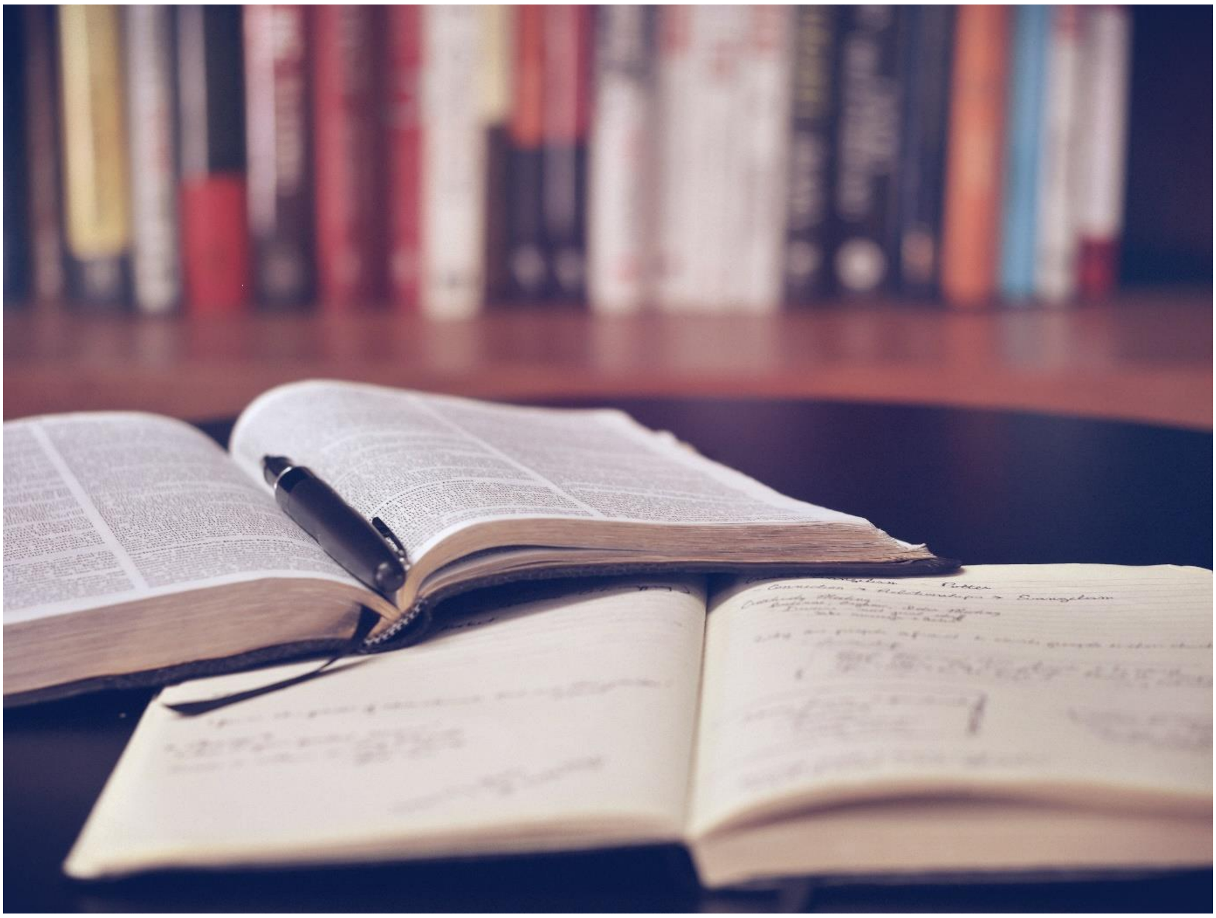
UMR CNRS 6240 LISA

Working Paper TerRA n°10

15-05-2018



In vino feracitas! Efficiency of wineries in and out of Sardinia's wine routes

Maria Giovanna Brandano, Claudio Detotto, Marco Vannini

In vino feracitas! Efficiency of wineries in and out of Sardinia's wine routes

Maria Giovanna Brandano[°], **Claudio Detotto***, **Marco Vannini**[+]

[°] Corresponding author: *University of Sassari* and *CRENoS (Italy)*, Via Muroni 23, 07100, Sassari-Italy, telephone number: +39079213511, ORCID ID: 0000-0001-9301-4505. Email: mgbrandano@uniss.it.

[+] *University of Sassari* and *CRENoS (Italy).* Email: vannini@uniss.it

[*] *University of Corsica (France)* and *CRENoS (Italy).* Email: claudio.detotto@universita.corsica

Abstract

The interest of travellers in wine tourism has been steadily increasing since the 1990s. Consequently, many regions around the world have adopted a variety of policies intended to promote eno-gastronomic tourism. In Sardinia (Italy) this form of tourism has shown a significant upward trend, and today provides a valuable opportunity to rural and often vulnerable inland communities to boost and diversify their economic structure. To encourage this type of tourism, in 2009 the Regional government identified some historic territories of the island and implemented the "wine routes programme" (WRP). These territories were selected according to their importance for growing local grape varieties and showcasing vineyards and winery establishments. The mandate of the routes was to create value around the local viticulture traditions, by sustaining the production of quality wines and by guiding visitors to the discovery of local produce, heritage landmarks and various expressions of the country's popular culture. Since winemakers play a pivotal role, the impact of the WRP on the performance of wineries is of paramount importance to achieve the final goal. To assess the impact of the WRP on the performance of local producers we carry out a controlled before-and-after study, taking the wineries within the wine routes areas as the treated units and the rest of the population as the untreated or control group. The performance of wineries is captured by the scores of a data envelopment analysis (DEA) over the time span 2004–2012. Findings reveal that the WRP increased the technical efficiency of wineries.

1. Introduction

Since the 1990s, wine tourism has grown steadily everywhere, not only in Europe but also across the wine-producing regions of the Northern and Southern hemisphere. As of today, it represents a major segment of gastronomy tourism, or more generally of culture tourism, and it is widely believed to be an effective driver of local development. With few exceptions, however, the relationship between tourism and wine had long been neglected by governments, researchers and enterprises (Hall *et al.*, 2000). In this context, the wine route - either as a spontaneous partnership or as a policy induced joint initiative among winegrowers, rural tourism businesses and public bodies or both - has emerged as the most relevant vehicle for linking wine and tourism, combining both the tangible and intangible dimensions of the wine tourist experience.

Around the world one can find different types of wine routes. An example could be the “boutique winery” that broke out in Australia back in the 1960s and 1970s contributing to the rapid expansion of this New World’s wine industry. This concept refers to many newly established small wineries that based their business on direct sales and visitations. They became quickly very popular and marked the beginnings of the Australian wine tourism. In the 1990s, Australian tourism bureaus acknowledged the importance of wine tourism as a regional development opportunity and started integrating wine tourism into the overall tourism product in a market mostly concentrated in metropolitan areas (Hall and Macionis, 1998). As regards Europe, perhaps the oldest wine routes are those located in Germany along the ancient Roman vineyards. They go back to the 1920s and by the 1970s every region had a wine itinerary. In France the first modern wine routes were created in the 1960s in the Alsace region. Nowadays wine routes are proliferating given the desire to learn more about wine, the wish to discover the world of wine and its undisputed allure (Gatti and Incerti, 1997). In more recent years, official wine routes (also roads or trails), i.e. networks propelled by some local government or business association, backed by formal agreements among the parties, linking the actors of an area with the aim of creating value around the culture of wine, have been established in Portugal, Spain and Italy. Eastern European countries, such as Hungary, have followed suit. These developments are an integral part of today's wine tourism industry (Bruwer, 2003), but it is only recently, as stressed by Hall and Mitchell (2000), that wine and tourism have been linked for addressing the issue of global rural restructuring.

Italy, the first wine producer in the world in 2016 (OIV, 2017), is one of the few countries which have two national associations that *de facto* coordinate the wine-tourism activities: Wine Tourism Movement (*Movimento del Turismo del Vino* – MTV) and Cities of Wine (*Città del Vino* - CW). The former, started in 1993 by a small group of winemakers that it has now grown to more than one thousand members across the country, prompted wine tourism not only by requiring associated members to stick to agree upon principles of cellar door hospitality, but also by promoting popular events like "cantine aperte" or "calici sotto le stelle". The latter, established shortly after the 1986 wine adulteration incidents, brings together a sizeable group of Italian local authorities from wine areas with the aim of carrying out communication, education and dissemination projects on the strategic role of quality winemaking for sustainable local development.

Against this backdrop of growing attention to wine routes as instruments of wine tourism development, here we attempt to measure the impact of such routes on the efficiency of local winemakers. To this end, we study the implementation of wine routes in the island of Sardinia and apply the difference-in-difference methodology, which basically evaluate the effectiveness of a program by comparing the average outcome of participants (the treated group) and non-participants (the non-treated or control group), by considering the wineries belonging to wine routes areas as our treated group and the rest of the wineries as the control group.

The paper is organized as follows. Section 2 illustrates the context of wine routes in Italy. Section 3 provides a brief overview of the literature related to a) wine and tourism and b) efficiency of wineries, with a focus on DEA. Section 4 describes the case study under analysis and the data. Section 5 explains the methodology used. Section 6 discusses the results and finally, Section 7 gives the main conclusions.

2. Wines routes in Italy

The Law n. 268 of 27 July 1999 and the associated Ministerial Decree of 12 July 2000 are the main pieces of legislation concerning the wine routes in Italy. They refer to wine routes as *"carefully signposted and publicized trail/roads, encompassing natural, cultural and environmental amenities, vineyards and wine cellars open to visitors. They constitute a tool for wine-oriented areas and their produce to be promoted, marketed and enjoyed as a tourist product".* In light of this official acts, regions have the possibility to establish wine routes at the local level. By 2013, according to CW, Italy boasted over 150 wine routes encompassing around 1,450 municipalities. While these numbers kept growing, it is important to notice that around 50% of the wine routes are still in a starting phase. This is hardly surprising, given the significant coordination efforts and specific investments that local administrations have to make in order to attain fully-functioning wine routes. Moreover, many of the targeted wine areas are located in regions which are lagging behind precisely because of the poor performance of local institutions at providing public goods and overcoming market failures. It is worth stressing that some regions, like Friuli Venezia Giulia, established some wine routes back in the 1970s, i.e. well before the 1999 act. Since then, the number of wine routes has continued to expand especially in the North (57 routes), followed by the South (41), the Centre (32) and the Islands (17). The regions with the highest number of wine routes are Tuscany (17) and Veneto (16), which are two of the most famous producer of Italian wine with protected names, i.e. Protected Denomination of Origin (PDO) and Protected Geographical Indication (PGI).

The regional distribution of wine routes along with the number of PDOs and PGIs is given in Table 1.

Table 1. Italian Wine Routes in 2017

REGIONS	**Number of wine routes**	**PDO**	**PGI**
Aosta Valley	1	1	0
Piedmont	7	59	0
Liguria	1	8	4
Lombardy	8	26	15
Veneto	16	43	10
Friuli Venezia Giulia	7	16	3
Trentino-South Tyrol	6	9	4
Emilia Romagna	11	21	9
NORTH	**57**	**183**	**45**
Tuscany	17	52	6
Marches	7	20	1
Umbria	4	15	6
Lazio	4	30	6
CENTRE	**32**	**117**	**19**
Abruzzo	6	9	8
Molise	1	4	2
Campania	11	19	10
Basilicata	1	5	1
Apulia	11	32	6
Calabria	11	9	10
SOUTH	**41**	**78**	**37**
Sicily	10	24	7
Sardinia	7	18	15
ISLANDS	**17**	**42**	**22**
ITALY	**147**	**420**	**123**

Source: Authors elaboration

Note: PDO and PGI data are provided by ISMEA (2017)

As shown by Asero and Patti (2009), the number of wine routes per region is associated with the quality of wines. Indeed, the Spearman correlation between the ranking of regions per number of wine routes and the ranking of regions per number of wines registered as PDO and PGI is positive and statistically significant. In particular, the results for the year 2017 indicate a strong correlation for PDOs (ρ=0.71) and a moderate correlation for PGIs (ρ=0.55; see Table 2).

Table 2. Italian Wine Routes and PDO/IGP Spearman correlation

	Wine routes	PDO	PGI
Wine routes	1.0000		
DOP	0.7128*	1.0000	
IGP	0.5504*	0.2857*	1.0000

Note: * specifies that the correlation coefficients are significant at the 5% level or lower.

3. Overview of the literature

In recent years the role of wine routes has been studied in relation to both the tourism sector and the wine industry (e.g. Brunori and Rossi, 2000 for Italy; Correia *et al.*, 2004 for Portugal; Bruwer, 2003 for South Africa and Peris-Ortiz *et al.*, 2016 for selected countries around the world). In this section we briefly recall two sets of contributions that motivate and help to interpret our exercise, namely a) wine routes and tourism and b) efficiency of wineries.

Wine routes and tourism

In Italy the first paper on wine routes and their socio-economic effects focuses on the case study of Tuscany (Brunori and Rossi, 2000). According to these authors, a successful wine route exerts a twofold effect on farms: on the one hand, existing activities become more profitable simply because the area and its products gets more appealing to consumers (*localization effect*); on the other hand, it opens up new opportunities for their business (*synergy effect*). Moreover, when the wine route is effective it adds value to the agricultural sector that drives the rural development. More recently, Santeramo *et al.* (2017) study the synergies between the wine and the tourism sectors through a standard gravity model over the period 2008-2012 in which domestic tourist arrivals in a region depend, in addition to mass and relative distance between generating and destination locations, on a number of key indicators of the wine industry. The authors find that PDOs and wine exhibitions positively affect tourism flows. On the contrary, the number of credited wineries and PGIs are negatively correlated with tourist arrivals at the regional level. Given the strong correlation between wine routes and quality denominations, one may be tempted to interpret the significant coefficient of PDOs as evidence that wine routes matter. But since the break in legislation occurred before the timespan of the analysis, this interpretation is not warranted.

Turning to case studies outside Italy, Telfer (2001) examines the Niagara wine route by qualitative in-depth interviews conducted at 25 local wineries. The author finds that strategic collaborations between wineries, food industries and tour operators located in the region as well as aggressive marketing policies were crucial for additional on-site wine and related merchandise sales. By applying a similar methodology to a sample of South African wineries located in the most representative wine routes of the country, after remembering that all wine route estates are per se involved in wine tourism, Bruwer (2003) examines to what extent the structure of the wine industry leads towards a lesser or greater involvement in wine tourism. It is found that, unlike larger suppliers, smaller estates participate more actively in wine tourism through the wine route. But are wine routes effective in creating value for affiliated wineries? Correia *et al.* (2004) attempted to answer the question by collecting the opinions of winery managers around the Bairrada wine route, Portugal. Four years after 1999, when the wine route started, only 29% of the respondents believed that they achieved the initial goals. More recently, Hojman and Hunter-Jones (2012) analyse Chilean wine routes by investigating the role that wine tourism plays in the strategies of a winery. Authors find that two broad different strategies are prominent among wineries: some see enotourism as a key link in a long-distance relationship strategy, with high quality productions; others consider wine tourism a key element of survival. This latter strategy denotes poor performances in wine production or exports.

Efficiency of wineries

Efficiency studies of wineries based on the non-parametric method called Data Envelopment Analysis (DEA) represent a relatively recent entry to wine economics (see section 5 below for a snapshot of the technique). Several papers analyse specific case studies in Europe, traditionally the most productive continent, with Spain emerging as the most studied country in this context.

Arandia and Aldanondo (2007) analyse 86 wineries in 2001 and find that organic wine producers are more efficient than conventional firms. Fernandez and Morala (2009) focus on the case of Castilla Leon region in the years 2006-2007. According to the DEA scores obtained from their sample, comprising 66 winemaking companies, about 23% of the companies are globally efficient in 2006 and 26% in 2007. Moreover, since the average score of the inefficient firms in both years are similar and slightly over 0.82, there is room for improving technical efficiency. In order to investigate the efficiency of 1,222 Spanish wineries in 2007, Sellers-Rubio (2010) applies both traditional methods and DEA. Results from different approaches do not converge and no dominant measure emerges. More recently, the case of Spain has been revisited by Sellers-Rubio and Mas-Ruiz (2015) and Sellers-Rubio *et al.* (2016). The first work assesses the impact of PDO labels, a collective reputation indicator which is assumed to trigger investments, on the efficiency of wineries. Data include 1,257 wineries: 437 are not members of any PDO, 820 are members of at least one the 58 PDOs represented in the sample, 110 are members of more than one PDO. Measured efficiency is rather modest for all firms in the sample, however both the non-parametric test on the DEA scores and the post-DEA regression analysis show that PDO companies have significantly higher economic efficiency than the non-PDO companies. The second contribution, on the total productivity change in a sample of Spanish and Italian wineries in the period 2005-2013, shows a declining Malmquist productivity index in both countries.

The efficiency of the Portuguese wine industry is analysed through DEA also in the works of Barros and Santos (2007) and Henriques *et al.* (2009). The former compares the efficiency of private wine-making companies and cooperatives operating in the same market on the basis of a panel dataset for the period 1996-2000. Out of 27 decision making units, 7 are cooperatives. Their main result indicates that cooperatives are, on average, more efficient than their privately-owned counterparts. Henriques *et al.* (2009), focussing on 22 wineries located in the Alentejo region for the years 2001 and 2004, after decomposing the calculated DEA efficiency scores into the three components (pure technical, scale and congestion efficiency), conclude that there is room to improve efficiency by mitigating scale and congestion inefficiencies.

The efficiency of Italian wineries, which are often organized as co-operatives with vineyard owners as members/owners who deliver the grapes to the winery (cantina sociale) for the production of wine and subsequent marketing activities, is analysed by Brandano *et al.* (2018) with reference to Sardinia. They study the whole population of winemaking companies operating in the island, which comprises 22 conventional firms and 20 co-operatives, over the period 2004-2009. The post-DEA bootstrap regression analysis shows that co-operatives producers are less technically efficient than conventional firms. Galluzzo (2014) examines the technical and economic efficiency of Italian wineries during the period 2008-2011. The dataset includes both organic and conventional producers in order to identify the most efficient group, which is found to be the conventional one. Seller and Alampi-Sottini (2016), by using a sample of 723 Italian wineries (both conventional and cooperatives) for the year 2013, find that size matters: positively affecting the economic performance of firms. Finally, Sellers-Rubio *et al.* (2016) compare Italian and Spanish wineries, between 2005-2013, relative to a common frontier. Italian wineries seem to be more efficient than the Spanish, even though the scores decline in both countries after 2010. The non-parametric approach that characterizes the majority of studies described above, sometimes combined with post-DEA multivariate regressions, has been applied to measure the efficiency of wineries also in many non-European countries, like China (Liu and Lv, 2010), South Africa (Townsend *et al.*, 1998) and Turkey (Bayramoglu and Gundogmus, 2008).

All in all, these efficiency studies point out that significant improvements can be reached almost everywhere mostly by adjusting firm-level factors and/or changing the scale of production. Efficiency gains may also come from adopting quality denominations, from knowledge spillovers between local operators as well as cellar doors relationship with customers. To our knowledge, however, despite the large number of internal and external, factors considered, little is known about the overall impact on the outcome "efficiency of wineries" of the treatment "wine route". Taking advantage of our sample properties, in what follows we try to fill this gap by estimating a post-DEA difference-in-difference (DD) model.

4. Case study and data

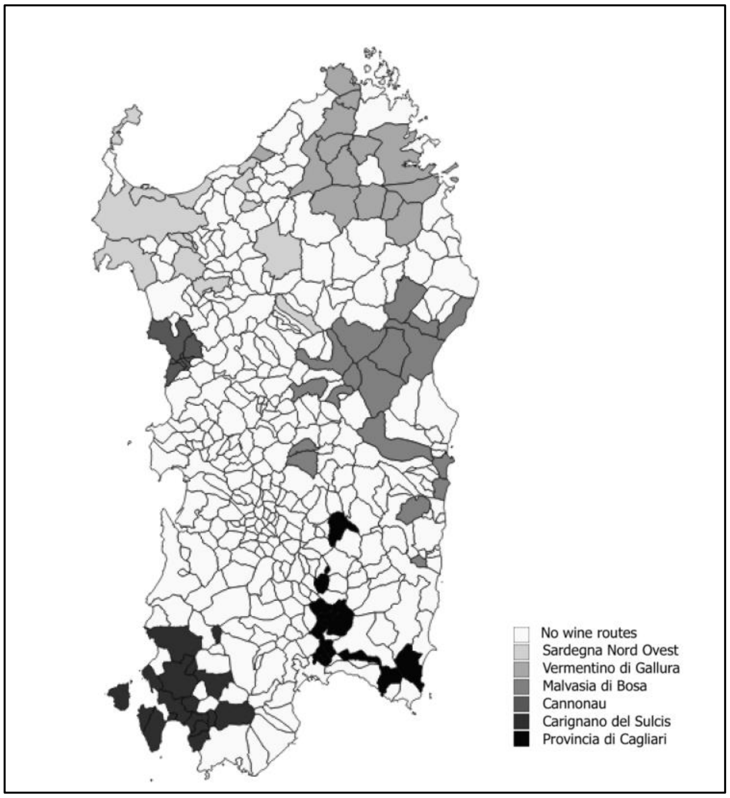
Up until 1999, when the legislation described in Section 2 finally passed, Sardinia did not boast any wine route. In line with the new regulation, in 2006 the Sardinian government stepped in and launched the wine routes programme (WRP), i.e. set a framework (see deliberation 45/14 of 2006), addressed to all interested and entitled parties, for establishing the wine routes. Accomplishing the task was easier said than done, owing to the richness of the local viticulture with its 14 core grapes and 18 quality appellations. Eventually, in 2009, seven routes were agreed upon as a result of a two-way process that involved both top-down initiatives by local authorities and bottom-up actions by winemakers, business associations and stakeholders. The grapes central to these routes are Cannonau, Vermentino, Carignano, Malvasia, Vernaccia and Nuragus. The first three, along with other grapes, are grown all over the island, while the remaining are only grown in specific territories. That is why the official names of the routes, listed below along with the associated provinces, sometimes omits the name of the core grape:

- *Carignano del Sulcis* (Carbonia –Iglesias Province);
- *Cannonau* (Nuoro and Ogliastra Provinces);
- *Provincia di Cagliari* (Cagliari Province);
- *Vernaccia di Oristano* and *Malvasia di Bosa* (Oristano Province);
- *Vermentino di Gallura D.O.C.G.* (Olbia – Tempio Province);
- *Sardegna Nord Ovest* (Sassari Province).

It is worth stressing that the WRP aimed at preserving and enhancing the production of quality wines, especially under the designation DOCG (Controlled and Guaranteed Denomination of Origin) and DOC (Controlled Designation of Origin). Further goals, spelled out in the framework regulation, are as follows: a) to foster the social and economic growth of rural and inner areas (characterized by high rates of unemployment and demographic decline); b) to increase the appeal of the designated territories as tourist destinations; c) to develop synergies with local popular culture, culinary traditions and sustainable management of environmental resources. In short, wine routes should act as magnets for attracting visitors and a catalyst to economic development.

The map in Figure 1 shows the territories in which the wine routes are situated. It doesn't include the Wine route of Vernaccia di Oristano which has not been implemented yet. It is interesting to note that most these territories stretch from unique coastlines into wild mountainous interiors, providing diverse landscapes often encompassing off-the-beaten-track destinations.

Figure 1. Map of Sardinian wine routes. Year 2017



Source: authors elaboration

Data

In order to analyse the efficiency of wineries and the impact of the WRP on local producers, we collected information about all Sardinian winemaking enterprises established as limited liability companies for the period 2004-2012. Business entities not considered in the study are mainly small winemakers producing for self-consumption organized as partnership or sole proprietorship. Unfortunately, the dataset is an unbalanced panel due to missing observations on some covariate. However, a large sub-panel (43 firms) is observed throughout the period of study for a total of 343 observations in the time span under analysis. The dataset includes both capitalist (or conventional) firms and agricultural (or winemaking) co-operatives. Accounting practices across the two types of organisations are not homogeneous. This refers in particular to the labour costs of the wine growers/members of the co-operatives, which are not explicitly considered in the co-operative income statement. However, since they are incorporated into the value of intermediate consumption, i.e. of the grapes delivered by members (vineyard owners) to the co-operative, we generate a composite variable, valid for all firm types, which reflects direct and indirect labour costs plus the value of any goods and services used as intermediate consumption.

In order to measure firm-level efficiency through DEA, we consider three inputs (labour, capital and land) and one output (sales revenue), all measured in monetary terms except for land. As in Brandano *et al.* (2018), labour is captured by the composite indicator (L) mentioned above, whereas capital (K) is the book value of buildings, machinery and other fixed assets except for land used in production. Land (T) indicates, for each unit and each year, the size in hectares of the vineyards. AS for the outputs, we use companies' sales revenue (S) that represents the product between the price at which goods are sold and the number of units sold (Pulina *et al.*, 2010; Detotto *et al.*, 2014). Table 3 shows the descriptive statistics of the variables used.

Table 3. Descriptive statistics: DEA inputs and output (# 343 obs.)

Variable	Type	Measurement unit	Mean	sd
K	Input	in thousands of €	3955.329	7884.839
L	Input	in thousands of €	2766.499	3488.243
T	Input	in hectares	263.921	272.664
S	Output	in thousands of €	3183.25	4990.307

Note: The variables *K*, *L* and *S* are expressed in real term (reference year 2010).

We assess the technical efficiency of our firms with reference to a common production frontier estimated using data envelopment analysis (DEA). The efficiency indicators derived from this calculation - the scores - are then further examined in a difference-in-differences (DD) application aimed at gauging the effect of the WRP on the efficiency of wineries, controlling for additional environmental variables. To implement this latter design, which allows the estimation of the causal effect of a specific intervention or treatment (here the WRP) by comparing the changes in outcomes (here the efficiency of wineries) over time between a population that is exposed to the programme (the intervention or treated group, here the wineries belonging to a wine route) and a population that is not (the control or untreated group, here the wineries located outside the wine route areas), we generate a dummy variable, $WINEROUTE_{it}$, which takes 1 if the *i*-th winery belongs to a wine route in a given year *t* and zero otherwise.

In detail, there are 21 treated wineries and 22 untreated. Table 4 depicts the descriptive statistics for both groups separately. Notice that the treated group shows higher values for all the variables observed.

Table 4. DEA descriptive statistics by group

	Untreated group		Treated group		
Variable	Mean	sd	Mean	sd	|test|
K	1633.379	221.330	5825.111	720.352	5.067*
L	959.189	65.249	4221.858	296.653	9.715*
T	107.738	10.401	389.689	21.222	11.087*
Sales	784.882	93.279	5114.574	432.775	8.843*

Note: * the difference between the means of the two groups is significant at the 5% level or lower.

5. Methodology

Data Envelopment Analysis

The DEA approach measures the efficiency of a given decision-making unit (DMU) evaluating its performance relative to an estimated production frontier generated by the best performing units in the sample. Unlike the parametric approach, which requires the specification of the functional form of the production function and its disturbance term a priori, DEA is a flexible technique that, in a multiple input-output framework, focuses on a virtual single-input-output structure (Charnes *et al.*, 1978). Mathematically, the efficiency

($\hat{\theta}$) of the *i*-th DMU is given by the following expression (see Simar and Wilson, 2000):

$$\hat{\theta} = \min\{\theta > 0 \mid y \le \sum_{i=1}^{n} \gamma_i y_i; \\ x \ge \sum_{i=1}^{n} \gamma_i x_i; \ \sum_{i=1}^{n} \gamma_i = 1; \ \gamma_i \ge 0, \ i = 1, \ldots, n\} \tag{1}$$

where γ_i is a vector of nonnegative parameters, and y_i and x_i are the observed vectors of outputs and inputs of the *i*-th DMU, respectively. This calculation is repeated for each year included in the analysis. A given DMU is deemed technically efficient or inefficient as long as $\hat{\theta} = 1$ or $\hat{\theta} < 1$. In order to take into account both scale efficiency and pure technical efficiency, we adopt the variable return to scale (VRS) model. Furthermore, because wine firms have more control over their inputs than over their output (at least in the very short-run), the input-oriented model seemed more appropriate.

Difference-in-Differences Estimation

The difference-in-differences (DD) method is the simplest way in observational settings to compare the outcomes overtime for two groups. In the simplest set up, in which outcomes are observed for two groups for two time periods, one of the groups, the treated one, is exposed to a treatment only after time *t*. The second group, called the control or untreated group, is not exposed to the treatment in either periods. As long as the same units within a group are observed in all periods, the average gain in the control group is subtracted from the average gain in the treatment group. This removes biases in the after-treatment period comparisons between the treatment and control group that could be the result from permanent differences between those groups, as well as biases from comparisons over time in the treatment group that could be the result of trends (Imbens and Wooldridge, 2007).

In a panel data framework, the DD model can be written as follows:

$$y_{it} = \lambda_t + \tau \, WINEROUTE_{it} + x_{it}\beta + u_i + \varepsilon_{it} \tag{2}$$

where y_{it} represents the DEA score for a given winery i at time t, as calculated in Equation (1). $WINEROUTE_{it}$ is the binary variable indicating the treatment and τ measures the gain in terms of DEA efficiency obtained by the firms after the implementation of the wine routes programme. ε_{it} is a continuous *iid* random variable. Then, λ_t and u_i represent time and individual fixed effects.

Finally, x_{it} contains the constant term and a set of time-varying covariates that could affect firm's efficiency and β is a vector of parameters. These covariates measure factors outside the control of the DMUs like temperature ($TEMP_{it}$) and precipitations ($RAIN_{it}$). Climate is a factor of the outmost importance to the viability and success of the wine industry. In general, viticulture requires moderate climate oscillation. We control for these components including local variations in temperature and rain precipitation between April and October. The two variables are calculated as the ratio between the annual average values at time t and the annual average values in the two years before. Values higher (lower) than one are associated with higher (lower) values of temperature and rain precipitation compared to past observations. The variables are observed at municipality level and then attributed to the wineries according to their location. Table 5 shows descriptive statistics.

Table 5. Post DEA descriptive statistics of covariates by groups

	Sample population		Untreated group (A)		Treated group (B)		
Variable	Mean	sd	Mean	sd	Mean	sd	|test|
RAIN	-0.004	0.056	-0.247	0.038	-0.274	0.034	0.518
TEMP	-0.262	0.470	-0.007	0.006	-0.001	0.001	0.915

Note: * the difference between the means of the two groups (A and B) is significant at the 5% level or lower.

The Nearest-neighbour matching

One of the possible drawbacks of the DD approach is related to the endogeneity of treatment. This issue can be due to individual self-selection or to the fact that some unobservable firm's characteristics can affect both the response variable and the likelihood to be treated. One solution is proposed by Wooldridge (2002, pp. 285). Basically, the procedure requires to re-estimate Equation (2) by leading the treatment variable $WINEROUTE_{it+1}$ by one period. An alternative procedure is based on the nearest-neighbour matching approach (Abadie and Imbens, 2006). Since the treated and control groups seem to be highly different regarding their inputs and output (Table 4), the latter method allows to identify similar pairs of (treated and untreated) units according to their inputs levels. Similarity between firms is based on a weighted function of the inputs for each observation. The average treatment effect (ATE) is computed by taking the difference between the treated group and the potential similar group.

6. Results

DEA results

In the first step we calculated the DEA efficiency indicator in each year. The results are shown in Table 6. The sample average efficiency score equals to 0.838 and no difference is detected between the two groups in the overall period. However, looking at their performance before and after the treatment, one can notice that, on average, their efficiency falls, with the decline being much more marked among the untreated wineries (Table 7). This pattern becomes even more evident when depicted as in Figure 2. Whilst the untreated firms are, on average, marginally more efficient before the implementation of the WRP (0.860 vs 0.851), afterwards they become the lagging group (0.791 vs 0.834).

Table 6. DEA efficiency scores

	All sample		Treated group		Untreated group	
Scores	Mean	sd	Mean	sd	Mean	Sd
θ	0.838	0.010	0.843	0.013	0.832	0.016
Number of obs.	343		190		153	

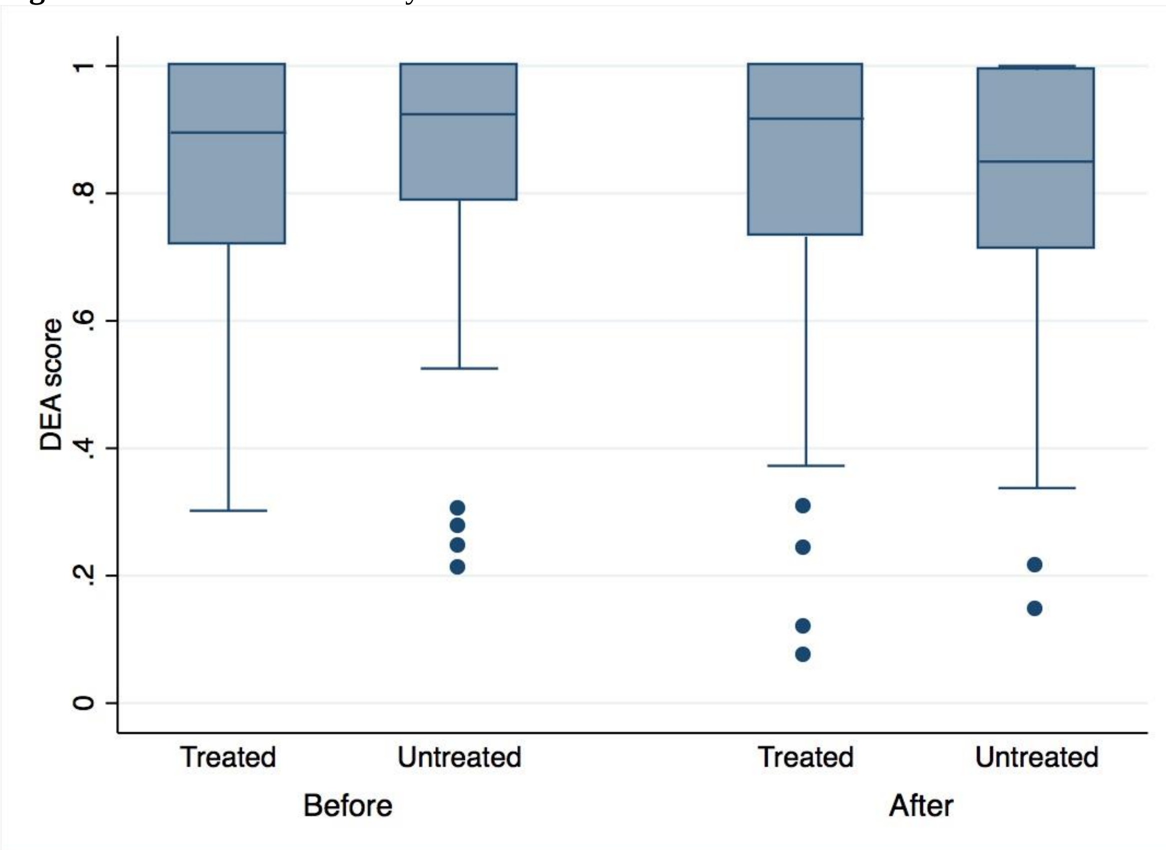
Table 7. DEA efficiency scores before and after the treatment

	Before the treatment		After the treatment		
	Mean	sd	Mean	sd	|t-test|
Treated group	0.851 $^{(A)}$	0.014	0.834 $^{(B)}$	0.023	0.622 $^{(1)}$
Untreated group	0.860 $^{(C)}$	0.018	0.791 $^{(D)}$	0.030	2.086 $^{(2)}$*
|t-test|	0.401 $^{(3)}$		1.146 $^{(4)}$		

Note: 1,2,3 and 4 represent, respectively, the t-values of the tests on the difference between the following sample means: (A)-(B), (C)-(D), (A)-(C) and (B)-(D).

* the difference between the means of two groups is significant at the 5% level or lower.

Figure 2. DEA scores efficiency before and after the treatment



Post-DEA results

The first set of findings refer to the DD model formulated in Equation (2) with a fixed effects estimator. The WRP impact is significant in all the specifications and it ranges between 0.084 and 0.099, which means that it brought about an increase in wineries technical efficiency of about 0.1 units in terms of DEA scores (see Table 8). In column (3) of Table 8, we split the binary treatment variable into three ones in order to understand if its impact is constant over time or not. The findings confirm that the impact is higher and statistically significant only in 2011 and 2012. The rationale is that the implementation of the wine routes took some time to produce its effects.

Looking at the remaining covariates, *RAIN* and *TEMP* are significant. The interpretation is that positive variations in terms of rain precipitation or temperature compared to short-run average leads to an increase of DEA efficiency scores.

Table 8. POST-DEA regression results (FE model). Dependent variable: DEA scores

Variables	(1)	(2)	(3)	(4)	(5)
WINEROUTE	0.095**	0.099**		0.084**	0.095**
	(0.038)	(0.038)		(0.039)	(0.039)
$WINEROUTE_{2010}$			0.012		
			(0.028)		
$WINEROUTE_{2011}$			0.073*		
			(0.046)		
$WINEROUTE_{2012}$			0.20**		
			(0.076)		
RAIN				0.30***	0.13**
				(0.063)	(0.061)
TEMP				0.076***	0.0072
				(0.017)	(0.021)
Trend	-0.13***			-0.078**	
	(0.033)			(0.030)	
Constant	0.86***	0.85***	0.86***	0.87***	0.84***
	(0.005)	(0.017)	(0.017)	(0.006)	(0.021)
Year dummies	No	Yes	Yes	No	Yes
Observations	343	343	343	343	343
R-squared	0.091	0.343	0.372	0.159	0.345
Number of firms	43	43	43	43	43

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Robustness checks

In line with the recommendations of Imbens and Wooldridge (2007), we test for the presence of individual trend components, and the null hypothesis of jointly zero coefficients cannot be rejected. This allows to use the Fixed effects approach instead of the First-difference estimator in equation (2). The endogeneity of the treatment variable is also tested using Wooldridge procedure (2002), and the null hypothesis of endogeneity cannot be rejected. Finally, the Wooldridge test for autocorrelation confirms the absence of first-order autocorrelation (Wooldridge, 2002).

As indicated in Table 4, treated and control firms are characterized by different levels of inputs and output, with the former group handling significantly larger amounts than the latter. This difference could be an issue if we think that only the biggest firms entered the wine routes programme leading to a treatment selection bias[1]. The result could be an upward bias of our DD estimates.

In order to avoid (or reduce) this selection bias, we employed a nearest-neighbour matching approach: for each treated individual *i* the control individual with the smallest distance from individual *i* is selected. The pairs selection is run according to the level of inputs. The average treatment effect is still significant (p-value = 0.023) and positive. The ATE coefficient equals 0.047 and as expected is slightly smaller than the previous DD estimated parameter.

7. Conclusions

Wine tourism is widely acknowledged as an instrument for local development, and wine routes have increasingly been used not only to put rural areas on the map and make them accessible to visitors but also to coalesce the efforts of private enterprises, public authorities and local stakeholders towards achieving sustainable development goals. Indeed, even a passing glance at the 2030 Sustainable Development Agenda (17 Sustainable Development Goals (SDGs) and 169 targets) endorsed by the members of the United Nations reveals several links between policy interventions like the wine routes and the objectives of the Agenda. Here we tried to assess the effect of such programmes on the efficiency of wineries in rural areas. As long as these companies are central to these territories, then any improvement in their performance is good news for local economic growth. Even more so if their success, magnified by the wine route, brings further external positive effects.

We pursued this task by means of a difference-in-differences estimation approach, i.e. by mimicking an experimental research design using observational data. Our findings show that the wine routes programme had a positive impact on the efficiency of Sardinian wineries measured by DEA scores. The estimations range between 0.095, when the standard DD approach is applied, and 0.047, when a propensity score matching technique, that accounts for the covariates that predict receiving the treatment, is used.

[1] Similarly, we can think that wine routes program follows big wineries, which means that policy makers decide the treatment zones according to the distribution of main Sardinian wineries.

Whilst our results seem to confirm empirically the beneficial effects of wine routes on a crucial driver of local economic development, a thorough assessment of the WRP would require investigating further dimensions, like for instance the environmental efficiency (or resource use efficiency) of winery operations not explicitly considered here.

References

Abadie, A. and G. W. Imbens (2006), Large sample properties of matching estimators for average treatment effects, *Econometrica* 74: 235-267.

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

Asero V. and S. Patti (2009), From Wine Production to Wine Tourism Experience: the Case of Italy, AAWE Working Paper No. 52.

Barros C.P. and J.C.G. Santos (2007) Comparing the productive efficiency of cooperatives and private enterprises: The Portuguese wine industry as a case study, *Journal of Rural Cooperation* 35:109–122.

Bayramoglu Z. and E. Gundogmus (2008), Cost efficiency on organic farming: a comparison between organic and conventional raisin-producing households in Turkey, *Spanish Journal of Agricultural Research* 6(1): 3-11.

Brandano M.G., Detotto C. and M. Vannini (2018), Comparative efficiency of producer cooperatives and conventional firms in a sample of quasi-twin companies, *Annals of Public and Cooperative Economics*, forthcoming.

Brunori G. and A. Rossi (2000), Synergy and Coherence through Collective Action: Some Insights from Wine Routes in Tuscany, *Sociologia Ruralis* 40(4): 409–423.

Bruwer J. (2003), South African wine routes: some perspectives on the wine tourism industry’s structural dimensions and wine tourism product, *Tourism Management*, 24: 423–435.

Censis servizi (2013) XI Rapporto annuale osservatorio sul turismo del vino, Osservatorio sul turismo del vino, Roma.

Charnes A., Cooper W.W. and Rhodes E. (1978), Measuring the efficiency of decision making units. *European Journal of Operational Research* 2(6):429–444.

Correia L., Passos Ascençao M.J. and S. Charters M.W. (2004), Wine Routes in Portugal: A Case Study of the Bairrada Wine Route, *Journal of Wine Research* 15(1): 15–25.

Detotto C., Pulina M. and Brida J.G. (2014), Assessing the productivity of the Italian hospitality sector: a post-WDEA pooled-truncated and spatial analysis, *Journal of Productivity Analysis* 42: 103

Fernandez Y. and B. Morala (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* 5: 31–51.

Galluzzo N. (2014), Analysis of efficiency in organic vine-growing farms using Italian F.A.D.N. Dataset, *European Journal of Business, Economics and Accountancy* 2(2): 73–83.

Gatti S. and F. Incerti (1997), The Wine Routes as an Instrument for the Valorisation of Typical Products and Rural Areas, Paper presented at the "Typical and traditional productions: Rural effect and agro-industrial problems", 52nd EAAE Seminar – Parma 1997: 213–224.

Hall M.C., Sharples L. Cambourbe B. and N. Macionis (2000), Wine Tourism Around the World, Elsevier Butterworth-Heinemann.

Hall M.C. and R. Mitchell (2000), Wine Tourism in the Mediterranean. A Tool for Restructuring and Development, *Thunderbird International Business Review* 42(4): 445–465.

Hall M.C. and N. Macionis (1998), Wine tourism in Australia and New Zealand. In R.W. Butler, M.C. Hall and J. Jenkins (Eds.), *Tourism and recreation in rural areas* (pp. 267–298) Chichester: Wiley.

Henriques P.D.D.S., Carvalho M.L.D.S. and R.M.D.S. Fragoso (2009) Technical efficiency of Portuguese wine farms, *New Medit* 1:4–9.

Hojman D.E. and P. Hunter-Jones (2012), Wine tourism: Chilean wine regions and routes, *Journal of Business Research* 65:13–21.

Imbens G. and Wooldridge J. (2007), What's New in Econometrics: Difference-in-Differences Estimation, *Lecture Notes 10*. Cambridge, MA: National Bureau of Economic Research.

Ismea (2018), Rapporto 2017 ISMEA – Qualivita, Ismea Qualivita - Fondazione Qualivita, Roma.

Liu H.Y. and K. Lv (2010), Productive efficiency and its influencing factors of wine-making firms in China. A research based on DEA-tobit approach, *Collected Essays on Finance and Economics*, 2:1–6.

OIV (2017), I dati sulla congiuntura vitivinicola mondiale 2017, Organisation Internationale de la vigne et du vin, Paris, France.

Peris-Ortiz M., de la Cruz Del Rìo Rama M. and Rueda-Armengot C. (2016), *Wine and Tourism: A strategic segment for suatainable economic development*, Springer, New York, Pulina M., Detotto C. and Paba A. (2010), An investigation into the relationship between size and efficiency of the Italian hospitality sector: a window DEA approach. *European Journal of Operational Research*, 20(4): 613–620.

Santeramo F.G., Seccia A. and G. Nardone (2017), The synergies of the Italian wine and tourism sector, *Wine Economics and Policy* 6: 71–74.

Sellers-Rubio R. (2010), Evaluating the economic performance of Spanish wineries, *International Journal of Wine Business Research* 22(1): 73–84.

Sellers-Rubio R. and F. Mas-Ruiz (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* 9(1): 175–196.

Sellers-Rubio R. and V. Alampi-Sottini (2016), The influence of size on winery performance: Evidence from Italy, *Wine Economics and Policy* 5(1): 33–41.

Sellers-Rubio R., Alampi-Sottini V. and S. Menghini (2016), Productivity growth in the winery sector: Evidence from Italy and Spain, *International Journal of Wine Business Research* 28(1): 59–75.

Telfer D.J. (2001), Strategic alliances along the Niagara Wine Route, *Tourism Management* 22: 21–30.

Townsend R.F., Kirsten J.F. and N. Vink (1998), Farm size, productivity and returns to scale in agriculture revisited: a case study of wine producers in South Africa, *Agricultural Economics* 19(1-2): 175–180.

Wooldridge J. M. (2002), *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.

Web sites:

http://www.agriturist.it/it/le-strade-del-vino-in-italia/30-5303.html

http://www.italianbestwine.it/strade-del-vino.php

https://www.tuttitalia.it/itinerari-tematici/

http://www.stradevinosardegnanordovest.it