fluctuations and how this evolves over time. For this purpose, we have to compute adequate statistics for the volatility and synchronization of the wine export cycles.

To measure the volatility, the standard deviations of the cycles are calculated, and to find the degree of synchronization between the wine export cycle of each country and the European aggregate (with and without the specific country), for volume and for real value, Spearman's correlation coefficients and concordance indices are computed.

The Spearman's correlation ( $\tau_s$ ) describes the degree of association between pairs of time series ( $x$ ,  $y$ ), assuming a value in the interval [-1; 1]. This correlation is similar to the Pearson correlation, but while Pearson's correlation assesses linear relationships, the Spearman's correlation has the advantage of not requiring the data to be normally distributed.

<sup>3</sup> The literature suggests several techniques for de-trending, of which the HP and BK filters are the most widely used. See [Canova \(2007\)](#) for a useful survey and discussion.

<sup>4</sup> The results obtained with the HP filter are available from the authors upon request.

<sup>5</sup> As the values are all in their natural logarithmic form, the units of the cycle correspond to percentage deviations from the trend growth paths.

In our case, for each country under study, we calculated the Spearman's correlation coefficients (contemporaneous, with leads and with lags) between the respective cycle and the European cycle. We considered a window encompassing a maximum of two years of leads and lags, and we chose the maximum correlation of the five correlations. Specifically, we defined  $\tau_s(x_{t+i}, y_t)$  as the correlation between the wine export cycle of each country  $x$  and the European cycle  $y$ , where  $i$  was an integer in the range  $-2 \leq i \leq 2$ . If the maximum correlation is obtained for  $i = 0$  the cycles have a contemporaneous co-movement, a positive (negative) value for  $i$  means that the cycle of each country lags (leads) the European wine export cycle by  $i$  years.<sup>6</sup>

The concordance indices show periods in which two time series are in the same cyclical phase. They are based on binary series (0; 1) for each country  $x$ , termed  $S_x$ , in which the unit represents the expansion periods (above the trend) and the zero represents periods below the trend. Since the indices of concordance were introduced by [Harding and Pagan \(2002\)](#), they have been increasingly used in the literature as a complement to the correlation coefficients. The level of agreement between two countries  $x$  and  $y$  ( $IC_{x,y}$ ) is given by the following expression:

$$IC_{x,y} = T^{-1} \left\{ \sum_{t=1}^T (S_{x,t} S_{y,t}) + (1 - S_{x,t})(1 - S_{y,t}) \right\}$$

Since we are interested not only in the degree of cyclical association but also on its evolution over time, we also computed correlation/concordance coefficients for rolling periods of 12 years.

#### 4.2. Empirical results

In terms of volatility, the standard deviation of the cycles confirms the lower dispersion of the cycles for value observed graphically in almost all countries, with exception of France and Germany that increased slightly ([Tables 4 and 5](#)). By volume, the wine exports of Germany and France present the lowest fluctuations, contrasting with Romania, Greece, and Austria, which display the highest cyclical dispersion (above 30%). For value, Germany, Italy, and Portugal have the lowest values, whereas Austria (23%), followed by Greece (15%), shows the greatest volatility.

As regards the synchronization, the correlation coefficients and the concordance index for the whole period for wine exports by volume ([Table 4](#)) reveal, in general, a lower cyclical association with the European cycle for the majority of the countries, with Italy and Spain being the only countries to display a strong correlation (0.7 and 0.6, respectively) with the EU cycle. The largest value for the concordance index is that for Italy, indicating that Italy and the EU are in the same cyclical phase 77% of the time.

<sup>6</sup> For a detailed exposition of the interpretation of correlation coefficients, leads and lags, see, for example, [Sørensen and Whitta-Jacobsen \(2010\)](#).

Table 4

Measures of volatility and synchronization for wine exports, by volume, 1957–2016.

	Standard deviation	Correlations		Concordance index
		EU10	Lags/leads	EU10
Austria	34	0.17	−2	0.37
Bulgaria	14	0.33***	0	0.58
France	9	0.26**	0	0.33
Germany	7	0.19	0	0.57
Greece	35	0.25**	0	0.55
Hungary	13	0.20	0	0.55
Italy	12	0.70***	0	0.77
Portugal	11	0.22*	0	0.52
Romania	44	−0.29**	2	0.52
Spain	15	0.59***	0	0.67

\*\*\* denote significance at the 10%, 5% and 1% levels, respectively.

Because comparisons between the cyclical movements of the largest European wine producers/exporters and the European wine export cycle suffer from the obvious bias that those countries contribute significantly to the fluctuations in the EU10 aggregate, we also calculate the correlations between the wine export cycles of each country and the aggregate cycle (EU10) without this country ([Table B1](#), in the [Appendix B](#)). For the whole period, when considering the aggregated cycle without the particular country, the coefficients lose significance for Italy and become weak for Spain.

In order to understand the evolution of the degree of synchronization, we calculate the rolling correlation coefficients ([Fig. 2](#)) and the rolling concordance indices ([Figure A.5](#) in the [Appendix A](#)) for the wine export cycle, as well as a linear trend fitted to the sequence of correlations/concordances. Overall, the sequential analysis of the period from 1957 to 2016 suggests that the patterns of synchronization are particularly idiosyncratic, as they feature large oscillations and an overall low level. The cycles for Austria, Italy, and Spain exhibit a declining trend, which is more pronounced in the case of Austria.

For this last country, an abrupt fall in their correlations with the European cycle is also perceived after the 1980s, remaining strongly negative since the middle of the decade, which reveals a contra-cyclical behaviour. As was mentioned before, in 1985 the Austrian wine glycol scandal occurred,

Table 5

Measures of volatility and synchronization of wine exports, by value, 1960–2016.

	Standard deviation	Correlations		Concordance index
		EU7	Lags/leads	EU7
Austria	23	0.44***	0	0.72
France	10	0.91***	0	0.93
Germany	9	0.65***	0	0.77
Greece	15	0.40***	0	0.70
Italy	9	0.76***	0	0.79
Portugal	9	0.85***	0	0.77
Spain	10	0.81***	0	0.83

\*\*\* denote significance at the 10%, 5% and 1% levels, respectively.

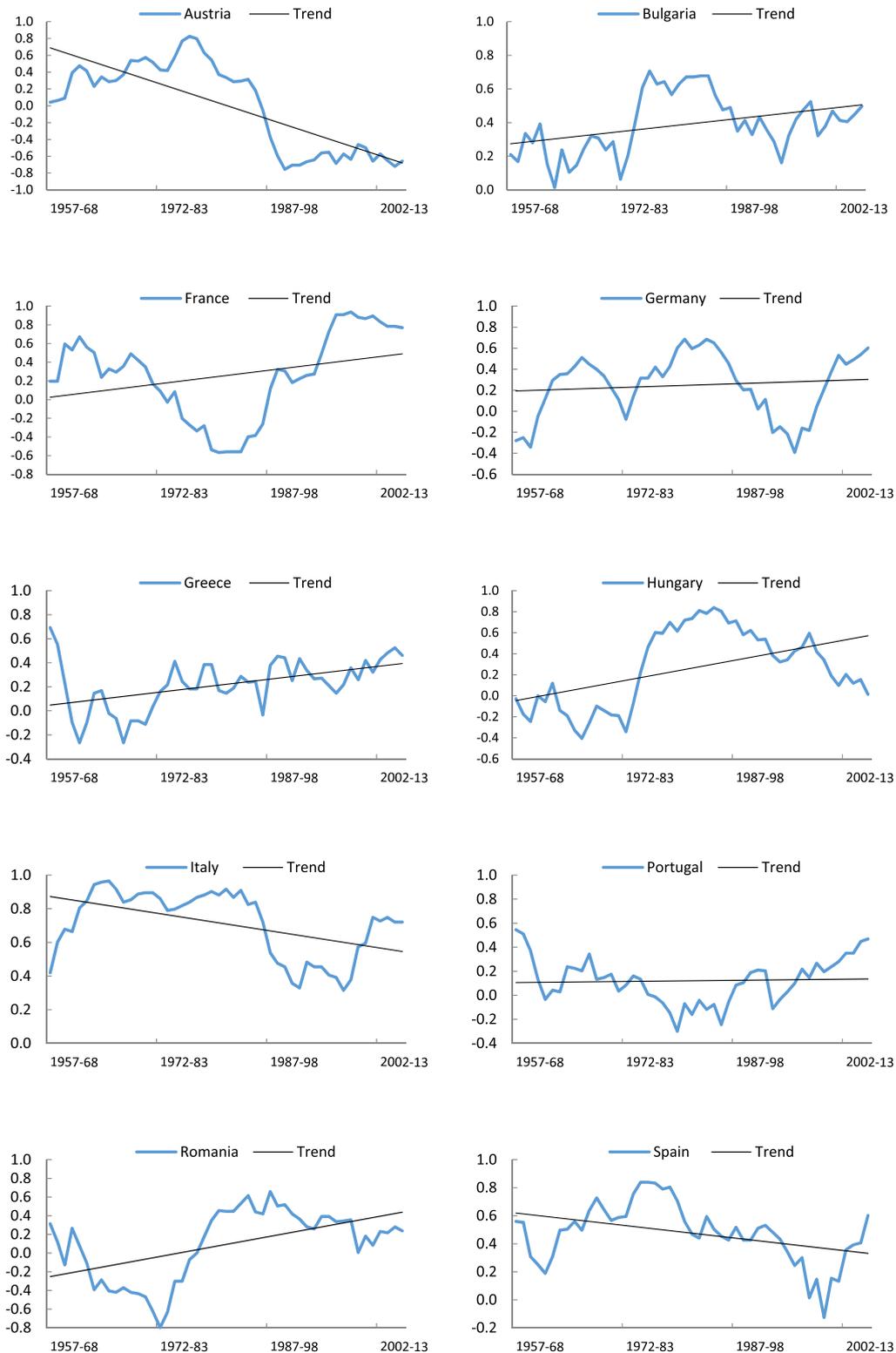


Fig. 2. Rolling correlation coefficients for individual export cycles with the EU10, by volume.

which implied dramatic changes in the respective exports and serious damages to the reputation of the wine industry for more than one decade. As much Austrian wine was at this time sold to the German market (Austria's largest customer) in bulk, the image of Germany's wine industry was also negatively

affected. This fact could be an explanation for the strong decrease and the negative German correlations in the mid-1980s and 1990s. Also noteworthy is the growth and the higher value of the correlations for the Eastern European countries - Bulgaria, Hungary, and Romania - in the 1980s and

early 1990s. This may be related to the collapse of the communist regime that led to a vinicultural uprising, namely a substantial growth of investment in the vineyards.

The results for the series by value (Table 5) suggest a great difference from the evidence obtained for the exports by volume. All the countries display a significant degree of association with the European wine cycle, and for the majority of them this is very strong (above 0.75). France, Portugal, Spain, and Italy display very strong correlations with the aggregated wine cycle; they are followed by Germany with a high association, and then Austria and Greece with moderate values. We also observe that the countries with the highest correlation with the EU7 also have wine export cycles with high concordance indices.

Moreover, from the analysis of the evolution of synchronization (Fig. 3) an interesting phenomenon can be observed:

all the countries exhibit a clear upward trend in their rolling correlations over time. However, an accentuated decrease is noticeable in the correlations of Austria and, in a smaller extension, of Germany in the period coincident with the effects of the Austrian glycol scandal. In fact, after experiencing a strong degree of association until the 1980s there is a fall to near zero in that decade, suggesting decoupling cycles from the European cycle. The correlation's behaviour changes after then, with the higher and increasing values reflecting the recuperation from the glycol incident. The rolling concordance indices (Figure A.6, in Appendix A) show results that are broadly consistent with those for the rolling correlation coefficients.

One possible explanation for the observed higher cyclical synchronization in value than in volume over time is related with the process of European integration that has been

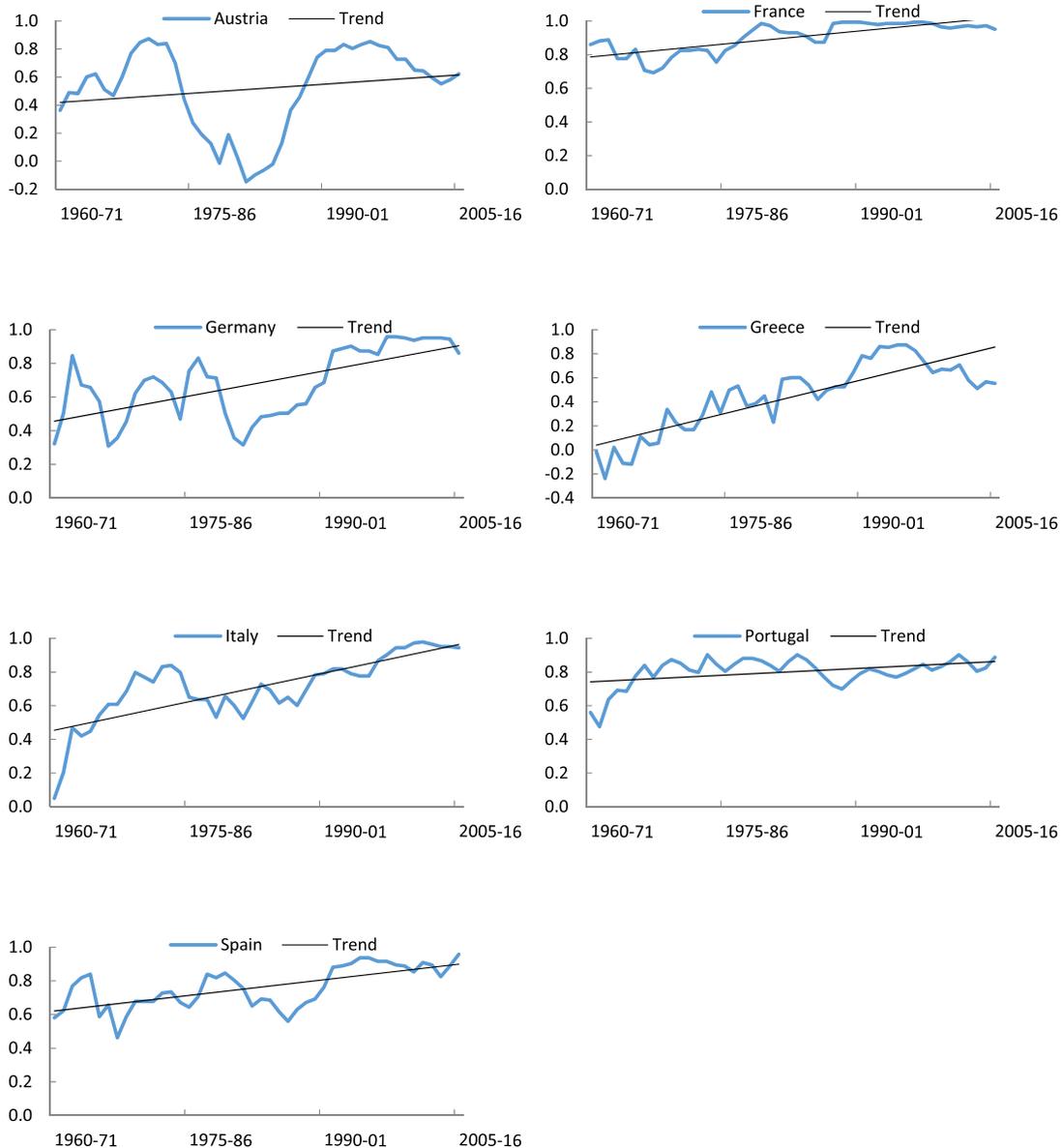


Fig. 3. Rolling correlation coefficients of individual export cycles with the EU7, by value.

accelerated since the mid-1980s, with the signature of the Single European Act (in 1986), the completion of the internal market (in 1993), and the introduction of a common currency (in 1999). Indeed, the dynamic measures of synchronization (rolling correlation and rolling concordance) show a greater and rising association between the fluctuations of each individual country and the European aggregate became more pronounced after the creation of the euro, the monetary unit in which all wine prices are expressed.

## 5. Conclusion

In some EU countries, wine has been an important part of agriculture for a very long time. The evolution of wine exports is closely related to changes in domestic economic conditions, as well as changes in the international markets. Over recent decades the world has experienced an important acceleration in the process of internationalization, which has affected all sectors of activity. The European wine industry is no exception.

The analysis of several indicators related to wine export performance for the ten most important wine-producing countries in the EU over the six most relevant phases of the European economic integration process since the inception of the EEC reveals that the deepening of European integration was accompanied by an increase in wine exports as a share of countries' wine production. It has also been concluded that the growth in wine exports over the 1957–2016 period has been far from steady. It has fluctuated considerably, with periods of rapid growth alternating with slow or negative growth.

The results from alternative measures of synchronization, for value, point to the existence of a positive and statistically significant degree of synchronization between the national and the aggregate European wine export cycle, as the majority of the countries have a high level of association with the European wine cycle. The wine export cycles of Greece and Austria are those with the lowest correlations/concordances with the European cycle, and they are those that display the greatest volatility. Moreover, the rolling correlation and concordance coefficients show that the synchronization with the EU cycle has increased over time.

The evidence obtained for the exports by volume suggest a great difference: by volume, all the countries show a lower cyclical association with the European wine cycle, with Italy and Spain being the only countries with a strong correlation/concordance with the EU cycle. However, these correlation coefficients lose significance for Italy and become weak for Spain when the aggregated cycle without the respective countries is used.

Overall the analysis conducted in this paper, which is based in a macroeconomic approach to business cycles, may be useful for understanding fluctuations in the wine trade in the past and may help with forecasting the evolution of the international trade of European wine, which is important to support policy decisions. Despite the strides that have been achieved in this study, it is necessary to analyze in greater detail the socio-economic, politics, and regulation issues

behind the behaviour of wine export cycle's synchronization in Europe. Another interesting line of future research would be to evaluate the impact of climate change on the European wine industry and, specifically, on international trade, since this is likely the bigger challenge in the near future. We are aware of the involved difficulties since as Pomarici, 2016 (2016: 1) pointed out: "Forecast of the future evolution of wine market is challenging and risky in a context dominated by discontinuities and there is not much research on how markets evolve".

## Conflict of interest

Nothing declared.

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## Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.wep.2019.04.001>.

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