

**Economic valuation of climate change induced vinery landscape impacts
on tourism flows in Tuscany**

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Abstract

It is widely acknowledged that landscape features can play a major role in determining tourism demand. The present paper assesses the impact of vinery landscape and high-quality wine production on regional tourism flows in Tuscany, an important tourist region in Italy and renowned for its enchanting countryside. Thus, vinery landscape and high-quality wine production have been included as explanatory variables in our model for tourism flows. This model has been estimated for both, international and domestic markets for the whole region of Tuscany. Estimation results confirm that land areas devoted to the production of these superb Tuscan wines, in the particular case of Siena including the *Brunello di Montalcino*, play an important role in explaining international tourism flows. In this context, we estimate climate-change-induced impacts on vinery landscape and quality wines in the tourism sector. These are estimated to cause a loss in the tourism revenues of nearly 15 and 20 million Euros a year, respectively for 2020 and 2050, for the Tuscany region. Such losses are quite significant, and reiterate the urgency to identify and implement adequate policy options so as to moderate such land use changes, and respective negative welfare impacts.

Keywords: Landscape diversity, Corine landcover, European Natura 2000 Network, international tourism, domestic tourism, quality wine production, landscape metrics

JEL classification: L8, Q57, R14, R52

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1. Introduction

Even though the study of the evaluation of the tourism sector requires a heuristic, multidisciplinary approach, from a strict economics perspective, two main streams of research have emerged: (1) research aiming at understanding the relationship between economic growth and tourism specialization in selected countries; and (2) research aiming at understanding the determinants that explain tourists' destination choice and demand. The present paper focuses on the second stream of literature. In this setting, most of the studies are characterized by the analysis of the touristic demand at national/regional/or local level and by the analysis of a particular touristic type/specialization at a selected destination, including art and local culture, wine and gastronomic production (see Brunori and Rossi, 2000; Telfer, 2001; Medina 2003; Poria et al., 2003; Onofri and Nunes, 2013).

Cultural and natural heritage are deemed to be significant determinants of the tourist's destination choice (Loureiro et al., 2012). Heritage and environmental tourism are often analysed as a specific tourism type, influenced by the tourist's personal characteristics, awareness and perception as well as by the site's attributes (see Ryan, 2002, Poria et al., 2003, Onofri and Nunes, 2013, Nunes et al., 2013). A number of studies have focused either on ecotourism or, in specific activities, related

to tourism markets, like safaris, scuba diving and bird watching (see, for example, Wunder, 2000; Naidoo and Adamovicz, 2005, Baral et al. 2008).

As far as we know, the existing literature, has explored tourists' destination choice and motivations with distinct perspectives, but has largely neglected, with some exceptions, to incorporate environmental and landscape dimensions. First, we propose to address this gap by using a comprehensive dataset that collects tourism arrivals in Tuscany together with a systematic profile of the Tuscany's landscape with respect to landscape related indicators, including biodiversity, Nature 2000 areas and wine production areas. Second, the paper constitutes the first worldwide attempt to estimate tourism demand segments by exploring an empirical strategy to model international and national demand functions, with particular focus on to the Siena province – also worldwide known as the *Montalcino* wine district. Third, the paper focuses on a specific and emergent touristic segment, highlighting the potential role that landscape amenities, environmental quality, and biodiversity factors may exert in the consumer choice and worldwide architecture of tourism flows for Tuscany. This information is, in turn, of high significance for regional governments that have responsibilities with respect to the sustainable management of this Region, its natural systems and respective benefits, with a particular focus to the global context of climate change.

This paper is organised in two main parts. The first presents a review of the relevant literature on the determinants of tourism demand and of the most widely used landscape metrics, highlighting the appropriateness of each of them for describing

specific phenomena. In addition, a detailed description of the indicators computed for the purpose of this study is provided. The second part is devoted to the use of those indicators to analyse tourist behaviour in the Tuscan municipalities as a whole, and in Siena in particular. A description of the features of landscape and tourism flows towards the different areas of Tuscany is provided and, subsequently, an econometric model is estimated to analyse the influence of landscape diversity, and the predominance of designations of origin in wines among other explanatory variables, on the number of tourist arrivals in each municipality, disentangling them into international and domestic tourism demands. The outcome of this analysis allows drawing some conclusions on the impact of quality wines in the analysis of the tourism destination choices and on the similarities and differences between the international and domestic segments of tourism flows towards Tuscany.

2. Literature review on the determinants of tourism demand and landscape amenities

The number of tourist arrivals is the most popular measure of tourism demand used in the reviewed literature. This variable can be further disaggregated according to the purpose of the visit; for instance holiday, business and visiting friends and relatives (Turner and Witt, 2001), the origin of the travellers (Bigano *et al.* 2007) or the means of transportation used (Rosselló-Nadal 2001). Some studies adopt tourist expenditure or tourism sector revenue or employment as the dependent variables (Witt *et al.*, 2004). However, most of the reviewed studies include economic variables such as

income, tourism prices, distance and cost of transportation, as well as exchange rates as explanatory variables to describe tourist arrivals (Witt and Witt 1995; Hamilton *et al.*, 2005(a; b); Bigano *et al.*, 2007; Lise and Tol 2002). Income is generally found to affect tourism demand in a positive way, while distance and cost, as well as the price level can be expected to deliver an opposite result.

The landscape profile plays a widely acknowledged role among the attraction factors of any tourist destination. The identification of landscape metrics and indicators has been addressed by a vast array of studies, which highlighted the importance of measuring landscape characteristics, both from a composition and a configuration perspective. In addition to its productive function, agricultural land provides public amenities, in the form of natural habitats, open spaces, pleasant scenery and cultural preservation. This link between agricultural activities and landscape value proves to be particularly strong in European countries, where rural areas are mostly characterized by farmed landscape (Vanslebrouck *et al.*, 2005). Agricultural landscape has been found to exert an influence on visitors' decisions (Fleitscher and Tsur, 2000; Hellerstein *et al.*, 2002). Madureira (2006) and Job and Murphy (2006) pointed out that the traditional vineyard landscape is one of the major tourism attraction factors of the Douro valley in Portugal and of the Mosel valley in Germany, respectively. Analogous arguments have been made for olive grows, which were found to be positively correlated to tourism flows towards the Greek islands (Loumou *et al.*, 2000).

Other aspects, such as environmental amenities are considered by most studies as relevant components of tourism demand determinants and they can be viewed as a growth factor for the tourism industry (Wunder, 2000; Naidoo and Adamovicz, 2005; Green, 2001). Tourists appear to attach a value to different types of landscapes. Hamilton (2007) analysed the impact of different types of coastal landscape on the price of tourism accommodation and found out that the length of open coast contributes to increase this value.

Furthermore, among the relevant tourism pull factors, several studies consider the types of tourism attractions of which a destination can take advantage, for instance art and local culture (Medina, 2003; Poria, 2003; Hamilton, 2004). Moreover, different segments of the tourism market can be identified depending on the characteristics landscape of the destination. For example, mountain and seaside destinations can be analysed with reference to their capacity to attract different types of tourism, whose consumption behaviour may differ (Manente *et al.*, 1996).

Finally, tourists may be attracted by specific products, particularly wine and gastronomic productions, linked to the territory of the region they chose to visit. An example, are the “wine routes”¹. Tourists who follow a wine route have the opportunity to visit wine farms, to take part in wine tasting, purchase wine, visit a vineyard or a local museum that provides them with information about the wine

¹ Wine routes are defined as sign-posted itinerary, through a well-defined area, whose aim is the ‘discovery’ of the wine products in the region and the activities associated with it (Brunori and Rossi, 2000).

traditions and history of the region. Williams (2001) analysed the evolution of wine region imagery during the 1990s and concluded that emphasis has shifted from wine production and related facilities to the experience of rural lifestyle, encompassing leisure, cuisine, scenery and outdoor activities. Getz and Brown (2006) argue that proximity to wine regions influences travel, but the tourist's perception goes beyond the mere presence of vineyards and wineries. As a matter of fact, wine tourists typically seek a bundle of benefits, including destination appeal, accommodation with regional character, gourmet restaurants and traditional scenery, in addition to the wine product.

Often there is also an opportunity to stay in agro-tourist accommodations, taste the culinary specialities of the area and buy typical products of the region (Brunori and Rossi, 2000; Telfer, 2001; Correia *et al.*, 2004). Bessière (1998) considers traditional food and gastronomy as elements of tourism development at the local level, since they can act as identity markers of a given geographical area or community.

The present study is consistent with the reviewed literature in the selection of dependent and explanatory variables to be included in the empirical model. Nonetheless, the reviewed studies rarely take into account simultaneously all the different aspects that could influence the tourists' destination choice, landscape features, socio-demographic characteristics of the destination, tourism attraction factors and the presence of cultural amenities provided by agriculture, such as typical wines, as it is done in the present paper. In addition, another innovative aspect of this

analysis is the disaggregation of tourism flows in their international and domestic components, with the aim of identifying differences in their choice patterns.

2.1 Review of existing landscape metrics and construction of landscape indicators

Landscape can be defined as a spatially heterogeneous area presenting at least one factor of interest (Turner and Witt, 2001). The spatial structures of landscapes are associated with the composition and configuration of landscape elements. The former refers to the number and occurrence of different types of landscape elements, while the latter encompasses their physical or spatial distribution within a landscape (McGarigal *et al.*, 1994).

A whole set of mathematical indices have been developed in order to provide an objective description of different aspects of landscape structures and patterns (McGarigal *et al.*, 1994), and it is important to note that no single metric can adequately capture the pattern on a given landscape. Several suggestions have been made for a meaningful set of metrics that minimize redundancy while capturing the desired qualities (Riitters *et al.*, 1995). A vast array of previous studies has reviewed the most commonly used landscape metrics, highlighting advantages and shortcomings of each (Hargis *et al.*, 1998; Botequilha Leitão and Ahern, 2002).

Landscape richness, namely the number of land cover classes, is the simplest way of capturing the diversity of the earth's surface, counting the number of different classes per unit area. This measure seemed to be more likely to influence tourist perceptions and choices than other more complex indicators, which would have been more appropriate if the objective was to analyse functionalities and the degree of fragmentation of landscapes and ecosystems (see Loureiro et al 2012).

The data provided by the CORINE database was used to construct two composition indicators, landscape richness and the share of agricultural land covered by complex agricultural patterns². This landscape type is characterised by a mosaic of patches of different permanent crops, such as fruit trees, berry plantations, vineyards and olive groves and can be expected to exert a positive impact on tourists' perception.

This paper applies the selected indicators to the Tuscany region in Italy and the unit of analysis is the municipality geographical scale. Landscape richness has been computed as the number of different land cover categories recorded in each municipality divided by the number of classes recorded in the whole region. All the classes included in the CORINE Land Cover database have been considered and

² The CORINE Land Cover Inventory is the only data set providing a synoptic but broad overview of land cover and land use at European level, enabling cross border investigations and comparisons at European level. For this reason, within the scope of this analysis, it has been chosen to use this information in order to construct landscape diversity indicators. The CORINE Land Cover Inventory is based on satellite images as the primary information source². The data presented in the inventory is clustered into 44 classes covering agricultural areas as well as urban and natural surfaces.

Table 1 shows the ones existing in Tuscany, which have been used in the calculation of the landscape richness indicator.

Insert Table 1 about here

2.2.A protocol for constructing biodiversity and landscape indicators using the Natura 2000 database

This section provides background information of how the Corine database can be used to obtain more precise indicators at the site level. The information contained in the database appears to be extremely detailed, thus it has been necessary to select the most relevant aspects in view of constructing landscape and biodiversity indicators. A category that offers a considerable amount of information in terms of land complexity is the one denoted as Complex Cultivation Patterns. This variable offers information on the juxtaposition of small parcels of diverse annual crops, pasture and/or permanent crops. None of these three categories covers an identifiable surface unit of more than 25 ha within a single land unit. Arable land, pasture and orchard each occupy less than 75% of the total surface area of unit.

$$ComplexPatterns = \frac{\sum_i^n x_i | x_i < 25Has}{x_j} \quad (1)$$

where x_i represents the number of landscapes with the cited features present in the site and x_j stands for the number landscapes on the existing territory.

Landscape richness represents the ratio between the number of landscapes recorded in each site and the total number of landscapes existing at the national level.

Since landscape richness has been defined as the number of different landscapes recorded in a site with respect to the number of landscapes existing on the national territory, these indicators have been computed according to the following Equation:

$$Richness = \frac{x_i}{x_j} \quad (2)$$

where x_i represents the number of landscapes present in the site and x_j stands for the number landscapes on the existing on the territory.

The result of this process has been the construction of a set of indicators addressing the most relevant aspects of landscape diversity.

The scores for complex agricultural patterns and landscape richness can be read on a scale ranging from 0 to 1. A high landscape richness score indicates that all the different landscape categories existing in Tuscany are present on the territory of the municipality. This can be interpreted as high landscape diversity.

3. The Tuscany case study

The remainder of this paper is devoted to the assessment of the impact of the landscape metrics described in the previous section on international and domestic tourism flows towards the Italian region of Tuscany as a whole, and Siena in particular, adopting 2007 as a reference year. To begin with, a description of the

explanatory variables and of the data sources will be provided. Then, an econometric model is estimated in order to describe the number of tourist arrivals as a function of a set of explanatory variables and its results are analysed.

3.1 Description of the selected variables and data sources

A large cross-section dataset has been constructed, using a set of different sources, and adopting 2007 as the reference year. As regards international and domestic tourism arrivals, data have been retrieved from the Tuscany regional administration, as well as data on the number of available accommodation per municipality, the share of luxurious accommodation solutions out of the total offer, and the types of tourism attraction characterising each municipality.

The surfaces covered by each land cover category and the information needed to construct the selected landscape metrics have been obtained from the CORINE Land Cover database, as discussed in the previous section. In addition, the share of municipal territory covered by Natura 2000 sites has been computed from the information contained in the Natura 2000 database and overlapped to the area of the municipality, using ArcGis. The same procedure has been followed to compute the number of existing Natura 2000 sites in a range of 25 kms around the municipality.

Finally, the information on the number of high quality wines, DOCG (Controlled Denominations of Origin in Italy) and DOC³ (Denominations of Origin) wines in this specific case, produced on the territory of each municipality has been retrieved from the Italian federation of sommeliers and hotel and restaurant owners (FISAR, 2007). Table 2 displays the variables used in this study and the data sources.

****Insert Table 2 about here****

The administrative territory of Tuscany is divided into ten provinces, namely, Arezzo, Florence, Grosseto, Livorno, Lucca, Massa Carrara, Pisa, Pistoia, Prato and Siena⁴. Complex cultivation patterns cover 38% and 29% of agricultural land in Lucca and Massa Carrara provinces and more than 20% of agricultural land in Arezzo, Florence, Livorno, Pistoia and Prato provinces, therefore it has been considered representative of the Tuscan agricultural landscape.

The scores of landscape richness are quite similar across the different provinces, ranging from 0.22 in the Pistoia province to the 0.27 of the Livorno province. This indicates that the number of landscape categories recorded in each province is

³ Quality wine produced in a specified region (QWPSR) is the generic EU term for quality wines such as the French AC, the Italian DOC/G, the Spanish DO/DOCa, and the German QbA/QmP. For DOC wines the “Disciplinare di Produzione” establishes the areas of production and collection of grapes, the cultivars allowed for wine-making, the type of land on which cultivation is possible, a maximum yield, production and ageing technologies, the characteristics of the final product and the possible label qualification of the commercialized product. DOCG wines have achieved, in addition to the DOC qualification and peculiar qualities, a well-established international reputation.

⁴ There are thirty-nine municipalities in the Arezzo province, forty-four in Florence province, twenty-eight in the Grosseto province, twenty in the Livorno, thirty-five in the Lucca province, seventeen in the one of Massa-Carrara, thirty-nine in the Pisa province, twenty-two in the Pistoia province, seven in the Prato province and thirty-six in the Siena province.

relatively similar, which is not surprising, considering the limited geographical extension of the study area. The scores of landscape diversity indicators are reported in Table 3.

****Insert Table 3 about here****

As regards the volume of tourism flows, 2007 data show that the Florence province is attracting the highest number of tourist arrivals in absolute terms, and they mostly visit the city monuments and art works. Other provinces that experience considerable inbound tourist flows for cultural purposes are Pisa, Siena, Arezzo and Lucca. Seaside tourism proves to be relevant for the provinces of Livorno, Grosseto, Lucca and Massa Carrara, while countryside tourism flows appears to be particularly significant for Siena, Florence, Pisa and Pistoia (Regione Toscana, 2008). The relevant figures are displayed in Table 4.

****Insert Table 4 about here****

According to the World Tourism Organization in 2007 worldwide tourism flows have experienced an expansion, thus confirming the medium and long term growing trend, with international arrivals growing by 6% with respect to 2006. In absolute terms, Italy has achieved a good position in the international arena, recording a 3.3 % increase in international inbound tourism flows. However, this variation appears to

be below the one achieved in 2006, as well as below the global trend for 2007 (WTO, 2008).

In the specific case of Tuscany, 2007 can be considered as a good year with increases in both, the international and the domestic component of tourism flows, scoring an increase of 2.7% and 1.1% respectively. However these gains have not been homogeneously distributed across the different provinces and types of tourism resources, such as art, mountain, coast and countryside. Those provinces characterized by mountainous territory have recorded a very good performance during 2007, while the increase in tourism arrivals in coastal areas has slowed down with respect to the previous year. The Tuscany regional administration states that tourism in Tuscany is gradually expanding to areas with lower tourism intensity and lower level of economic development, for instance mountain areas.

4. Model specification and estimation results

The primary objective of this work has been the identification and the construction of a set of appropriate indicators, taking into account the peculiarities of the tourism sector in this area. A secondary objective has been the specification of an econometric model, assessing the impacts of landscape diversity on the volume of tourism flows towards particular destinations, namely the municipalities of Tuscany, Italy.

In order to estimate the impact of landscape diversity and agricultural amenities on the tourism destination choice, a model has been constructed according to the specification displayed in Equation (3):

$$\begin{aligned}
 \ln Arrivals_i = & \beta_0 + \beta_1 SizeArea_i + \beta_2 Beds_i + \beta_3 Prices_i + \beta_4 ProtectedAreas_i \\
 & + \beta_5 LandRichness_i + \beta_6 ComplexPatterns_i + \beta_7 Natura25Kms_i \\
 & + \beta_8 Art_i + \beta_9 DOC_i + \beta_{10} Seaside_i + u_i
 \end{aligned}
 \tag{3}$$

In the above equation, the number of tourist arrivals in each municipality is adopted as the dependent variable⁵ and it has been estimated for the entire Tuscany area and separately for the province of Siena. The selected explanatory variables (in both specifications) are the geographical size of each municipality (x_1), accommodation availability or number of beds (x_2), and price levels⁶ (x_3), the share of protected area on the municipal territory and the number of neighbouring protected sites (x_4), the selected landscape metrics (x_5) and (x_6), the types of surrounding areas (x_7), the types of touristic attraction factors (x_8)⁷, including the existence of art and

⁵ The logarithmic transformation of the number of tourists was performed as this fits the data better than the linear form. This choice is consistent with the majority of recreation studies that apply this functional form.

⁶ Price levels are measured by the Consumer's Price Index for each province of the region, as computed by the Italian bureau of statistics (ISTAT). This index is expressed as the change in the price of a selected basket of goods with respect to the base year, in this case 1995.

⁷ It would have been interesting to include a variable referring to tourist income. However, the data on tourist flows has not been retrieved from a survey, therefore such an information was not available. Moreover, the country of origin of international tourists and the region of origin of domestic ones were not available either.

monuments in the area, the number of DOCG and DOC wines produced per municipality (x_9) and the coastal municipalities (x_{10}).

Results for the entire region of Tuscany appear in Table 5, and for the province of Siena in Table 6. Clear differences appear between domestic and international tourism flows in both Tuscany and Siena. According to the obtained results, the municipality's spatial dimension appears to be positively influencing the number of domestic and international arrivals. The accommodation availability turns out to be positively significant for both international and domestic tourist arrivals as well as the presence of protected areas in the municipality or in its surroundings.

When it comes to landscape metrics, it can be noted that landscape richness is not significant for the entire Tuscany (probably due to its large heterogeneity). On the contrary, the surface characterized by complex cultivation patterns has a positive and significant impact on domestic and international arrivals. Other variables highly relevant to understand tourism flows are those related to the natural habitat. Specifically, the number of sites belonging to Natura 2000 and in a radius of 25 Kms exert a positive and statistically significant influence on the number of visitors, both domestic and internationally. In addition, tourism attraction factors, such as the existence of art and monuments in the area affects also both, domestic and international visitors. However, a remarkable difference is observable in terms of preferences for recreational activities. In particular, international tourists have a higher tendency to visit areas with DOC and DOCG wines produced in the

municipality, whereas local tourists prefer the coast and beach destinations. This result conveys the idea that the popularity of Italian wines, and not only their quality, may be a substantial pull-factor especially for international tourists. Such effect is remarkably noticeable in the area of Siena, where the magnitude of the associated coefficient carried by the quality wines variable is much larger than that for the overall Tuscany. As is well known, Siena is the house of the *Brunello di Montalcino* wine, one of the most prestigious and worldwide recognized Italian wines around the world.

Insert Table 5 and Table 6 about here

4.1.2 Monetary evaluation of the climate-change-induced impacts on vinery landscape and quality wines in the tourism sector

Since the results of the econometric analysis showed that quality-wine production positively influence international tourism flows, it seems interesting to attach a monetary value to these externalities. This results in an economic valuation of the impacts of wine production in the different provinces of Tuscany.

The total revenues generated by tourism in 2007, aggregated at the province level, were retrieved from the Tuscany regional administration's statistical service. Predictions from the above regression allow us to determine the impact of international arrivals when the variable DOC may take values from zero to its actual

number. The difference between the predicted arrivals ($\exp(\ln \text{arrivals}(\text{DOC}))$) accounting for the mean number of municipalities within a province with DOC and the predicted arrival of tourism without the existence of quality wines ($\exp(\ln \text{arrivals}(\text{DOC}=0))$), allows us to understand the total impact of DOCs in international arrivals. Multiplying this difference on tourism arrivals due to the presence of DOCs, by the average expenditure per visitant, and the average length of stay, we can approximate the monetary impact of the presence of DOCs in the international tourism segment. Mathematically, this can be represented by Equation (4):

$$\text{Monetaryvalue}(DOC_i) = \exp(\ln \text{arrivals}(DOC_{i=\text{score}})) - \exp(\ln \text{arrivals}(DOC_{i=0})) \quad (4)$$

$$* (\text{expenditure} - \text{daily}_i) \times (\text{Duration} - \text{stay}_i)$$

The result is an estimation of the monetary value of the positive externalities represented by high-quality wines at the province level. These values appear to be quite significant and they differ quite substantially across the different provinces. This consideration allows ranking the different Tuscan provinces with respect to the monetary values associated to their agricultural landscape and high-quality wine production.

These monetary values derived from international tourism arrivals are displayed in Table 7.

Insert Table 7 about here

The policy implications of this analysis involve the definition of priorities in terms of valorisation and branding of two of the main touristic resources in Tuscany, wine and in general, agricultural landscape. Furthermore, these estimates allow us to understand the potential economic dimensions of current climate change impacts on land use in this region, in particular, in areas devoted to the production of quality wines. Employing future climate conditions as simulated by HadCM3 General Circulation Model to predict the possible spatial changes of grapevine cultivated area in 2020 and 2050 under A2 IPCC scenarios⁸, Moriondo *et al.* (2013) find that quality wine areas will be reduced in this region by 61.5% by 2020 and 83.5% by 2050. Taking into account these land use projections under climate change, on one hand, and the econometric estimates, on the other hand, we are able to estimate the effect of climate change in the tourism sector. According to our computations, climate-change-induce impacts on agricultural landscape and quality wines in the tourism sector cause a loss in the tourism revenues of 14 and 20 million Euros a year, respectively for 2020 and 2050, for the Tuscany region. Such losses are quite significant, particularly if we were to consider that in a dynamic setting, the change of area in quality wines may also have serious impacts on terms of other characteristics that are also valued by tourists, including the reduction of the production of Tuscan DOC and DOCG wines.

⁸ The climate model HadCM3, is driven by a scenario of CO₂ concentrations arising from the A1B emissions scenario with a 2.5° by 3.75° resolution (Gordon *et al.*, 2000; Collins *et al.*, 2001). The Hadley Centre atmospheric models have been shown to be among the more realistic climate models in simulating the climate of Tuscany Moriondo *et al.* (2013)

This evaluation is not intended to be an ultimate measure of the economic value of such resources in the tourism sector; nonetheless, it provides a useful benchmark for the definition of the investment choices aiming at promoting the tourism industry. It also helps identifying the type of tourist attraction factor generating the highest revenues in each province and would thus allow the Tuscany region to better calibrate and differentiate its offer to match a complex and composite tourism demand.

6. Discussion and further research needs

The main aim of the present paper was to assess the influence exerted by agricultural landscape and high quality wine production on tourism demand. In addition, it seemed interesting to ascertain the potential differences in the impact of those metrics on the behaviour of international and domestic tourists. Finally, in order to analyse the policy implications of the achieved results, a monetary evaluation of those impacts was performed on the basis of the revenue generated by tourism services in each province. This allows drawing some conclusions on the use of landscape metrics as explanatory variables in a model explaining the tourists' destination choice.

Complex cultivation patterns turn out to exert a positive impact for domestic tourists. Complex cultivation patterns encompass small parcels of different annual crops, fruit

trees, berry plantations, vineyards and olive groves, thus creating the typical countryside patchwork image. The fact that tourism arrivals are positively influenced by this landscape structure reinforces the result obtained for landscape richness and is consistent with the results of reviewed studies that highlighted the value of rural landscapes as a tourism attraction factor.

An attempt has also been made to assess the impacts of specific landscape categories, such as vineyards and olive groves, on tourism demand, finding that the production of DOC and DOCG wines (in the particular case of Siena) in the territory of a municipality exerts a positive influence on international tourist arrivals. This is an important result since DOC and DOCG wines represent the most well-known high quality Italian wines and are linked to the specificities of the location. We should note that our economic evaluation relies on the *ceteris paribus* assumption, so that we assume that climate change scenarios only impact the number of DOC and DOCG wines, while the rest of the variables remain to their actual levels. Additional and richer scenarios may be constructed considering the simultaneous influence of climate change on multiple factors

The second part of this analysis focused on the differences between the determinants of international and domestic tourism demand. The two segments present some clear similarities, since they are both positively influenced by the spatial extension of the municipality, by accommodation availability, and by art destinations. However some discrepancies can be identified as well, since the international visitors appear to be

positively influenced by the presence of vineyard landscape and high-quality and internationally renowned wines. Domestic tourists instead, do not seem to be influenced by high-quality wine production, and prefer sea site destinations. These differences in perceptions of tourism pull factors is an interesting outcome of this paper as it suggests that domestic tourists are less influenced by those factors directly linked to the popularity and reputation of the destination. The proximity of protected sites is significant for the domestic segment, indicating that tourists are sensitive to the political choices regarding environmental protection.

The relevance of agricultural landscape and high quality wine production in attracting tourism flows is already taken into account when designing policies to enhance the tourism potential of Tuscany. However, further research on the different structures of domestic and international tourist demand would allow the region and its municipalities to select and encourage certain segments of tourism. This choice could also profit from an economic valuation exercise, aiming at attaching a monetary value to agricultural landscape and high-quality wine production, since this could help determining the resources having the highest tourism attraction power for each specific location. Such information becomes quite relevant in order to design climate change adaptation and mitigation policies for this area, since as it was observable, future revenues caused by climate change alterations will produce great losses to the tourism industry. In order to study the impact of these issues in more detail, it could be interesting to repeat the analysis including other traditional products, such as meat and cheese products promoted by the “*Slow Food*”

movement, as well as variables describing the tourists' behaviour during their stay at the destination, such as the type of preferred accommodation, the activities undertaken and duration of stay.

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Tables

Table 1 CORINE Land Cover classification and classes considered in the development of landscape metrics

Code	Description
1.1.1	Continuous urban fabric
1.1.2	Discontinuous urban fabric
1.2.1	Industrial or commercial units
1.2.2	Road and rail networks
1.2.3	Port area
1.2.4	Airport
1.3.1	Mineral extraction sites
1.3.2	Dump sites
1.3.3	Construction sites
1.4.1	Green urban areas
1.4.2	Sports and leisure facilities
2.1.1	Non-irrigated arable land
2.1.2	Permanently irrigated land
2.1.3	Rice fields
2.2.1	Vineyards
2.2.2	Fruits and berries plantations
2.2.3	Olive trees
2.3.1	Pastures
2.4.1	Annual crops associated with permanent crops
2.4.2	Complex cultivation patterns
2.4.3	Principally agriculture with natural vegetation
2.4.4	Agro-forestry areas
3.1.1	Broad-leaved forest
3.1.2	Coniferous forest
3.1.3	Mixed forest
3.2.1	Natural grasslands
3.2.2	Moors and heathland
3.2.3	Sclerophyllous vegetation
3.2.4	Transitional woodland shrubs
3.3.1	Beaches, dunes and sand plains
3.3.2	Bare rock
3.3.3	Sparsely vegetated areas
3.3.4	Burnt areas
3.3.5	Glaciers and perpetual snow
4.1.1	Inland marshes
4.1.2	Peat bogs
4.2.1	Salt marshes
4.2.2	Salines
4.2.3	Intertidal flats
5.1.1	Water courses
5.1.2	Water bodies
5.2.1	Coastal lagoons
5.2.2	Estuaries
5.2.3	Seas and oceans

Source: CORINE Land Cover Database

Table 2 Description of the data sources

Variable	Unit	Year	Source
International arrivals(tourist arrivals)	000	2007	Regione Toscana
Domestic arrivals(tourist arrivals)	000	2007	Regione Toscana
Area of the municipality	Ha	2007	Regione Toscana
Population	000	2001	Regione Toscana
Accommodation availability(beds)	Number	2007	Regione Toscana
Share of budget accommodation	%	2007	Regione Toscana
Consumer's Price Index		2007	ISTAT
Protected Area (share of Natura 2000 of municipality area)	0-1 scale	2007	Natura 2000 database; ARCGIS
Elevation above sea level	M	2007	Regione Toscana
No. DOC	Number	2007	FISAR
No. DOCG	Number	2007	FISAR
Landscape richness	0-1 scale	2007	CORINE Land Cover Database
Complex Cultivation Patterns	0-1 scale	2007	CORINE Land Cover Database
N2000 sites within 25 km	Number	2007	CORINE Land Cover Database; ARCGIS
Art (main tourism attraction)	Dummy	2007	Regione Toscana
Seaside (main tourism attraction)	Dummy	2007	Regione Toscana
Mountain (main tourism attraction)	Dummy	2007	Regione Toscana
Other (main tourism attraction)	Dummy	2007	Regione Toscana

Table 3 Scores in the landscape metrics for Tuscan provinces

Province	Landscape richness	Complex cultivation patterns
Arezzo	0.24	0.25
Firenze	0.26	0.24
Grosseto	0.24	0.13
Livorno	0.27	0.21
Lucca	0.24	0.38
Massa Carrara	0.24	0.29
Pisa	0.24	0.15
Pistoia	0.22	0.21
Prato	0.25	0.21
Siena	0.23	0.16

Source: CORINE Land Cover Database, own elaboration

Table 4 Descriptive statistics of 2007 tourist arrivals in Tuscany by origin and tourism resource

Province	Art		Mountain		Countryside		Seaside		Other		Tourist arrivals	
	International	Domestic	International	Domestic	International	Domestic	International	Domestic	International	Domestic	International	Domestic
Arezzo	101,711	200,215	8,972	31,709	17,367	21,799	0	0	16,833	13,194	144,883	266,917
Firenze	2,173,899	907,746	38,370	32,057	97,112	83,679	0	0	508,059	270,861	2,817,440	1,294,343
Grosseto	21,275	39,401	18,146	43,318	2,140	4,747	172,264	682,760	10,737	75,107	224,562	845,333
Livorno	0	0	0	0	5,759	10,470	336,057	836,087	8,540	12,516	350,356	859,073
Lucca	151,601	142,508	13,364	36,353	0	0	204,813	337,780	2,881	5,058	372,659	521,699
Massa Carrara	8,529	21,596	108	690	2,506	7,017	50,930	149,942	2,297	7,462	64,370	186,707
Pisa	404,581	337,232	0	0	61,914	49,573	0	0	42,900	46,407	509,395	433,212
Pistoia	40,439	55,975	5,987	43,451	33,485	56,094	0	0	485,238	212,972	565,149	368,492
Prato	132,703	77,027	524	3,387	7,102	7,570	0	0	271	535	140,600	88,519
Siena	404,663	335,393	2,069	17,335	168,665	110,748	0	0	142,701	245,022	718,098	708,498
Total	3,439,401	2,117,093	87,540	208,300	396,050	351,697	764,064	2,006,569	1,220,457	889,134	5,907,512	5,572,793

Source: Regione Toscana, 2008

Table 5 Estimation results for domestic and international tourist arrivals (ln) in Tuscany
(Robust OLS estimates)

	International			Domestic		
	Coef.	Std.Err	Pvalue	Coef.	Std.Err	Pvalue
area_in_ha_	0.0319	0.0132	0.0160	0.0455	0.0108	0.0000
Beds	0.2001	0.0350	0.0000	0.1586	0.0309	0.0000
cpi_2007	-0.0239	0.0154	0.1210	-0.0180	0.0126	0.1550
n2k	0.6994	0.5306	0.1890	1.2691	0.4411	0.0040
landscape_richness	-1.1052	2.3307	0.6360	0.8297	1.6038	0.6050
complex_cultiv_pattern	2.1460	1.1144	0.0550	1.5694	0.9011	0.0830
nat25	0.0608	0.0214	0.0050	0.0465	0.0156	0.0030
Art	0.8204	0.2336	0.0010	0.9236	0.1692	0.0000
No. DOC	0.1889	0.1058	0.0760	0.0486	0.0738	0.5110
Seaside	0.2487	0.3524	0.4810	1.1708	0.2926	0.0000
_cons	9.3281	1.9680	0.0000	8.6422	1.5245	0.0000
R2	0.411			0.543		

Table 6 Estimation results for domestic and international tourist arrivals (log) in Siena
(Robust OLS estimates)

	International			National		
	Coef.	Std. Err.	Pvalue	Coef.	Std.Err.	Pvalue
area__in_ha_	.0706	.0285	0.020	.0008	.0382	0.983
Beds	.3217	.0551	0.000	.0002	.0433	0.000
cpi_2007	.0169	.0507	0.741	.0220	.04816	0.651
n2k	.9575	.9938	0.344	1.1087	.7522	0.152
landscape_richness	-7.7689	4.8674	0.123	-3.0976	5.0937	0.548
complex_cultivation_patterns	4.4285	3.5441	0.223	3.0082	2.4489	0.230
nat25	.0257	.0214	0.239	.0236	.0179	0.199
Art	.8467	.2685	0.004	1.007	.2469	0.000
No. DOCG	.7340	.2355	0.004	-.2292	.2277	0.323
_cons	6.4494	5.9199	0.286	5.8948	5.6525	0.307
R2	0.73			0.68		

Table 7 Monetary evaluations of the impact of the reduction of high-quality wine production (DOC and DOCG) due to climate change on international tourism flows in Tuscany (in Euro/year)

	DOC current contribution to tourism revenues	Economic Losses due to 61.5% reduction	Economic Losses due to 83.5% reduction
Arezzo	65,175	-40,635	-54,741
Firenze	264,720	-165,928	-222,846
Grosseto	166,665	-106,709	-141,577
Livorno	17,320,215	-11,058,976	-14,695,805
Lucca	130,124	-80,955	-109,192
Massa-Carrara	4,490,160	-2,801,487	-3,772,453
Pisa	232,421	-147,070	-196,449
Pistoia	85,102	-53,173	-71,543
Siena	741,129	-476,299	-630,571
TUSCANY	23,495,711	-14,931,232	-19,895,178