PRODUCTIVITY GROWTH IN THE WINERY SECTOR: EVIDENCES FROM ITALY AND SPAIN

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Structured Abstract

Purpose: The goal of this paper is to estimate total productivity change in the winery sector, decomposing it into efficiency change and technical change.

Design/methodology/approach: The methodology is based on the estimation of the Malmquist productivity index for a sample of Spanish and Italian wineries between 2005 and 2013.

Findings: The results show very low efficiency levels for the wineries under study. Further, Spanish and Italian wineries show a decrease in their average annual productivity for the period of time analysed.

Practical implications: The analysis of the efficiency and the productivity of the wineries is crucial to improve their competitiveness and guarantee their survival.

Originality/value: For the first time, a comparative analysis is carried out with data from two major wine producing countries.

Key Words: Wineries; Productivity; Malmquist; Efficiency.

Research paper.

1. Introduction

Growing competitiveness among wineries and the globalisation of the wine market have given rise to an economic environment in which it is becoming increasingly difficult for companies to survive. The emergence of new wine-producing countries in the international wine market (e.g. Australia, Chile or the USA) that use modern production techniques and up-to-date marketing strategies has stimulated those of the old world, Spain and Italy included, to strengthen their efforts to compete in the market. As Chambolle and Giraud-Héraud (2003) state, these new world wine-producing countries base their strategy on strong branding and relatively homogeneous, high quality, competitively priced products, reinforcing these strategies with significant investments in promotion, technology and innovation (Roberto, 2003; Campbell and Guilbert, 2006; Hussain et al., 2008).

In this context, efficiency and productivity have become an important issue for winery managers as they play an important role in the control and management of wineries, providing vital information for a number of tactical, strategic and policy related decisions. However, increasing productivity in the wine sector can be difficult to achieve due to the characteristics of the sector, which make the measurement of productivity a challenging task. The heterogeneous nature of the products obtained (most wineries produce different wines that are sold at different price levels) hinders the estimation of efficiency and productivity. Further, in the wine sector not only is the quantity of wine produced important but also the quality of the wine and the ability of the winery to market it at a viable price.

In the last two decades, several authors have analysed this topic at different levels of analysis. Although most authors estimate the efficiency of wine producers, comparing the performance of different wineries or vineyards (e.g. Barros and Santos, 2007), several authors have estimated efficiency from a global perspective, comparing the efficiency of wine producers at a country level (e.g. Fleming et al., 2014) or even comparing the efficiency at a Protected Designation of Origin level (e.g. Aparicio et al, 2013). Further, several papers consider efficiency from a static perspective (e.g. Conradie et al., 2006; Moreira et al., 2011; Sellers-Rubio, 2010), while most papers consider the evolution of efficiency estimates over several years (e.g. Fekete et al., 2009; Liu and Lv, 2010; Aparicio et al., 2013).

This paper estimates productivity and efficiency at a winery level through a dynamic perspective, considering two different samples of wineries from two of the main wine producing countries in the world. Productivity change is broken down into two terms: efficiency change and technical change. The first reflects the ability of a firm to obtain the maximum level of output from a fixed level of input, given the available technology. The second reflects movement on the efficient frontier that could be attributed to innovation or technological change. The research methodology used measures productivity change using Malmquist productivity indexes computed via non parametric techniques. The empirical analysis is carried out on a sample of Spanish and Italian wineries between 2005 and 2013.

To reach this objective, the rest of the paper is organised into the following sections. The second section revises the productivity and efficiency concepts in the wine industry. In the third section, the methodology, the database and the variables used are described. The fourth section presents the results obtained and some concluding remarks are offered in the final section.

2. Literature review

In recent years, productivity and efficiency have become an important goal for winery managers. Although the terms productivity and efficiency have been used interchangeably, this is unfortunate because they are not exactly the same thing. The most common interpretation in economics is expressed by Bucklin (1978) who states that: ‘Total ratio productivity is the ratio of all outputs to all inputs. Partial input productivity is the ratio of all outputs to a single input’. In this sense, productivity indexes are calculated by inserting numbers into predetermined formulas or ratios and do not take into account the performance of other companies. As an alternative, relative efficiency focuses on the performance of a decision making unit (i.e. a winery) relative to the best performers rather than the average performers as with the traditional absolute measures. Under this approach, the best performers describe the efficient frontier while the inefficient wineries remain beneath the frontier. The farther from the frontier the more inefficient the winery is.

Previous papers on this topic have analysed the efficiency of wine producers using several parametric (e.g. Henriques et al., 2009) and non-parametric techniques (e.g. Bojnec and Latruffe 2008, 2009). Further, several papers consider efficiency from a static perspective (e.g. Conradie et al., 2006; Moreira et al., 2011; Sellers-Rubio, 2010) while other papers consider the evolution of efficiency estimates over several years (e.g. Fekete et al., 2009; Liu and Lv, 2010; Aparicio et al., 2013). Table 1 summarizes previous research on this topic.

From a methodological perspective, the definition of inputs and outputs is one of the main problems faced when estimating efficiency in the wine industry. In this sense, when comparing the relative performance of wine producers it is possible to consider a technical perspective, analysing the ability of the wine producer to transform some inputs into wine outputs volume (e.g. litres of wine) or analysing the ability to transform some inputs into wine outputs value (e.g. sales). The first approach leads to a technical concept of efficiency while the second approach considers an economic concept of efficiency. The efficiency literature related to the wine sector has analysed vineyards, cooperatives, firms and agrifood sectors.

Most of the authors consider the technical approach (e.g. Townsend et al., 1998; Conradie et al. 2006; Bonfiglio, 2006; Henriques et al, 2009; Bojnec and Latruffe, 2008, 2009; Zago, 2009, Vidal et al, 2013; Aparicio et al, 2013). Townsend et al. (1998) estimate partial and total productivity for a sample of wine grape producers located in South Africa analysing the effect of size on these productivity indexes. The results show that the inverse relationship between farm size and productivity is weak, not consistently negative and differs among regions. Henriques et al. (2009) also analyse the impact of size on efficiency and use a stochastic production frontier to estimate technical efficiency for a sample of Portuguese vineyards for the period 2000-2005. The results show a positive influence of economic vineyard size on efficiency and that there is room to improve the levels of technical efficiency in input use. In the same line, Conradie et al. (2006) estimate the relationship between technical efficiency and size with panel data for a sample of South African vineyards for the years 2003 and 2004, and cross-sectional data for table grape farms for 2004. Their results showed that efficiency is affected by labour quality, age and education of the farmer, location, the percentage of non-bearing vines and expenditure on electricity for irrigation. Bonfiglio (2006) analyses efficiency and productivity changes of a sample of Italian agrifood cooperatives in the period 2000-2002. The results show that wine cooperatives present the lowest average levels of efficiency. Moreover, their productivity decreased due to a worsening of managerial capabilities. Bojnec and Latruffe (2008, 2009) estimate farm business efficiency and the determinants of technical efficiency in Slovenian farms (among them, grape and wine producers) using panel data. Coelli and Sanders (2013) estimate the technical efficiency of wine grape growers in Australia using a translog stochastic production function on an unbalanced panel including 134 producers over four years. Their study reveals a significant potential improvement of efficiency and some evidence of increasing returns to scale. Pastor et al. (2012) analyse the Spanish wine sector using a new additive based efficiency measure known as BAM (Bounded Adjusted Measure). Zago (2009) proposes a methodology to measure the characteristics of intermediate products when quality is multidimensional, using a general representation of the multi-output technology via directional distance functions. The application is carried out with data for Chardonnay and Merlot grapes from Italy and collected between 1994 and 1996. Vidal et al (2013) analyse the efficiency of a sample of Spanish PDOs between 2008 and 2010 with the non-parametric technique of Data Envelopment Analysis (DEA), BAM and Malmquist indexes. The results show that the efficiency behaviour of the subset of Spanish PDOs is uniform over the time periods analysed and that productivity experiments highlight only minor and irrelevant changes. Aparicio et al. (2013) analyse the revenue, technical and allocative inefficiency of a sample of Spanish PDOs with an output oriented version of the weighted additive DEA model. Overall, the results show that technical inefficiency is clearly greater than allocative inefficiency. Further, the results showed that revenue efficiency was greatest in the case of PDOs with specific wine products serving niche markets and without clear competition.

Although the results are not directly comparable, most of the papers show low levels of efficiency in the winery sector (e.g. Bonfiglio, 2006; Liu and Lv , 2019; Sellers-Rubio, 2010), which implies that a potential improvement could be achieved by wineries. Further, from a dynamic perspective, results are not consistent. While some papers evidence a slight decrease of productivity over time (e.g. Bonfiglio, 2006; Vidal et al., 2010), others (e.g. Liu and Lv, 2010) evidence a slight increase.

Alternatively, the economic efficiency approach has been employed by several authors (e.g. Barros and Santos, 2008; Echeverria and Gopinath, 2008; Fernandez and Morala, 2009; Tasevska and Hansson, 2010; Sellers-Rubio 2010), also evidencing low levels of economic efficiency. Barros and Santos (2007) compare the efficiency of cooperatives and private enterprises in the Portuguese wine industry, showing that cooperatives, on average, are more efficient than their private counterparts. Echeverria and Gopinath, (2008) analyse the export behaviour of Chilean agribusiness and food processing firms and the relative importance of firm-specific and geographic characteristics within this behaviour. In general, firm-specific characteristics significantly impact export behaviour in Chilean agribusiness and processed food industries, while the contribution of geography attributes appears mixed. Tasevska and Hansson (2010) provide an empirical analysis of the performance of Macedonian grape growing family farms assessed in terms of technical, allocative and economic efficiency, and they relate aspects targeted in the Rural Development Program to the efficiency scores. Fernandez and Morala (2009) study the cost efficiency of wine firms in Castilla Leon (Spain), verifying improvements in the global efficiency as well as in the pure technical efficiency of the analysed firms. Sellers-Rubio (2010) simultaneously applies traditional profitability and productivity measures and a non-parametric technique to estimate efficiency, and compares the results obtained for a sample of Spanish wineries in 2007. Fekete et al. (2009) use the Malmquist index to examine productivity and its elements in the agriculture of new EU member states.

Finally, at a country level, Tóth and Gál (2014) and Fleming et al. (2014) evidence that New World countries are more efficient than traditional countries. Tóth and Gál (2014) perform a two-stage model on a panel of most of the major wine producing countries over the period 1995-2007 estimating a Cobb-Douglas production function. The results show that New World countries are more efficient than Old World countries. Moreover, inefficiency is related to some macroeconomic factors such as the development of the financial system, the quality of human capital and per capita wine consumption. Fleming et al. (2014) examine and compare the transformation of wine grapes into wine volume and value in the 11 largest wine-exporting countries during the years 2000–2009. The results show two key trends. First, all countries migrated to higher price points, albeit with differing degrees of success: slightly declining productivity in transforming wine grapes into wine output was compensated by price/quality effects, leading to substantial gains in transforming wine grapes into wine value. Second, New World producers plus Portugal and Spain were much more successful in achieving gains in their export value proposition than they were in extracting value in their domestic markets.

<Take in Table 1>

3. Methodology, contextual setting, sample and variables

3.1. Methodology

The Malmquist index was introduced by Caves, Christensen and Diewert (1982). Estimated using distance functions, the Malmquist index allows changes in productivity to be broken down into technical and efficiency changes. Technical change reflects the frontier shift over time while efficiency change represents deviations from the best practice frontier.

One way to measure productivity change is to see how much more output has been produced, using a given level of inputs and the present state of technology, relative to what could be produced under a given reference technology using the same level of inputs. The relative movement of a winery over time may be because it is improving its efficiency (moving closer to the frontier) and/or because the frontier is shifting over time (as a consequence of technological progress). Thus, the Malmquist index is defined as the product of the “catching-up” and the “frontier shift” terms. The “catching-up” term relates to the extent by which a winery improves its efficiency, while the frontier-shift term reflects the change in the efficient frontier surrounding the winery between the two periods of time.

To define the Malmquist index it is useful to think of the general distance function as being evaluated relative to the frontier of the “true” but unknown underlying technology. Färe and Lovell (1978) showed that the distance function was the Farrell (1957) reciprocal measure of efficiency. The output distance is defined on the output set, $P(x) = \{y : x$ can produce $y\}$, as:

$$D^t(y,x) = \min \{\delta : (y/\delta) \in P(x)\} \quad (1)$$

The Malmquist index based on outputs uses distance functions defined in (1), and analyses productivity changes as the differences at the maximum level of output that can be attained from a fixed level of inputs. The formulation of this approach taking the technology of the period t as reference according to Caves et al. (1982) is the following:

$$\frac{D^t(y^{t+1},x^{t+1})}{D^t(y^t,x^t)} \quad (2)$$

Alternatively, the Malmquist index can be estimated in the reference period $t+1$ as:

$$\frac{D^{t+1}(y^{t+1},x^{t+1})}{D^{t+1}(y^t,x^t)} \quad (3)$$

Since the choice of period t or $t+1$ is arbitrary, Färe et al. (1994) defined the Malmquist index as the geometric mean of the two indices above:

$$M_{t,t+1}(y^{t+1},x^{t+1},y^t,x^t) = \left(\frac{D^t(y^{t+1},x^{t+1})}{D^t(y^t,x^t)} \frac{D^{t+1}(y^{t+1},x^{t+1})}{D^{t+1}(y^t,x^t)} \right)^{1/2} \quad (4)$$

A value of M greater than one will indicate productivity growth from period t to period $t+1$, while a value less than one indicates a productivity decline. Operating and reordering the terms of the equation (4), the decomposition of productivity change into efficiency change (catching-up, CU) and technical progress (technical change, TC) is the following:

$$M_{t,t+1}(y^{t+1},x^{t+1},y^{t},x^{t}) = \underbrace{\frac{D^{t+1}(y^{t+1},x^{t+1})}{D^{t}(y^{t},x^{t})}}_{CU} \underbrace{\left(\frac{D^{t}(y^{t+1},x^{t+1})}{D^{t+1}(y^{t+1},x^{t+1})} \frac{D^{t}(y^{t},x^{t})}{D^{t+1}(y^{t},x^{t})} \right)^{1/2}}_{TC} \qquad (5)$$

Thus, the productivity changes reflected in the index will be a mixture of efficiency changes (CU) and frontier shifts (TC). The first ratio (CU) is the index of efficiency change (i.e. whether the firm has moved closer or farther from the frontier over time) between years *t* and *t+1*. A value of the CU ratio greater than one indicates productivity growth as a consequence of an efficiency improvement between period *t* and period *t+1.* A value of the CU ratio less than one indicates efficiency decline. The second term (TC) is the index of technical change between the two periods evaluated as a result of frontier displacement. A value of the TC ratio greater than one indicates productivity growth as a consequence of frontier shift between period *t* and period *t+1,* which is interpreted as technical progress.

As it is not possible to observe the real set of production possibilities, the indices which describe productivity, efficiency and technology changes, as well as the distance function must be estimated. We have considered a DEA model (Fare et al., 1994) to measure the distance functions. Specifically, given that this paper considers that the environment could affect the ability of the winery to achieve its goals, some environmental variables have been included as non-discretionary inputs (Ferrier and Lovell, 1990), as they are out of the control of wineries' managers. In order to establish a cross-country comparison, a common frontier has been estimated.

3.2. Contextual setting, sample and variables

3.2.1. Contextual setting

Spain and Italy are two of the world's leading wine producers; only marginally surpassed by France. Together these three countries account for over 50% of wine production worldwide. Table 2 summarizes the main characteristics of the wine industry in these two countries.

The Spanish wine industry is an economically important sector in terms of the added value it generates and the number of people it employs (Sellers-Rubio, 2010). The wine industry in Spain is composed of approximately 4,500 wineries that belong to two primary groups of firms: big corporations and family-owned wineries. Although both groups are oriented to the export market, the former tends to sell a low price mass product, while many of the firms in the latter group are focused on the production of high price quality wines that are produced on a reduced scale.

Spanish production increased in the first decade of the 21st century compared to the 90s. Its current output stands at between 40 and 45 million hl, showing a slight decline after 2007. Approximately 38% of the wine produced is under a Protected Designation of Origin (PDO). Moreover, the Spanish wine sector shows great export performance, reaching 18.47 million hectolitres in 2013. This, however, has been offset by a dramatic drop in domestic consumption, which currently accounts for barely one third of overall production, and has continued to fall under the pressure of the economic crisis (Martínez-Carrión and Medina, 2012), which has led to a significant imbalance between internal supply and demand. In this context, export growth and new market entry are key requirements to ensure the viability of the sector (Bardají et al., 2014).

The wine sector also plays a major role in Italy, with production that reached 48.16 million hectolitres (including juice) for 2013, with an estimated value higher than 9.1 billion euros for that year (Mediobanca, 2014). The Italian wine sector is characterised by a very large number of vineyards and its most evident peculiarity is its strong fragmentation and its marked duality: 55% of the total number of vineyards are smaller than 3 hectares, covering a little over 17% of the total vine area, while 4% of the total number of farms are larger than 30 hectares, covering over 24% of the total vine area.

The wine produced in Italy is mainly a quality wine, which can boast a certification of origin (a DOC/DOCG or an IGT) and only 24.5% is sold as table wine. The Italian wine sector is also showing great export performance, which, for 2013, reached 20.32 million hectolitres (while imports were only 2.68 million hectolitres). Conversely, internal wine consumption has been in constant decline since the second half of the 70s, and for 2013 its value reached 21.8 million hectolitres (38.0 litres per capita, against the 93.5 of 1977), but thanks to exports the sector is still accomplishing very interesting revenues.

<Take in Table 2>

3.2.2. Sample and variables

The application of the methodology proposed in the previous section is made on a sample of Spanish and Italian wineries between 2005 and 2013. The aim to establish an international comparison between these two countries imposes certain restrictions in obtaining homogeneous samples and variables. Thus, the sample is taken from the wineries included in the 1102 NACE code (European Union classification of economic activities), which includes firms dedicated to “Manufacture of wine from grapes”. In order to guarantee the homogeneity of the companies analysed, mainly brandy and spirits manufacturers are excluded. The Spanish sample is obtained from the SABI database (which provides accounting information on Spanish companies) and has an initial size of 2,563 firms. The Italian sample is obtained from the AIDA database (which provides accounting information on Italian companies) with an initial size of 1,196 Italian wineries. After some adjustments to remove outliers and to reduce the number of infeasibilities of the Malmquist index, the final sample is comprised of 622 and 609 Spanish and Italian wineries, respectively.

To estimate the total factor productivity, three inputs and two outputs are considered. As this paper is concerned with the economic aspect of winery performance, monetary variables are employed. Although two different databases have been used, the consistency of the variables is guaranteed as they consider publicly available accounting data that are highly harmonized across countries. Specifically, two monetary outputs are used: i) The sales revenue of each winery. The justification for this choice is that wineries work with an assortment of wines that are sold at different prices, which hinders the collection of disintegrated information on outputs produced; ii) The profit volume of the winery. This variable is included for the following reasons: i) wineries can obtain atypical income apart from their main activity, which is not included in their sales volume figures; ii) apart from sales volume, winery managers pay special attention to results as they guarantee the viability of the company as well as future investments; and iii) considering the volume of profits allows for inclusion of the influence of other types of costs not considered as inputs.

With regard to inputs, the following three controllable productive factors are used: i) Number of employees, a representative input of the labour factor. We have considered the number of full time equivalent employees as the number of employees in the winery can vary during the year; ii) Equity level of the winery (capital plus reserves); and iii) Level of debt (short and long-term debt). These two latter variables are used instead of a single capital variable because access to financing and its costs is a fundamental dimension of international competition in the wine industry (Viviani, 2008).

To account for differences in the environmental conditions between the two countries, four variables have been considered. First, two variables related to the economic environment: i) Gross domestic product; and ii) Employment rate. Second, two contextual setting variables related to the wine sector: i) Volume of wine production. To a certain extent it considers factors related to the climate, as better or worse climate conditions could lead to a bigger (smaller) harvest; and ii) Domestic wine consumption. Following the Ferrier and Lovell (1990) proposal, we have inserted the environmental variables directly into the DEA linear program formulation as non-discretionary inputs, because they remain out of the control of the managers. The values of the environmental variables are different for each country but take equal values for each winery in each country by year.

Finally, given the temporal field of the study, all the monetary variables are deflated and expressed in thousands of Euros of the year 2005. The conversion to constant Euros is performed through the implicit deflator of GNP for each country. The Spanish and Italian final sample is of 57.22% and 55.65% of total wineries sales revenue in 2013, respectively. Table 3 presents the main descriptive statistics of the sample.

<Take in Table 3>

4. Results

To estimate the wineries' efficiency, the non-parametric DEA methodology has been applied. In order to establish a cross-country comparison, a common frontier has been estimated (see Table 4). The basic assumption is that production technology does not differ between Spanish and Italian wineries. In fact, the structure and characteristics of the industry in these two countries is very similar. As shown in Table 4, for the whole period considered, the results show low levels of efficiency for the Spanish and Italian wineries. The average efficiency of the analysed wineries between 2005 and 2013 is 0.348, which reflects a high degree of inefficiency in the winery industry. On average, the wineries could have achieved the same levels of outputs using 65.2% fewer resources. The deviation from the efficiency frontier is due to poor use of inputs (Technical efficiency=0.596) and to firms not operating at optimum size (Scale efficiency=0.584).

Further, the results evidence that the efficiency of the Spanish wineries (0.343) is lower than the Italian wineries (0.354). According to the Kolmogorov–Smirnov (K–S) test, this difference is significant. This result implies that Spanish wineries need a larger amount of inputs to obtain the same level of outputs than the Italian wineries or, alternatively, that the Italian wineries are able to obtain a higher level of outputs than the Spanish wineries with the same level of inputs. In spite of the similarity of these two wine producing countries, this result confirms the idea that Italian wineries are able to gain more value from their wine in the market than Spanish wineries. Regarding the evolution of efficiency for the period analysed, Table 4 shows that efficiency declines after 2010 in both countries.

<Take in Table 4>

To estimate the Malmquist productivity index the Färe et al. (1994) proposal has been employed. This proposal allows us to decompose productivity change into technical change (TC) and efficiency change (the *catching-up* effect, CU). The results obtained are shown in Table 5.

<Take in Table 5>

The results suggest that in the period 2005–2013, the Spanish and Italian wineries experienced an annual productivity change of -0.02%, which is explained by the confluence of two factors acting with contrary signs. On the one hand, the 3.1% improvement as a consequence of frontier shift, which is interpreted as technical change (TC) and, on the other hand, the 3.12% negative catching up (CU) effect. The technical progress (3.1%) means that, over time, firms on the frontier use a lower amount of inputs to produce the same outputs. In other words, the wineries on the efficient frontier improve their management with regard to previous years. The negative catching up effect (–3.12%) implies that the efficiency of the wineries decreases over the period of time analysed. Thus, managers should be aware that lack of productivity growth is a problem for their firms, meaning that they should take the necessary measures to follow its development and make an analysis of its determinant factors.

This pattern is very similar in both countries. For the Spanish sample, the results show that annual average productivity is constant for the global period considered, which is explained by the confluence of two factors acting with contrary signs. On the one hand, the 3.3% improvement as a consequence of frontier shift, which is interpreted as technical change (TC) and, on the other hand, the 3.3% negative catching up (CU) effect. For the Italian sample, the results show an annual average productivity decrease of 0.03% for the global period considered, which is also explained by the confluence of two factors acting with contrary signs. On the one hand, the 2.8% improvement as a consequence of frontier shift, which is interpreted as technical change (TC) and, on the other hand, the 3.1% negative catching up (CU) effect. Generally speaking, these results show that wineries are not able to improve their efficiency over the period of time analysed.

Further, the results confirm the idea that the positive contribution of technological progress to productivity growth is offset by a deterioration of the wineries' efficiency. Overall, the growth of the gap between efficient and inefficient wineries and the technological advances suggest that much of the decrease in efficiency can be attributed to the failure of wineries to adapt to the technological improvements made by some of their competitors. In this sense, a few wineries are innovators and shift the frontier, while most of the other wineries fail to adapt to the technological improvements and fall behind. Among the most productive wineries we find Bodegas Baigorri S.A. and Osborne Selección, S.A. in Spain, and Piera Martellozzo SPA. and Ruffino S.R.L. in Italy. Some of them are characterised by the intensive use of new technologies such as GIS applications to follow the development of the vineyard, efficient water-use techniques, or optimized vineyard practices to reduce pesticides (in the framework of the InnoVine project).

Finally, it is important to highlight that the results show an important decrease in productivity between 2007 and 2009. Although it is very difficult to identify the particular reasons of this decline, it should be noted that the distillations subsidized by the Common Market Organization (CMO) budget for wine disappeared in 2008. The regulation in the wine sector in the EU is based on the CMO and affects wine production, and commercialization in all EU countries (Bardají et al., 2014). This regulation has evolved over time, and the latest reform in 2008 has meant a substantial modification in the conditions of competition among wine producers. Under the current regulation, the connection to competitiveness in world markets has taken prevalence. In the national plans that each producing country has elaborated, international promotion has been acquiring great relevance. The disappearance of distillations subsidized by the CMO has driven many firms to open their business channels to world markets, allowing them an outlet for large volumes of wine that were previously dedicated to alcohol distillation for oral use.

5. Conclusions and recommendations for future research

The objectives of this study are to estimate the productivity change of companies operating in the Spanish and Italian wine sector between 2005 and 2013, and to decompose into efficiency changes (catching-up effect) and changes due to frontier shifts and interpreted as technical change or technological progress.

The results show high levels of inefficiency in the Spanish and Italian winery sectors and a slight decrease in the average annual productivity among the firms analysed between 2005 and 2013. Inefficiency reflects the failure of some wineries to obtain the maximum feasible output given the amount of inputs used. In many contexts, inefficiency can be interpreted as the result of a lack of knowledge about certain critical aspects of the productive activity, and its measurement is crucial to quantify the importance of poor performances in a productive activity. In order to improve efficiency, firms should be able to identify the sources of poor performance and the alternatives available to make better use of their resources. In these cases, efficiency improvements may be achieved if the inefficient firm is able to learn better production routines, develop new processes or adopt new technologies into their production process. Managers should think about the methods and processes available to improve production without worsening quality.

Further, the negative evolution of total productivity over the period of time considered is the consequence of two forces with contrary signs, as the positive contribution of technological progress to productivity growth is offset by a deterioration of the wineries' efficiency. Although the most efficient wineries are able to improve their performance over the period of time, thus shifting the efficient frontier, most of the wineries fail to adapt to these technological improvements. The results also show a decline in productivity between 2007 and 2009 as the distillations subsidized by the CMO disappeared. In fact, government regulations within the EU might have direct, or indirect, effects on the relative efficiencies of different producers within (and across) countries. As we know from the American market (e.g. Wiseman and Ellig, 2007, Ellig and Wiseman, 2013), various regulatory structures can have nontrivial implications for winery production, marketing and other aspects of winemaking and sales that could have implications for the output metrics that are the sources of analysis. This highlights the importance of regulators and the sector working together in order to define the future of the wine industry.

Finally, we propose several future research lines directed at improving knowledge on the productivity of the winery sector. Firstly, we suggest the inclusion of other variables that could affect the production process of the wineries. These variables could be included as inputs (e.g. the degree of technological development of the wineries themselves), or they could be related to the environment where the wineries develop their activity. In this sense, it would be interesting to add a New World production variable, as increased production in the New World might have an indirect impact on productivity through competition channels.

Secondly, future research should be directed towards considering the variables and factors that determine and explain productivity in the winery sector. Global competition and excess quantities of grapes worldwide highlight the importance of focusing on practices and methods that could help to improve wineries' productivity in the long term. In this sense, we propose the consideration of other aspects such as the different types of management practices currently being implemented in Spanish and Italian wineries, which could have a positive impact on productivity. Furthermore, it would be very interesting to consider the effect that wine quality has on wineries' productivity. Although wine quality can be very difficult to assess in the wine industry, this variable has a great impact on wineries' costs and earnings (as the price of the wine varies with its quality), which, in the end, determine wineries' productivity.

References

Aparicio, J., Borras, F., Pastor, J.T., and Vidal, F. (2013), "Accounting for slacks to measure and decompose revenue efficiency in the Spanish Designation of Origin wines with DEA", *European Journal of Operational Research*, Vol. 231, pp. 443–451.

Arandia, A., and Aldanondo, A. (2007), "Eficiencia técnica y medioambiental de las explotaciones vinícolas ecológicas versus convencionales", *Revista Española de Estudios Agrosociales y Pesqueros*, Vol. 215–216, pp. 155–184 (in Spanish),

Bardají, I., Estavillo, J., and Iráizoz, B. (2014), "Export performance: insights on the Spanish wine industry", *European Journal of International Management*, Vol. 8 No. 4, pp. 392–414.

Barros, C.P., and Santos, J. C. G. (2007), "Comparing the productive efficiency of cooperatives and private enterprises: the Portuguese wine industry as a case study", *Journal of Rural Cooperation*, Vol. 35 No. 2, 109–122.

Bojnec, S., and Latruffe, L. (2008), "Measures of farm business efficiency", *Industrial Management & Data Systems*, Vol. 108 No. 2, pp. 258–270.

Bojnec, S., and Latruffe, L. (2009), "Determinants of technical efficiency of Slovenian farms", *Post-Communist Economies*, Vol. 21 No. 1, pp. 117–124.

Bonfiglio, A., (2007), "Efficiency and productivity changes of the Italian agrifood cooperatives: A Malmquist index analysis", Universita Politecnica delle Marche. Working paper no. 250.

Brandano; M.G.; Detotto, C. and Vannini, M. (2012) "Comparative efficiency of producer cooperatives and conventional firms in a sample of quasi-twin companies", Centro Ricerche Economiche Nord Sud (Crenos). Working paper 2012/28.

Bucklin, L.P. (1978), *Productivity in marketing.* A.M.A. Chicago.

Campbell, G. and Gilbert, N. (2006), "Old world strategies against New World competition in a globalizing wine industry", *British Food Journal*, Vol. 108 No. 4, pp. 233–242.

Caves, D.W.; Christensen, L.R. and Diewert, W.E. (1982), "The economic theory of index numbers and the measurement of input, output, and productivity", *Econometrica*, Vol. 50 No. 6, pp. 1393-1414.

Chambolle, C. and Giraud-Héraud, E. (2003), "Economic analysis of certification by an AOC", in Gatti, S., Giraud-Héraud, E. and Mili, S. (Eds): *Wine in the Old World: New Risks and Opportunities*, Franco Angeli, Milan, Italy, pp.15–28

Coelli, T. and Sanders, O. (2013), "The technical efficiency of wine grape growers in the Murray-Darling Basin in Australia", in Giraud-Héraud, E. and Pichery, M.C. (Eds.), *Wine Economics Quantitative Studies and Empirical Applications*. London: Palgrave Macmillan, pp. 231-249.

Conradie, B., G. Cookson, and C. Thirtle. (2006), "Efficiency and farm size in Western Cape grape production: Pooling small datasets", *South African Journal of Economics*, Vol. 74, pp. 334-343.

Echeverria, R., and Gopinath, M. (2008), "Export behaviour in the Chilean agribusiness and food processing", *Industry Chilean Journal of Agricultural Research*, Vol. 68 No. 4, pp. 368–379.

Ellig, J. and Wiseman, A. (2013), “Price effects and the commerce clause: the case of state wine shipping laws”, *Journal of Empirical Legal Studies*, Vol. 10 No. 2, pp. 196-229.

Färe, R.S. and Lovell, C.A.K. (1978) “Measuring the technical efficiency of production”, *Journal of Economic Theory*, Vol. 19 No 1, pp. 150-162.

Färe, R.S., Grosskopf, S. and Lovell, C.A.K. (1994), *Production Frontiers*. Cambridge University Press. Cambridge.

Farrell, M.J. (1957), “The measurement of productive efficiency”, *Journal of the Royal Statitical Society, Serie A (general)*, Vol. 120 No. III, pp. 253-281.

Fekete, M., Szucs, I., Varga, T., (2009), “Efficiency and its reserves in the agriculture of Visegrad countries – benchmarking analyzing”, *3rd Central European Conference in Regional Science – CERS*, pp. 261–268.

Fernandez, Y., and Morala, B. (2009), “Estudio de la eficiencia en costes en las empresas del sector vinicola de la Comunidad Autonoma de Castilla y Leon (España)”, *Revista del Instituto Internacional de Costos*, Vol. 5, pp. 31–51 (in Spanish).

Ferrier, G.D. and Lovell, C.A.K. (1990), “Measuring cost efficiency in banking: Econometric and linear programming evidence”, *Journal of Econometrics*, Vol. 46, pp. 229-245.

Fleming, E., Mountera, S., Grant, B., Griffith, G., Villanoa, R. (2014), “The New World challenge: Performance trends in wine production in major wine-exporting countries in the 2000s and their implications for the Australian wine industry”, *Wine Economics and Policy*, Vol. 3, pp. 115–126.

Henriques, P. D. S., Carvalho, M. L. S., Costa, F., Pereira, R., and Godinho, M. L. F. (2009), “Characterization and technical efficiency of Portuguese wine farms”, *Ciencia e Tecnica Vitivinicola*, Vol. 24 No. 2, pp. 73–80.

Hussain, M., Cholette, S. and Castaldi, R.M. (2008), “An analysis of globalization forces in the wine industry”, *Journal of Global Marketing*, Vol. 21 No. 1, pp.33–47.

ISTAT, (2010), “6th Agricultural Census”, ISTAT, Rome.

Liu, H.Y. and Lv, K., (2010), “Productive efficiency and its influencing factors of winemaking firms in China. A research based on DEA-Tobit approach”, *Collected Essays on Finance and Economics*, Vol. 2, pp. 1–6.

Martínez-Carrión, J.M. and Medina, F.J. (2010), “Change and development in the Spanish wine sector, 1950-2009”, *Journal of Wine Research*, Vol. 21 No. 1, pp.77–95.

Mediobanca, Ufficio Studi (2014), *Indagine sul settore vinicolo*, Mediobanca - Ufficio Studi, Milano.

Moreira, V.H., Troncoso, J.L., and Bravo-Ureta, B.E. (2011), “Technical efficiency for a sample of Chilean wine grape producers: A stochastic production frontier analysis”, *Ciencia e Investigación Agraria*, Vol. 38 No. 3, pp. 321-329.

Pastor, J.T., Vidal, F., Borras, F., Pastor, D., (2012), “The quality wine sector in Spain. An efficiency analysis”. International Conference on Business and Information (BAI). In: *Proceedings of Business and Information*, Vol. 9, pp. 1262–1269. Sapporo (Japan).

Roberto, M.A. (2003), “The changing structure of the global wine industry’, *International Business and Economics Research Journal*, Vol. 2 No. 9, pp. 1–14.

Sellers-Rubio, R. (2010), “Evaluating the economic performance of Spanish wineries”, *International Journal of Wine Business Research*, Vol. 22 No. 1, pp. 73–84.

Sellers-Rubio, R. and Mas-Ruiz, F. (2015), “Economic efficiency of members of protected designations of origin: sharing reputation indicators in the experience goods of wine and cheese”, *Review of Managerial Science*, Vol. 9 No. 1, pp. 175-196.

Tasevska, G. and Hansson, H., (2010), “Influence of rural development policy targets on farm efficiency. An efficiency study of labour intensive grape growing family farms”. IAMO Forum 2010. Halle, Germany.

Townsend, R. F., Kirsten, J. F., and Vink, N. (1998), “Farm size, productivity and returns to scale in agriculture revisited: a case study of wine producers in South Africa”, *Agricultural Economics*, Vol. 19 No. 1-2, pp. 175–180.

Tóth J. and Gál P. (2014), “Is the New Wine World more efficient? Factors influencing technical efficiency of wine production”, *Studies in Agricultural Economics*, Vol. 116, pp. 95-99.

Vidal, F., Pastor, J.T., Borras, F., and Pastor, D. (2013), “Efficiency analysis of the designations of origin in the Spanish wine sector”, *Spanish Journal of Agricultural Research*, Vol. 11 No. 2, pp. 294-304.

Viviani, J.L. (2008), ‘‘Capital structure determinants: an empirical study of French companies in the wine industry’’, *International Journal of Wine Business Research*, Vol. 20 No. 2, pp. 171-94.

Wiseman, A. and Ellig, J. (2007), “The politics of wine: trade barriers, interest groups and the commerce clause”, *Journal of Politics*, Vol. 69 No. 3, pp. 859-875.

Zago, A. (2009), “A nonparametric analysis of production models with multidimensional quality”, *American Journal of Agricultural Economics*, Vol. 91 No. 3, pp. 751–764.

Table 1. Previous evidence on the estimation of efficiency in the wine sector.

Authors	Methodology	Data	Results
Townsend et al. (1998).	Data envelopment analysis (DEA).	Wine grape producers in South Africa during 1992-1995.	Prevalence of constant returns to scale. Co-operatives overcome the economies of scale. The inverse relationship between size and productivity is weak, not consistently negative and differs between regions.
Conradie et al. (2006).	Parametric model.	Wine grape farms in South Africa during 2003-2004, and in the De Doorns region for 2004.	Efficiency is affected by labour quality, farmer's age and education, location, percentage of non-bearing vines and expenditure on electricity for irrigation.
Bonfiglio (2006).	Data envelopment analysis (DEA) and Malmquist indexes.	Italian agrifood cooperatives during 2000-2002.	Wine cooperatives present the lowest average levels of efficiency. Productivity decreases due to a worsening of managerial capabilities.
Arandia and Aldanondo (2007).	Data envelopment analysis (DEA).	86 wine producers in Spain in 2001.	Organic wine producers are more efficient that conventional ones.
Barros and Santos (2007).	Data envelopment analysis (DEA).	Portuguese wine producers during 1996-2000.	Wine cooperatives are more efficient than private firms.
Bayramoglu and Gundogmus (2008).	Data envelopment analysis (DEA).	44 organic and 38 conventional raisin-producing households in Turkey during the season 2003-2004.	Conventional households are more efficient relative to their own technology.
Echeverria and Gopinath, (2008).	Econometric model, DEA and Malmquist.	Chilean agribusiness and food processing firms (including 27 wine producers) during 1998-2003.	Firm-specific characteristics significantly impact export behaviour. The contribution of geography attributes appears mixed.
Zago (2009).	Multi-output technology. Directional distance functions.	Italian Chardonnay and Merlot grape producers during 1994-1996.	Trade-off between quantity and aggregate quality in wine grapes.
Henriques et al. (2009).	Stochastic production function.	22 wine grape farms of Portugal during 2000-2005.	Positive influence of size on efficiency. Potential improvement of technical efficiency in input use.
Bojnec and Latruffe (2008, 2009).	Data envelopment analysis (DEA) and parametric stochastic frontier.	13 Slovenian farms (among them, grape and wine producers) during 1994-2003.	High levels of efficiency.
Fernandez and Morala (2009).	Data envelopment analysis (DEA).	66 wine firms in Castilla Leon (Spain) during 2006-2007.	Improvements in global and pure technical efficiency.
Liu and Lv (2010).	Data envelopment analysis (DEA) and Malmquist.	22 winemaking firms in China during 2004-2007.	Low levels of technical efficiency and a rising trend (except in 2007).
Sellers-Rubio (2010).	Data envelopment analysis (DEA).	1222 Spanish wineries in 2007.	Low levels of efficiency.
Moreira et al. (2011).	Cobb-Douglas	38 wine grape producers in	Strong relationship between certain

	production function.	Chile in the agricultural year 2005-2006.	vineyard training systems and yields per hectare.
Brandano et al. (2012).	Data envelopment analysis (DEA).	Sardinian wine producing companies during 2004–2009.	Cooperatives are less efficient than capitalist firms.
Coelli and Sanders (2013).	Translog stochastic production function.	Unbalanced panel of 134 wine grape growers in Australia over four years.	Significant potential improvement of efficiency and some evidence of increasing returns to scale.
Vidal et al (2013).	Data envelopment analysis (DEA), Bounded Adjusted Measure (BAM) and Malmquist index.	34 Spanish PDO during 2008-2010	The efficiency behaviour is uniform over time. Minor and irrelevant changes in productivity. Differences among PDO.
Aparicio et al. (2013).	Weighted additive data envelopment analysis (DEA).	24 Spanish PDO in 2010.	Differences between the obtained values with respect to the two components of the revenue inefficiency. Technical inefficiency is greater than allocative inefficiency. Revenue efficiency is the most in the case of PDOs. PDO Cava is the best benchmark.
Tóth y Gál (2014).	Cobb- Douglas production function.	Major wine producing countries during 1995-2007.	New World wine countries are more efficient. Inefficiency is related to some macroeconomic factors (development of the financial system, quality of human capital and per capita wine consumption).
Fleming et al. (2014).	Four performance ratios and their decomposition into frontier shifts and technical, scale and mix efficiency effects.	11 largest wine-exporting countries during 2000–2009.	Slightly declining of productivity over time. New World producers plus Portugal and Spain are more successful in achieving gains in their export value than in their domestic markets.
Sellers and Mas (2015)	Data envelopment analysis (DEA).	1257 Spanish wineries in 2010.	PDO labels have a positive influence on the economic efficiency.

Table 2. Main characteristics of the Spanish and Italian wine sectors in 2013.

	Spain	**Italy**
Vineyards surface area (Has.)	950639	664296*
Wine production (millions Hl.)	42.7	44.90
Wine exports (millions Hl.)	18.47	20.32
Wine consumption (millions Hl.)	9.10	21.79
Wine consumption (litres per capita)	19	38
Number of wineries	4500 (aprox.)	31875*

* ISTAT (2010).

Table 3. Summary of descriptive statistics (2005-2013).

	INPUTS			OUTPUTS	
2005-2013	**Equity (thousands of Euros)**	**Debt (thousands of Euros)**	**Employees**	**Operational results (thousands of Euros)**	**Sales revenue (thousands of Euros)**
ITALY					
Mean	3175.16	6589.82	14.00	170.81	6862.54
SD	9442.01	12387.24	22.92	1104.73	14463.51
Max	141838.00	193732.00	349.00	61674.00	202338.00
Min	1.00	3.00	1.00	-6258.14	1.00
SPAIN					
Mean	6305.67	5003.99	18.94	515.08	5407.36
SD	23501.29	15696.06	51.13	2191.01	19090.23
Max	417233.14	228307.85	886.00	43257.00	262821.24
Min	1.00	1.00	1.00	-14251.12	4.10

Table 4. Economic efficiency of wineries

	Economic Efficiency		
	Global	**Spain**	**Italy**
2005	0.381	0.375	0.382
2006	0.371	0.357	0.385
2007	0.366	0.366	0.366
2008	0.339	0.333	0.344
2009	0.341	0.333	0.350
2010	0.367	0.355	0.380
2011	0.351	0.354	0.348
2012	0.297	0.303	0.291
2013	0.321	0.307	0.336
2005-2013	0.348	0.343	0.354

Table 5. Productivity change: technical change and efficiency change

	Malmquist Index (MI)			Technical change (TC)			Efficiency change (CU)		
	Global	Spain	Italy	Global	Spain	Italy	Global	Spain	Italy
2005-2006	1.018	1.018	1.018	1.040	1.068	1.012	0.981	0.953	1.011
2006-2007	1.041	1.050	1.032	1.048	1.017	1.081	0.993	1.033	0.954
2007-2008	0.942	0.947	0.936	1.041	1.054	1.028	0.904	0.898	0.911
2008-2009	0.918	0.910	0.927	0.922	0.921	0.923	0.996	0.988	1.004
2009-2010	1.010	1.022	0.997	0.920	0.940	0.901	1.097	1.088	1.107
2010-2011	1.024	1.042	1.006	1.118	1.087	1.150	0.916	0.958	0.875
2011-2012	1.019	1.025	1.013	1.272	1.252	1.294	0.801	0.819	0.783
2012-2013	1.022	0.995	1.050	0.930	0.965	0.895	1.099	1.031	1.173
Geometric Mean	0.998	1.000	0.997	1.031	1.033	1.028	0.969	0.967	0.969