An exploratory study on the productivity and efficiency of Spanish and Italian wineries

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Abstract:

Purpose: The objective of the paper is to estimate the total change in productivity, broken down into efficiency change and technical change, comparing Italian and Spanish winery sectors.

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: Spanish and Italian wineries show a decrease in their average annual productivity for the period analysed.

Practical implications: The success of these wineries is underpinned on taking actions based on the results of the efficiency and productivity analysis. These results will guide the wineries to improve their competitiveness in the global market.

Keywords: Wineries, Productivity, Efficiency, Malmquist index

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 new wine-producing countries (e.g. Australia, Chile and the USA), which use modern production techniques and up-to-date marketing strategies, has stimulated those of the old world, Spain and Italy included, strengthening their efforts to compete in the international market. Efficiency and productivity analysis has become an important issue for winery managers, as it plays an important role in the 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 due to the characteristics of the sector. The heterogeneous nature of the products obtained (most wineries produce different wines that are sold at different price levels) makes difficult the estimation of efficiency and productivity to inform decision making as the analysis results could be different from product to product.

The paper estimates the productivity and efficiency of Italian and Spanish wineries, with the hypothesis that these countries are far from reaching their potential levels of efficiency and productivity, due to structural problems and/or lack of managerial skills. To verify the performance of the wineries, the paper will try to answer the following questions:

- What is the actual level of efficiency and productivity among Spanish and Italian wineries? How did it change in the period 2005-2013? Is Italy performing better than Spain or vice versa?
- What are the causes of the inefficiencies, if this is the case, among the wineries? How can the wineries improve their performance?

To answer these questions, the research methodology measures productivity change using Malmquist productivity indexes computed via non-parametric techniques. 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 of efficiency that could be attributed to innovation or technological change. The empirical analysis is carried out on a sample of Spanish and Italian wineries between 2005 and 2013.

2. LITERATURE REVIEW

From a methodological perspective, the definition of inputs and outputs is one of the main problems faced when estimating efficiency in the wine industry. When comparing the performance of wine producers it is possible to consider a technical perspective (technical concept of efficiency), 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) (economic concept of efficiency).

Most of the authors consider the technical approach (e.g. Townsend et al., 1998; Bonfiglio, 2006; Vidal et al, 2013; Aparicio et al, 2013). While 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. The results show that the inverse relationship between farm size and productivity is weak, not consistently negative and differs among regions. Bonfiglio (2006)

analyses efficiency and productivity changes of a sample of Italian agrifood cooperatives in the period 2000-2002. Results show that wine cooperatives present the lowest average levels of efficiency. Moreover, their productivity decreased due to a worsening of managerial capabilities. 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 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 the allocative one. The results also showed that revenue efficiency was the greater in the case of PDOs with specific wine products serving niche markets and without clear competition. Although results are not directly comparable, most of the academic papers show low levels of efficiency in the winery sector (e.g. Bonfiglio, 2006; Liu and Lv, 2019;), which could suggest that wineries could improve under the right conditions. 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.

On the other hand, several authors adopt the economic efficiency approach (e.g. Barros and Santos, 2008; Fernandez and Morala, 2009; Fekete et al., 2009;), evidencing also 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. Fernandez and Morala (2009) study the cost efficiency of wine firms in Spain, verifying improvements in global efficiency as well as pure technical efficiency of the analysed firms. Fekete et al. (2009) use the Malmquist index to examine productivity 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 and that 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.

The existing literature shows that several authors have made the effort to analyse efficiency (economic or technical approach) in the wine industry, implementing different methodologies. However, there is a gap in the research of efficiency in the Italian wine sector, since Bonfiglio (2006) focused on the agrifood cooperatives in general, for the period 2000-2002. Literature research highlights that only broad comparisons among wine producing countries have been made (Old World vs. New World, Tóth and Gál (2014) and Fleming et al. (2014)). This paper is an attempt to fill this gap, focusing on specific countries, such as Italy and Spain. The paper provides a fact based analysis of the actual level of efficiency of Italy and Spain. Lastly, the paper will try to point out those factors and strategies that lead to a higher level of efficiency.

3. METHODOLGY, SAMPLE AND VARIABLES

3.1 Methodolgy

The Malmquist index, estimated using distance functions, allows changes in productivity to be broken down into technical change and efficiency changes (Caves et al.1982). Technical change reflects the frontier shift over time while the efficiency change represents deviations from the best practice frontier. In simpler terms, 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 efficiency frontier of the winery between the two periods of time.

The Malmquist index based on outputs uses output distance functions defined on the output set, P(x) = {y : x can produce y}, as (Farrell, 1957):

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

and it 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:

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

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), the second (TC) is the index of technical change between the two periods evaluated as a result of frontier displacement both between years *t* and *t+1*. A value of the CU ratio or TU ratio greater than one indicates productivity growth as a consequence of an efficiency improvement or a frontier shift (technical progress) respectively between period *t* and period *t+1*. A value of the CU ratio less than one indicates efficiency decline.

As it is not possible to observe the real set of production possibilities, the indexes which describe productivity, efficiency, and technology changes, as well as the distance function

must be estimated. Particularly, we have considered a DEA model (Färe et al., 1994) to measure the distance functions. In addition, 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

Spain and Italy are two of the world's leading wine producers and the wine industry is a relevant economic sector in terms of added value it generates, number of people employed and for the country balance of trade (Table 1). However, a significant drop in domestic consumption, which caused a significant imbalance between internal supply and demand, offsets these positive aspects. Export growth and new market entry are key requirements to ensure the viability of the sector.

Table 1 Main characteristics of the Spanish and Italian wine sectors.

	Spain (2013)	**Italy (source ISTAT, 2010)**
Vineyard surface area (ha)	950,639	664,296
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	4,500 (approx.)	31,875

The methodology proposed is based on samples of Spanish and Italian wineries between 2005 and 2013. The Spanish sample is obtained from the SABI database (which provides accounting information on Spanish companies). The initial sample is comprised of 2,563 firms. The Italian sample is obtained from the AIDA database (which provides accounting information on Italian companies). The initial sample is comprised of 1,196 Italian wineries, after exclusions to remove outliers and reduce the number of infeasibilities of the Malmquist index, the final sample is comprised of 622 Spanish and 609 Italian wineries. The Spanish and Italian final sample represents 57.22% and 55.65% of total wineries' revenue for 2013, respectively.

The total factor productivity is estimated using three inputs and two outputs. The consistency of the variables is guaranteed even when using two different databases, because both store published accounting data that is highly harmonized across countries in the European Community. This paper uses two monetary outputs:

i) sales revenue of each winery, because the wineries work with multiple wines that are sold at different prices. The availability of non-aggregated information on outputs produced is

usually not available for large samples;

ii) profit of the winery, since: a) wineries can obtain atypical income apart from their main activity, which is not included in their sales volume figures; b) 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 c) considering the profits allows for inclusion of the influence of other types of costs not considered as inputs.

With regard to inputs, three controllable productive factors are used: i) number of employees, as the 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). The 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 are considered: i) gross domestic product; and ii) employment rate (both related to the economic environment); ii) volume of wine production, which considers to a certain extent factors related to climate; and iii) domestic wine consumption (both contextual setting variables related to the wine sector). We included environmental variables directly into the DEA linear program formulation as non-discretionary inputs (Ferrier and Lovell, 1990). 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.

4. RESULTS

The non-parametric DEA methodology has been applied for the estimate of the wineries' efficiency. A common frontier has been estimated (Table 2) in order to establish a cross-country comparison. The basic assumption is that the production technology substantially doesn't differ between Spanish and Italian wineries, since the structure and characteristics of the industry in these two countries is very similar. For the period under analysis, 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, indicative of a high degree of inefficiency in the wine industry. On average the wineries could have achieved the same levels of outputs using 65.2% fewer resources (Table 2). The analysis results show 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 bigger 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. This result confirms the idea that Italian wineries are able to value the wine in the market to a higher extent than Spanish wineries. Regarding the evolution of the efficiency for the period analysed, Table 2 shows that the efficiency declines after 2010 in both countries.

Table 2 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

To estimate the Malmquist productivity index the Färe et al. (1994) proposal has been employed. The results obtained are shown in Table 3.

Table 3 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

The results suggest that in the period 2005–2013, the Spanish and Italian wineries have experienced an annual productivity change of -0.02%, which is explained by the confluence of two factors acting with contrary signs: the 3.1% improvement as a consequence of frontier shift, which is interpreted as technical change (TC), and 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. The negative catching up effect (–3.12%) implies that the efficiency of the wineries decreases over the period of time analysed. This pattern is very similar in both countries. For the Spanish sample, the results show that the annual average productivity is constant for the global period considered, which is explained by the confluence of two factors acting with contrary signs, the 3.3% improvement as a consequence of frontier shift (TC) and the 3.3% negative catching up (CU) effect. For the Italian sample, the results show an annual average productivity decrease of 0.03%, which is also explained by the confluence of two factors acting with contrary signs: the 2.8% improvement as a consequence of frontier shift and the 3.1% negative catching up effect.

The results confirm the idea that the positive contribution of technological progress to productivity growth is offset by a deterioration of the wineries' efficiency. The widening gap between wineries and the technological advances suggest that much of the decrease in efficiency can be attributed to the wineries' failure to adapt to the technological improvements made by the leading competitors. Few wineries are innovators and shift the frontier, while most of the other wineries fail to adapt to the technological improvements and fall behind.

The study highlights an important decrease in productivity between 2007 and 2009. Although it is 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. This was a substantial modification in the market conditions, because many firms had to establish new business channels to sell large volumes of wine that were previously dedicated to alcohol distillation for oral use.

5. CONCLUSIONS

Results show high levels of inefficiency in the Spanish and Italian winery sector and a slight decrease in the average annual productivity among the firms analysed between 2005 and 2013. The results shown are aggregate for a productive system which is extremely heterogeneous (especially in Italy). The use of mean values hides those wineries that are innovative and efficient and equally those that are extremely inefficient. In many cases, in both Italy and Spain, inefficiency can be interpreted as the result of a lack of knowledge about certain critical aspects of the productive activity. Being able to measure performance is crucial to quantify the loss of value due to poor performances in a productive activity. In order to improve revenues, firms should be able to identify the sources of poor performance and implement plans to make better use of their resources. 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 processes.

The negative evolution of the total productivity over the period of time considered is the consequence of two forces with contrary sign, as the positive contribution of technological progress to productivity growth is offset by a deterioration of the wineries' efficiency against the technology frontier. Most of the wineries fail to adapt to the technological improvements: 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. Results also show a decline in the productivity between 2007 and 2009, when the distillations subsidized by the CMO disappeared. This fact highlights the importance that regulators have in defining the future of the wine industry.

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