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ORIGINAL ARTICLE

Assessing complementarity and substitution effects of cultural events in rural communities: insights from a Mediterranean island

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Abstract
Previous studies do not systematically investigate complementarity and substitution effects of cultural participation and consumption in rural areas. Fairs, fiestas, and festivals, often performed in rural communities, have a substantial role in economic development. Nowadays, smartphones and the integration of global positioning system technology in mobile phones trace quantitative big data useful for studying complex systems and spaces. The present research analyses cultural events in the rural area of Gennargentu-Mandrolisai Mountain Community located in the Mediterranean island of Sardinia (Italy). This paper contributes to the literature at least in two ways. Methodologically, it analyses a complex cultural product that combines tangible and intangible cultural heritage. It explores complementarity and substitution effects between events within a coopetition setting. Empirically, it investigates consumption behaviour and tracks the inter-regional/inter-national cultural flows. An econometric analysis of a unique big dataset evaluates the supply-side market conditions that influence demand-side spill-over effects. This study has practical relevance and provides a valuable reference for policymakers in inner areas.

Keywords Cultural events · Big data · Coopetition · Rural · Inner area · Policy

1 Introduction

Rural areas have a low population density, below 150 inhabitants per km^2, and play an essential role in maintaining economic and social cohesion and ecosystem protection (OECD Regional Outlook, 2016; SNAI, 2019). In the European Union (EU),

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rural development is the 'second pillar' of the Common Agricultural Policy (CAP). Each member state implements a rural development policy within this umbrella to promote opportunities to help remote areas face current challenges. These policies are also in line with the EU 2020 Biodiversity Strategy, which aims at preserving and enhancing biodiversity and to support and encourage rural communities for the farming and primary processing sectors, rural enterprise and business development, diversification, and rural tourism (European Commission, 2018; Plieninger et al., 2013). Rural and inner areas are often endowed with unique and appealing natural and cultural amenities, serving as a catalyst for socioeconomic development (Brandano & Mastrangioli, 2020; Ferrarese et al., 2021). In alignment with the EU agenda for 2030, these areas require digitalisation to co-design strategic actions (De Toni et al., 2021; EU, 2021).

The enhancement of socioeconomic conditions and social cohesion also goes through cultural access, as recognised by the New Agenda for Culture (European Commission, 2018). Fairs, *fiestas*, and festivals, often performed in rural communities, have a deep cultural component that encompasses both tangible and intangible cultural heritage, playing a substantial role in economic development (Capello et al., 2020; Detotto et al., 2022; Palma et al., 2013). Tangible heritage encompasses physical entities such as buildings, structures, monuments, landscapes, and historic city centres. In contrast, intangible heritage refers to the cultural practices, representations, expressions, knowledge, and skills that communities, groups, and individuals create, utilise, and pass down through generations (UNESCO, 2003).

The events are often the leaver for attracting visitors in remote areas and making them more attractive for people and businesses may also enhance population rebalancing (EU, 2021). Since the 1980s, numerous destinations have prioritised cultural tourism as a driver of economic development, with a specific emphasis on cities (OECD, 2009). This trend is evident in European urban areas, where cities are progressively recognising tourism as a pivotal sector for local growth. Consequently, they are strategically investing in cultural attractions and infrastructure to establish a distinctive position in the competitive tourist market (Noonan, 2023; Russo & van der Borg, 2002). Hence, this domain has a crucial role. The contribution of culture to tourism has received extensive consideration in the academic literature. In this context, the complexity and multifaceted nature of cultural participation have been acknowledged (Guccio et al., 2017) and studied from different perspectives. These threads range from the exploration of various cultural activities (Stylianou-Lambert, 2011), to investigating the relationship between tourism and cultural participation (Borowiecki & Castiglione, 2014; Brandano & Meleddu, 2021; Richards & van der Ark, 2013; Zieba, 2016, 2017) and extending to the examination of cultural amenities in destination efficiency (Figueroa et al., 2018; Gomez-Vega et al., 2022; Herrero-Prieto and Gomez-Vega, 2017). Various papers have assessed the role of cultural amenities in exploring destination efficiency. Looking at Spain, Herrero-Prieto and Gomez-Vega (2017) focus on destinations' efficiency, specifically examining the relationship between available cultural resources and cultural tourism. Their findings reveal that the accumulation of UNESCO cultural heritage declarations positively impacts tourism efficiency. Similarly, Figueroa et al. (2018) focussed on Chile, revealing that the efficiency in optimising tourist flow is influenced by a

mix of cultural endowments, activities, and natural resources. Expanding globally, Gomez-Vega et al. (2022) conducted an evaluation across 140 countries, finding that cultural heritage significantly enhances tourism efficiency. Beyond efficiency, prior research has predominantly concentrated on the analysis of preferences and the conventional economic impacts associated with cultural events at destinations (Detotto et al., 2022). This objective was predominantly achieved through the utilisation of administrative records and survey data. Researchers have also explored individual preferences, attendance patterns, and the socioeconomic contributions of cultural events, employing a range of methodological approaches to extract insights into the micro-level dynamics of cultural phenomena (Plikynas et al., 2022).

To the best of the authors' knowledge, no previous study has specifically concentrated on examining cultural participation in cultural events to extrapolate complementarity and substitution effects amongst proximate destinations or communities (Patuelli et al., 2013). The complementarity effect implies that visiting a specific community for an event influences the probability of visiting another community where a similar event occurs. Conversely, the substitution effect indicates that individuals who visit a particular community are less likely to visit another community, reflecting a trade-off.

This study addresses this gap by proposing a theoretical framework that considers a coopetition strategy which comprises two economic concepts: cooperation and competition, within the cultural and hospitality participation stages. Indeed, a supply characterised by coopetition strategies tends also to drive demand spill-over effects (Brandenburger & Nalebuff, 1995). This paper examines the dynamics of cultural participation, specifically exploring the potential spill-over effects of cultural events by utilising the potential of big data. Big data are crucial from a supply- and demand-side perspective. Cultural planners can exploit this data to optimise costs, tailor products to customers' needs, and increase welfare (Peukert, 2019). Besides, access to information, product purchases, comments, blogs, and evaluation of customer satisfaction generate qualitative and quantitative big data that provide an in-depth understanding of consumer preferences, choices, and future stated behaviour (Deloumeaux, 2020). Yet, this thread of research is still at an early stage, and the impact of cultural supply and customers' behaviour in rural areas is still understated (Romanelli, 2018).

The present research applies the theoretical framework to cultural events that take place in the rural area of Gennargentu-Mandrolisai Mountain Community located on the Mediterranean island of Sardinia (Italy). The big data are from an application managed by a private for-profit company that allows visitors to discover several attractions of the island. The application enables the monitoring of individuals' movements and visits within the designated communities, based on the access to a virtual geographic boundary, which the global positioning system (GPS) defines. Analysing and processing data on visitors' movements allows for the assessment of cultural participation through the definition of a dichotomous variable indicating whether an individual has visited a community during the event. To perform the analysis, this big data matrix is implemented with further supply-side controls that identify possible drivers of demand spill-over effects amongst communities within the same geographical area. Hence, through an econometric analysis of this

extensive database, it is possible to assess what type of supply-side market conditions are likely to influence demand-side spill-over effects. Data are structured as a pseudo-panel[1] with an individual and a time dimension. Given the statistical characteristics of the dependent variable, logistic modelling estimates the impact of a set of socioeconomic determinants on individuals' choices and assesses substitution and complementary effects.

The measure of the impacts improves the understanding of complex and heterogenous systems and spaces and the formulation of ad hoc policies and investment strategies. The development of win–win policy strategies in rural areas should result from constant monitoring of already implemented actions and their effects on more expansive geographical settings.

This paper contributes to the literature in at least two ways. From a methodological perspective, it analyses a complex cultural good that merges tangible and intangible cultural heritage by exploring complementarity and substitution effects between events, within a coopetition setting. From an empirical perspective, it explores individual behaviours and spill-over effects drawing on a unique big dataset of flows and cultural participation.

The paper is structured as follows. Section 2 highlights the underlying mechanism of analysis; Sect. 3 presents the data and empirical specification; while, Sect. 4 illustrates the results of the empirical application. The last section provides a discussion of the results and concluding remarks.

2 The underlying mechanism of analysis

New technologies produce large volumes of novel and more informative data about agents' behaviour as assessed in several fields of research: finance (Hasan et al., 2020; Kumar et al., 2022), environmental (Ilieva & McPhearson, 2018; Ismagiloiva et al., 2019), tourism (Li & Cao, 2022; Li et al., 2018; Li et al., 2018; Raun, 2020; Shoval & Ahas, 2016) and cultural economics (Wuepper & Patry, 2017). Data sources are social media and mobile devices. They find several applications because of their potential to track individuals at aggregate and disaggregate levels and as a valuable method for studying complex systems (Balduini et al., 2019; Fugini et al., 2021; Wuepper & Patry, 2017). The spatial and temporal scale of analyses of big data (BD) is broader than traditional data collection consent. Indeed, BD may play a pivotal role in studying socioeconomic dynamics that require tailored analyses, especially in remote and inner rural areas where several factors constrain data availability and usability (Fantechi et al., 2020; Modica et al., 2021; Sinclair et al., 2022). The drawback of these data sources is the absence of individual preferences and information, partially fulfilled in the literature by employing social media sources. Combining mobile phone data with data from other sources is a compromise to

[1] A pseudo-panel data set is a simulated version of traditional panel data. Instead of collecting observations from the same entities over time, it combines cross-sectional data from different time periods to create a synthetic panel (see Verbeek, 2008 for further details).

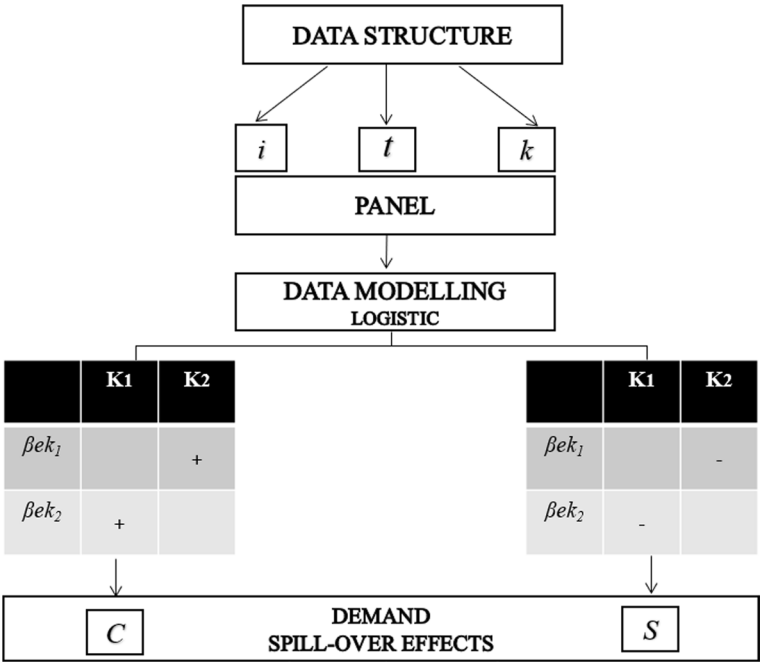

Fig. 1 From the data structure to demand spill-over effects: complementarity (*C*) and substitution (*S*) effects

gather evidence to inform policymakers on the dynamic of a territory. Frequently, these data have an individual and a time dimension, so a statistical database can be structured as a pseudo-panel. A pseudo-panel data set is a statistical structure that mimics a panel data structure using cross sectional data over multiple periods. In traditional panel data, observations are collected from the same entities (individuals, firms, etc.) over time. In a pseudo-panel data set, cross sectional data are aggregated from different time periods, creating a synthetic panel (Verbeek, 2008). Indeed, the data retrieved from mobile applications are a permanent statistical sample of statistical decision-making units (namely *i*) observed in consecutive periods (namely *t*) at a geographic point or, in the case of the present paper, inner community (namely *k*). This 3-way data structure, alongside the individual and time dimension, combines more comprehensive information relating to the characteristics of *N* individuals, observed at the same instant in time, and at *T* different periods, at a set of inner communities, *K*.

As already stated, these data have a typical cross sectional and longitudinal dimension. Yet, in the present research, the cross section relates to different samples of decision-making units: those who visited a sole community *k* at time *t*; those who visited multiple communities at time *t*; those who visited either a single community or several inner communities at different *T*. Combining the data into a pseudo-panel setting and performing an econometric analysis (in the present paper case, a logistic modelling, considering the characteristics of the dependent variable) it is possible to

elicit the relations and the type of spill-over amongst rural communities K (Fig. 1). As a simplification, considering two communities, k_1 and k_2, and two events, ek_1, and ek_2:

- A complementarity effect C occurs if the parameter β for the event e_1 in community k_1 (βek_1) on the estimated coefficient presents a positive sign for community k_2 and the parameter for the event e_2 in community k_2 (βek_2) has a positive sign for community k_1. Hence, a bidirectional effect exists between these communities.
- A substitution effect S occurs if the parameter β for the event e_1 in community k_1 (βek_1) on the estimated coefficient has a negative sign for community k_2, and the parameter for the event e_2 in community k_2 (βek_2) presents a negative sign for community k_1. Also, in this case, a bidirectional effect exists between these communities.

Therefore, this study assesses the hypothesis that the impact observed through the cultural participation behaviour in one community is influenced by events occurring also in neighbouring communities. Demand spill-over effects also tend to be driven by supply characterised by coopetition strategies (Brandenburger & Nalebuff, 1995). Semantically, this expression comprises two economic concepts: cooperation and competition, which can occur at the cultural and hospitality participation stages. Indeed, intense competition between communities may lead to substitution effects. Under this market scheme, communities compete to obtain a self-advantageous result, while complementarity effects are likely to arise under a cooperation strategy amongst communities. Under this market strategy, communities work together to reach common objectives. However, in recent years, especially in remote areas, a different market policy, namely coopetition, has been adopted, combining cooperation and competition (Dagnino, 2009; Machado et al., 2021). This market strategy supports financing sunk costs that small- and medium-sized agents cannot easily sustain independently (Falk, 2017). Coopetition has also proved to be a win–win strategy for businesses during the COVID-19 pandemic (Crick & Crick, 2020). Cooperation can often be achieved in remote areas thanks to the public planner[2] that supplies public infrastructure as a baseline to encourage an involvement stage by private entrepreneurs and facilitates relationships amongst communities around specific goals. Communities share resources (e.g. funds and infrastructure) and capabilities (e.g. networking, knowledge, and experience) for win–win strategies and outcomes. They may also compete to attract demand and achieve the best economic performance (Ferrarese et al., 2021). Namely, demand spill-over in terms of complementarity and substitution effects may occur between proximity communities, offering similar natural and cultural amenities (Fig. 2).

[2] In the model, the public planner is treated as an exogenous agent responsible for establishing policy directions at time 0. The temporal focus of this paper is designated as time 1.

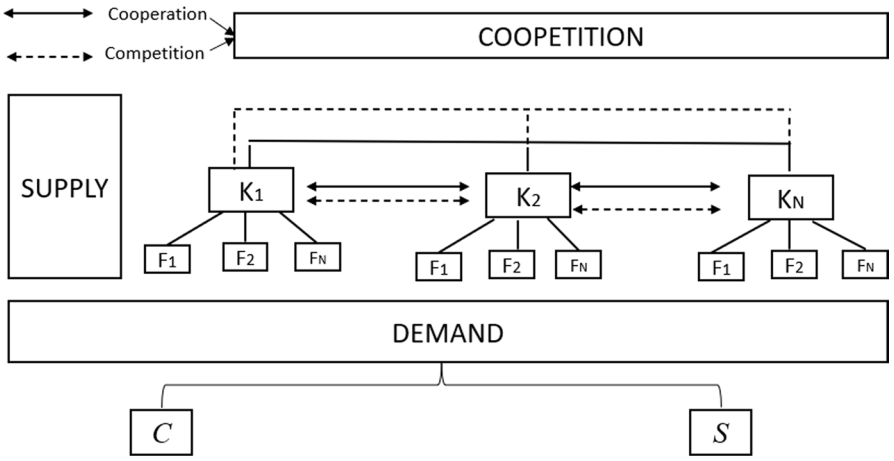

Fig. 2 From market policies to demand spill-over complementarity (*C*) and substitution (*S*) effects

3 Data and empirical specification

3.1 The case study

The geographical setting to apply the theoretical framework is the inner area of Gennargentu-Mandrolisai located on the Mediterranean island of Sardinia (Italy; Fig. 3). In 2008, the region's president, by following national laws, established the Mountain Community Gennargentu-Mandrolisai.[3] De Montis et al. (2017) and SNAI (2019) define it as an inner area due to geographic characterisation. The purpose is to enhance mountain areas and provide municipal services and functions. Eleven municipalities belong to this Community (Aritzo, Atzara, Austis, Belvì, Desulo, Gadoni, Meana Sardo, Ortueri, Sorgono, Teti, and Tonara) for a total of 562,890.916 km^2 and 16,000 inhabitants. The territorial area under consideration (equivalent to 2.3% of the whole region) immersed in is unspoiled nature with a low population density (27.92 inhabitants per square Km against a regional density of 66.9 and a national density of 197.4). In this respect, this inner area offers the opportunity to visit places rich in intangible cultural heritage, such as cultural practices, representations, expressions, knowledge and community identity, with spaces and attractions in an open and high-quality ecosystem. Like other inner areas, this geographical zone sees a continuous demographic decrease and remoteness (SNAI, 2019).

A special cultural activity, 'Autumn in Barbagia' (also known as *Cortes Apertas*), annually held in each municipality on different dates during the autumn season, taking the form of eleven separate events. In 1996, the inner town council of Oliena

[3] For more details see: https://www.sardegnaautonomie.it/sites/default/files/ccmm_mandrolisai_statuto.pdf; https://www.gennargentumandrolisai.it/index.php).

Fig. 3 Geographical overview of the Gennargentu-Mandrolisai. Source: SNAI, 2019

held this innovative event for the first time. Since 2000 local public planners in other rural areas have joined efforts to coordinate and schedule these cultural events as yearly recurrences. The aim is to make small communities known for their richness in archaeological sites, architecture, a preserved natural environment, history, identity, ancient uses, traditions, and unique eno-gastronomic heritage. Each event has distinctive features and settings and shares a high proportion of tangible and intangible cultural heritage with the others.

3.2 Data and indicators

The attractiveness and the firm provision of those municipalities can be studied according to the Italian Institute of Statistics (Istat) indicators' Classification tables of Italian communities by hospitality density'.[4] Indeed, Istat assigned scores within a 5-point Likert scale to each Italian community. The "D Index" classifies the communities according to the supply level. The value 1 represents a community with a very low hospitality intensity, while 5 a community with a very high hospitality intensity. Based upon this index, a categorical variable 'supply_index' can be defined for the communities within the territory under study.

[4] Available at https://www.istat.it/it/archivio/247191.

The dataset is obtained from a private for-profit company managing the Heart of Sardinia application. Users voluntarily download the app when searching for vacation planning tools in Sardinia, seeking guidance during their trips. The application, freely available for download to all users, is designed to help visitors discover various attractions, events, and activities on the island. Simultaneously, it tracks visitors' movements based on their access to a virtual geographic boundary defined by GPS or radio frequency identification (RFID) technology. These technologies enable software to trigger a response when a mobile device enters or leaves a particular area. Hence, the visits represent the number of accesses to the virtual boundary of the municipality. Indeed, data on movements are associated with this geographical area from virtual perimeters, called geo-fence.

These data refer to April 2019-December 2019, and have a weekly frequency. These data aggregation makes it impossible to trace individual users' identities and, therefore, guarantees and solves privacy issues. The database comprises users' socio-demographic-economic characteristics and mobility, such as the places and communities visited, and the level of expenditure at the municipality. Table 1 provides the label and the description of all employed indicators built according to the available data and information on the events; while, Table 2 reports the main descriptive statistics.

3.3 Sample features

The sample consists of 160,966 observations. Each observation, identified by a numerical code assigned directly by the data supplier, refers to a person who visited the area between April and December 2019. Information on nationality, gender, age group, spending propensity, and the visited community in the area under study is available for the sample. Each person may have visited the same community or area more than once during this period. The sample includes approximately 61% Sardinians, 21% foreigners, and 14% Italians from the mainland. In terms of gender, 56% are male and 44% female. The group aged between 25 and 44 is the most represented sample (56%). The 3% is under 18 years old, the 10% 18–24, the 30% 25–34, the 26% 35–44, the 15% 45–54 years old, the 11% 55–64 years old and 5% over 65.

The users are classified into three spending propensity categories (i.e. low, medium, and high) based on their behaviour during the visit across various sectors, including hospitality (e.g. five-star hotel and hostel), restaurants (e.g. three-star Michelin and fast food), attractions, leisure activities, and other tourism services. Although it does not directly measure spending in monetary terms, it provides an insightful overview of economic performance and an approximation of purchases in tangible cultural heritage. The manager of the Heart of Sardinia application developed this categorical indicator by tracking the number of geo-fence visitors accessing commercial activities. For example, consider a visitor who, over the course of a day, leaves a two-star hotel, has lunch at a bar, purchases an ice-cream, and dines at a fast-food. These activities represent four distinct economic interactions, which can be categorised as indicating a medium spending propensity. The majority of people (56%) have an average spending

Table 1 Label and description of the indicators

Label	Description
sardinian	Dichotomous variable which takes the value 1 if the individual who registered in the app is Sardinian; zero otherwise
italian	Dichotomous variable which takes the value 1 if the individual who registered in the app comes from the rest of Italy; zero otherwise
european	Dichotomous variable that takes the value 1 if the individual who registered in the app was from the EU; zero otherwise
age	Categorical variable. The categories are: 1 = 13–17 years old; 2 = from 18 to 24 years; 3 = from 25 to 34 years; 4 = from 35 to 44 years; 5 = from 45 to 54 years; 6 = from 55 to 64 years; 7 = from 65 and over
gender	Dichotomous variable that takes the value 1 if female; zero otherwise
spending	Categorical variable. The categories are: 1 = low spending propensity; 2 = average spending propensity in Italy; 3 = high spending propensity
easter	Dichotomous variable which takes the value 1 for the holiday date, 04/21/2019, and zero for the other dates
mid-august	Dichotomous variable which takes the value 1 for the holiday date, 08/15/2019, and zero for the other dates
all-saints	Dichotomous variable which takes the value 1 for the holiday date, 01/11/2019, and zero for the other dates
christmas	Dichotomous variable which takes the value 1 for the holiday date, 12/25/2019, and zero for the other dates
new years's eve	Dichotomous variable which takes the value 1 for the holiday date, 12/31/2019, and zero for the other dates
*e*_atzara	Dichotomous variable which takes the value 1 for the dates of the event, the 16–17/11/2019, and zero for the other dates
*e*_austis	Dichotomous variable which takes the value 1 for the dates of the event, the 21–22/09/2019, and zero for the other dates
*e*_belvi	Dichotomous variable which takes the value 1 for the dates of the event, the 19–20/10/2019, and zero for the other dates
*e*_desulo	Dichotomous variable which takes the value 1 for the dates of the event, the 01–02-03/11/2019, and zero for the other dates
*e*_gadoni	Dichotomous variable which takes the value 1 for the dates of the event, the 30/11–01/12/2019, and zero for the other dates
*e*_meana_sardo	Dichotomous variable which takes the value 1 for the dates of the event, the 05–06/10/2019, and zero for the other dates
*e*_ortueri	Dichotomous variable which takes the value 1 for the dates of the event, the 07–08/12/2019, and zero for the other dates
*e*_sorgono	Dichotomous variable which takes the value 1 for the dates of the event, the 19–20/10/2019, and zero for the other dates
*e*_teti	Dichotomous variable which takes the value 1 for the dates of the event, the 30/11–01/12/2019, and zero for the other dates
*e*_tonara	Dichotomous variable which takes the value 1 for the dates of the event, the 28–29/09/2019, and zero for the other dates
*e*_*bis*_tonara	Dichotomous variable which takes the value 1 for the data of the event, 04/22/2019, and zero for the other dates
*e*_aritzo	Dichotomous variable which takes the value 1 for the data of the event, 10/27/2019, and zero for the other dates

Table 1 (continued)

Label	Description
*e_bis*_aritzo	Dichotomous variable which takes the value 1 for the dates of the event, the 14–15–16–17/08/2019, and zero for the other dates
supply_index	Categorical variable, the synthetic index of intensity and characteristics of the supply (quintiles) that accounts for the presence of infrastructural equipment (hotel and non-hotel accommodation establishments) in the community; the categories are: "1 = very low (1st quintile), 2 = low (2nd quintile), 3 = medium (3rd quintile), 4 = high (4th quintile), 5 = very high (5th quintile)"

Table 2 Descriptive statistics of the indicators

	Obs	Mean	Std. Dev.	Min	Max
Sardinian	160,955	0.611	0.487	0	1
Italian	160,966	0.143	0.350	0	1
European	160,966	0.209	0.406	0	1
Age	160,955	3.932	1.423	1	7
Gender	160,955	0.444	0.499	0	1
Spending	160,955	2.007	0.659	1	3
Easter	160,966	0.008	0.088	0	1
Mid-August	160,966	0.011	0.104	0	1
All-saints	160,966	0.006	0.078	0	1
Christmas	160,966	0.007	0.084	0	1
New Years's eve	160,966	0.006	0.078	0	1
*e*_aritzo	160,966	0.005	0.067	0	1
*e*_atzara	160,966	0.006	0.081	0	1
*e*_austis	160,966	0.009	0.094	0	1
*e*_belvi	160,966	0.009	0.098	0	1
*e*_desulo	160,966	0.016	0.125	0	1
*e*_gadoni	160,966	0.007	0.082	0	1
*e*_meana_sardo	160,966	0.008	0.088	0	1
*e*_ortueri	160,966	0.005	0.071	0	1
*e*_sorgono	160,966	0.009	0.098	0	1
*e*_teti	160,966	0.007	0.082	0	1
*e*_tonara	160,966	0.009	0.094	0	1
*e_bis*_tonara	160,966	0.008	0.087	0	1
*e_bis*_aritzo	160,966	0.026	0.159	0	1
Supply_index	160,966	2.960	1.229	0	5

propensity; while, the remainder of the sample belongs to the low (22%) and high (22%) spenders cluster. Three out of eleven communities stand out for the number of visitors: Aritzo, Desulo, and Sorgono, with 48,483, 43,677, and 45,045 observations, respectively. Teti lags with 26,591 registrations in the app. The monthly access trend to the application highlights a peak in August, confirming the seasonal component that characterises Sardinia.

3.4 Probabilistic modelling

Examining and processing data related to visitors' movements enables the evaluation of cultural demand by generating a dichotomous variable that indicates whether an individual attended a community event. Expanding upon this data foundation and delving into the analytical mechanism elucidated in Sect. 2, the generic demand function is articulated as follows:

$$V_{itk} = f_{it}(\text{SE}, H, E, F) + \varepsilon_{itk} \tag{1}$$

V is the visit of individual i, at time t. Hence, V is structured as a dichotomous variable which equals one if the visit happened at community k and zero otherwise. SE includes socioeconomic characteristics such as age, gender, nationality, and spending propensity. H is the holiday domain that consists of the institutional scheduled holidays such as mid-August and special religious celebrations such as Christmas and Easter. E comprises the cultural events domain, which is all the dates of the events at the various inner communities K under analysis. F is the indicator that measures the hospitality supply propensity of each community k *(supply_index)*, provided specific infrastructural facilities for hospitality (e.g. accommodation). Considering the characteristics of the dependent variables, a series of logit models (Hill et al., 2018) are employed for in-depth investigation controlling for the supply-side indicators to pinpoint potential factors influencing demand spill-over effects.

4 Results

The comprehensive estimation tables for the logit models, derived from the aforementioned framework, are available in Table 3. This table presents the estimation results for Eq. (1) expressed as marginal effects for a standard interpretation.[5]

As far as the socioeconomic variables are concerned, factors such as age, gender, and spending propensity do not significantly impact the probability of visiting the communities in question. The analysis suggests that spending propensity may not substantially affect the likelihood of visiting inner communities, except in the case of Belvì. This outcome is consistent with the fact that visiting these inner destinations generally requires a modest budget, making them affordable to a broader range of consumers. It also aligns with the research by Pateman (2011) for England and Wales. Interestingly, an increase in spending propensity may lead to a decrease in the probability of visiting one of these communities. Notably, the negative sign associated with Belvì underlines this intuition. Concerning the visitors' origin variables, the statistically significant and positive coefficients are always for the Sardinian cluster. This result is expected, given the insularity of this region. Hence, being a regional visitor positively affects the likelihood of visiting all the communities in the inner areas.

[5] Table 5 in the Appendix presents the identical models but expressed in terms of odds ratios.

Table 3 Estimation results based on Eq. (1)

	Aritzo	Atzara	Austis	Belvi	Desulo	Gadoni	Meana_sardo	Ortueri	Sorgono	Teti	Tonara
Sardinian	0.0460	0.0839**	0.0952***	0.0693**	0.101***	0.137***	0.0169	0.138***	0.0125	0.00950	0.102**
	(0.0311)	(0.0356)	(0.0354)	(0.0353)	(0.0320)	(0.0346)	(0.0334)	(0.0371)	(0.0315)	(0.0431)	(0.0400)
Italian	0.503***	−0.0266	0.00667	−0.0721*	−0.0201	0.00387	−0.119***	−0.0146	−0.000202	−0.0325	−0.145***
	(0.0327)	(0.0381)	(0.0377)	(0.0378)	(0.0341)	(0.0369)	(0.0358)	(0.0396)	(0.0336)	(0.0459)	(0.0428)
European	0.0103	−0.0121	−0.0642*	0.0138	0.00858	0.0199	−0.0459	−0.000178	−0.0237	−0.0271	−0.0620
	(0.0321)	(0.0368)	(0.0366)	(0.0364)	(0.0330)	(0.0357)	(0.0345)	(0.0383)	(0.0325)	(0.0443)	(0.0413)
Age	−0.000960	−0.00786*	−0.00131	−0.00229	0.00364	0.00186	0.000739	−0.00899*	−0.000203	0.00631	0.00111
	(0.00389)	(0.00448)	(0.00445)	(0.00444)	(0.00404)	(0.00431)	(0.00427)	(0.00465)	(0.00401)	(0.00552)	(0.00512)
Gender	0.00870	−0.0185	−0.0105	0.0123	0.00921	0.00334	−0.00957	−0.0122	−0.00775	−0.00979	0.00781
	(0.0112)	(0.0128)	(0.0128)	(0.0127)	(0.0116)	(0.0124)	(0.0122)	(0.0133)	(0.0115)	(0.0159)	(0.0147)
Spending	−0.00324	0.00221	0.0154	−0.0272**	0.00961	−0.00312	0.00481	−0.00319	−0.00295	−0.000351	0.0120
	(0.00965)	(0.0110)	(0.0110)	(0.0109)	(0.00997)	(0.0106)	(0.0105)	(0.0114)	(0.00992)	(0.0137)	(0.0127)
Easter	−0.325***	−0.504***	−0.368***	−0.276***	−0.348***	−0.487***	−0.409***	−0.694***	−0.128*	−0.469***	−0.538***
	(0.0682)	(0.0849)	(0.0812)	(0.0772)	(0.0695)	(0.0799)	(0.0766)	(0.0876)	(0.0668)	(0.0992)	(0.0919)
Mid-August	0.221***	−0.181**	−0.0764	−0.0422	−0.0239	0.412***	0.0841	0.0378	−0.0881	−0.0109	0.0846
	(0.0506)	(0.0807)	(0.0746)	(0.0785)	(0.0716)	(0.0699)	(0.0762)	(0.0834)	(0.0709)	(0.0888)	(0.0865)
All-saints	0.239***	−0.0112	−0.338***	−0.0230	0.518***	0.0833	−0.395***	0.00232	−0.145	0.128	−0.594***
	(0.0896)	(0.0995)	(0.0968)	(0.0990)	(0.0673)	(0.0972)	(0.0918)	(0.103)	(0.0901)	(0.111)	(0.109)
Christmas	0.00976	0.227***	0.0757	0.122*	0.126*	0.227***	0.216***	0.207***	0.0106	0.453***	0.0583
	(0.0649)	(0.0711)	(0.0738)	(0.0727)	(0.0664)	(0.0685)	(0.0689)	(0.0760)	(0.0662)	(0.0781)	(0.0778)
New Years's eve	0.0748	0.170**	0.243***	0.0784	0.133*	0.134*	0.208***	0.205**	0.0888	0.280***	0.0667
	(0.0711)	(0.0788)	(0.0770)	(0.0801)	(0.0723)	(0.0765)	(0.0752)	(0.0820)	(0.0721)	(0.0912)	(0.0881)
*e*_aritzo		−0.0309	0.0848	0.135	0.0540	0.368***	0.183**	0.255***	0.0556	0.221**	−0.157
		(0.0956)	(0.0917)	(0.0903)	(0.0840)	(0.0827)	(0.0866)	(0.0931)	(0.0824)	(0.104)	(0.103)

Table 3 (continued)

	Aritzo	Atzara	Austis	Belvi	Desulo	Gadoni	Meana_sardo	Ortueri	Sorgono	Teti	Tonara
*e_bis_*aritzo		0.114** (0.0512)	0.310*** (0.0484)	0.101** (0.0511)	0.0626 (0.0467)	0.203*** (0.0481)	0.00349 (0.0505)	0.0327 (0.0548)	0.0379 (0.0460)	0.228*** (0.0584)	−0.0536 (0.0573)
*e*_atzara	−0.0370 (0.0688)		0.112 (0.0757)	0.189** (0.0738)	0.122* (0.0688)	0.194*** (0.0715)	0.123* (0.0730)	0.235*** (0.0778)	0.114* (0.0677)	0.396*** (0.0831)	−0.0178 (0.0823)
*e*_austis	0.0982* (0.0580)	0.0439 (0.0665)		−0.00746 (0.0668)	0.0671 (0.0593)	0.0789 (0.0632)	0.101 (0.0625)	0.0133 (0.0685)	0.110* (0.0592)	−0.366*** (0.0918)	0.333*** (0.0741)
*e*_belvi	−0.0777 (0.0568)	0.147** (0.0619)	0.264*** (0.0597)		0.131** (0.0563)	0.0803 (0.0605)	0.0826 (0.0604)	0.0930 (0.0653)	0.872*** (0.0517)	−0.514*** (0.0902)	0.201*** (0.0695)
*e*_desulo	−0.135** (0.0571)	0.148** (0.0619)	0.450*** (0.0569)	0.146** (0.0615)		0.0291 (0.0613)	0.589*** (0.0545)	0.193*** (0.0652)	0.161*** (0.0547)	0.238*** (0.0680)	0.530*** (0.0629)
*e*_gadoni	−0.00503 (0.0667)	0.221*** (0.0736)	0.211*** (0.0731)	0.142* (0.0748)	0.239*** (0.0673)		0.0721 (0.0742)	0.395*** (0.0765)	0.0344 (0.0671)	1.117*** (0.0726)	−0.259*** (0.0789)
*e*_meana_sardo	0.0170 (0.0629)	−0.0313 (0.0726)	0.146** (0.0690)	0.0170 (0.0708)	0.0837 (0.0631)	0.0344 (0.0682)		0.0593 (0.0723)	0.101 (0.0632)	−0.607*** (0.105)	0.490*** (0.0778)
*e*_ortueri	0.137* (0.0754)	0.224*** (0.0832)	0.198** (0.0835)	0.0830 (0.0858)	0.0985 (0.0779)	0.0166 (0.0845)	0.0890 (0.0829)		0.123 (0.0770)	0.398*** (0.0952)	0.237*** (0.0918)
*e*_sorgono	0 (.)	0 (.)	0 (.)	0.609*** (0.0552)	0 (.)	0 (.)	0 (.)	0 (.)		0 (.)	0 (.)
*e*_teti	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	1.480*** (0.0616)	0 (.)	0 (.)	0 (.)		0 (.)
*e*_tonara	−0.0760 (0.0585)	0.210*** (0.0642)	0.142** (0.0649)	0.124* (0.0654)	0.0270 (0.0611)	0.0672 (0.0642)	0.173*** (0.0628)	0.244*** (0.0688)	0.0540 (0.0583)	−0.856*** (0.0929)	
*e_bis*_tonara	−0.145** (0.0660)	−0.277*** (0.0792)	−0.172** (0.0767)	−0.427*** (0.0824)	0.275*** (0.0618)	0.588*** (0.0612)	−0.391*** (0.0772)	−0.556*** (0.0851)	−0.207*** (0.0690)	−0.570*** (0.104)	
Supply_index	0.269*** (0.00475)	−0.145*** (0.00507)	−0.0759*** (0.00510)	−0.172*** (0.00501)	−0.306*** (0.00458)	−0.159*** (0.00485)	−0.266*** (0.00482)	−0.637*** (0.00535)	0.320*** (0.00498)	1.440*** (0.0114)	1.679*** (0.0112)

Table 3 (continued)

	Aritzo	Atzara	Austis	Belvi	Desulo	Gadoni	Meana_sardo	Ortueri	Sorgono	Teti	Tonara
lnsig2u	− 5.399*** (1.175)	− 9.096*** (1.827)	− 9.045*** (2.047)	− 8.877*** (1.865)	− 4.835*** (0.713)	− 4.494*** (0.575)	− 9.124*** (1.951)	− 11.58*** (2.974)	− 4.497*** (0.506)	− 2.602*** (0.148)	− 2.820*** (0.160)
Aic	192,635.5	155,674.8	157,071.8	157,945.7	183,493.8	167,362.8	166,572.9	144,853.3	186,130.6	113,330.5	126,678.0
Bic	192,865.3	155,914.5	157,311.5	158,195.4	183,733.5	167,612.5	166,812.6	145,093.1	186,380.3	113,580.2	126,907.8
N	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955

Marginal effects; Standard errors in parentheses; standard errors in parentheses *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

In the holidays domain (*H*), Easter presents a highly statistically significant coefficient for all communities. Indeed, it homogenously decreases the probability of visiting one of the communities in the Gennargentu-Mandrolisai area. Mid-August event (a traditional national holiday called Ferragosto) and All Saints' Day unevenly affect the likelihood of visiting the various communities. Although the coefficients are not always statistically significant, Christmas and New Year festivities positively influence the possibility of visiting all communities. It could be that people who visit relatives and friends during these holidays organise excursions and trips to the surrounding areas on this occasion and may behave like real tourists.

On the complementarity and substitution effects, the emphasis lies mainly on the variables with the '*e*' prefix, which represent the event domain (*E*) and are the primary focus of this study for spill-over effects. A complementarity effect (*C*) emerges when the parameter β or its marginal effect for event e_1 in community k_1 (βek_1) exhibits a positive sign for community k_2. For instance, from Table 3 let's consider the communities Aritzo and Austis and two events *e*_aritzo and *e*_austis where a bidirectional complementarity effect is detected. The parameter β, or the marginal effect, for event e_1 (*e*_aritzo) in community k_1 (Aritzo) displays a positive sign for community k_2 (Austis). Concurrently, the parameter for event e_2 (*e*_austis) in community k_2 (Austis) exhibits a positive sign for community k_1 (Aritzo).

As for a substitution effect (*S*) a negative sign is expected. This outcome is exemplified in Aritzo and Tonara: the parameter for event *e_aritzo* held in community Aritzo displays a negative sign for community Tonara. Simultaneously, the parameter for event *e_tonara* held in community Tonara demonstrates a negative sign for community Aritzo. Once again, a bidirectional effect is observed between these communities, signifying a substitution effect.

Table 4 comprehensively summarises the complementarity (*C*) and substitution (*S*) effects derived from the regression models outlined in Table 3. The analysis features the intricate relationships between events in the same inner area, shedding light on their significant influence on the likelihood of visiting other communities. The complementarity effect implies that visiting a particular community raises the probability of exploring another community where a similar event occurs. On the contrary, the substitution effect suggests that individuals who visit a particular community are less likely to explore another, showing a trade-off between the two. The notation *C*–*S* indicates mixed findings regarding the direction of the relationship changes according to the event's timing. The symbol—indicates that no estimation was provided. Overall, the analysis highlights the net prevailing complementarity effect between the communities in the Gennargentu-Mandrolisai inner area. Hence, this outcome addresses the likelihood of visiting other communities when an event is held within the same inner area.

As far as the *Supply_index* is concerned, it presents a highly statistically significant coefficient for all communities with different effects. Indeed, the positive sign indicates the higher provision of infrastructural equipment (e.g. hotel and non-hotel accommodation establishments) in the communities leads to a higher probability of attracting demand in four out of eleven communities (i.e. Aritzo, Sorgono, Teti, and Tonara). In the remaining communities, a negative sign implies a lower infrastructural provision and, hence a smaller likelihood of attraction.

Table 4 Overall demand spill-over effects also controlling for the supply-side hospitality degree

	Aritzo	Atzara	Austis	Belvi	Desulo	Gadoni	Meana Sardo	Ortueri	Sorgono	Teti	Tonara
Aritzo		*S–C*	*C*	*C*	*C*	*C*	*C*	*C*	*C*	*C*	*S*
Atzara	*S*		*C*	*C*	*C*	*C*	*C*	*C*	*C*	*C*	*S*
Austis	*C*	*C*		*S*	*C*	*C*	*C*	*C*	*C*	*S*	*C*
Belvì	*S*	*C*	*S*		*C*	*C*	*C*	*C*	*C*	*S*	*C*
Desulo	*S*	*C*	*C*	*C*		–	*C*	*C*	*C*	*C*	*C*
Gadoni	*S*	*C*	*C*	*C*	*C*		–	*C*	*C*	*C*	*S*
Meana Sardo	*C*	*S*	*S*	*C*	*C*	*C*		*C*	*C*	*S*	*C*
Ortueri	*C*	*C*	*C*	*C*	*C*	*C*	*C*		*C*	*C*	*C*
Sorgono	–	–	–	*C*	–	–	–	–		–	–
Teti	–	–	–	–	–	*C*	–	–	–		–
Tonara	*S*	*C–S*	*C–S*	*S*	*C*	*C*	*C–S*	*C–S*	*C–S*	*C–S*	

Demand and supply could be simultaneously determined. Hence, Table 6 (in the Appendix) shows estimation results without the supply index as reported in Eq. (1). The findings reveal the stability of the coefficients in terms of statistical significance and relative magnitude, signalling the specification's robustness. An additional analysis was conducted, incorporating a supplementary index, namely the T_index, which represents the "economic activity linked to tourism." This index is part of Istat's indicators in the Classification tables of Italian communities by hospitality density, as specified in Footnote 4. It has been constructed based on several indicators encompassing various dimensions, including the added value of cultural local units connected to tourism per inhabitant. In this study, the T_index is a proxy for the number of cultural attractions and/or cultural heritage, considered important determinants of cultural participation. As evidenced in Table 7, the incorporation of this new measure not only affirms the validity of the findings but also reinforces their robustness. The results of the T_index align with those of the *Supply_index*. The positive sign indicates that a higher provision of economic activity linked to tourism, beyond infrastructural equipment in the community, correlates with an increased likelihood of attracting demand. This result holds in four out of eleven communities (namely, Aritzo, Sorgono, Teti, and Tonara) that are highly specialised. Besides, the complementarity and substitution effects remain unaltered, further confirming the robustness of the findings.

5 Discussion and conclusions

The study examines participation in cultural events and complementary and substitution effects amongst proximate communities. The utilisation of big data provides opportunity to expand knowledge on individual behaviour within inner spaces and elicit specific market strategies.

Overall, the analysis highlights the net prevailing complementarity effect between the communities in the Gennargentu-Mandrolisai inner area and indicates a substantial impact on the likelihood of visiting other communities when an event takes place within the same area. The findings are somewhat consistent with the role of cultural amenities in enhancing destination efficiency, as indicated by previous studies (Figueroa et al., 2018; Gomez-Vega et al., 2022; Herrero-Prieto and Gomez-Vega, 2017). This not only adds more evidence supporting the positive impact of cultural amenities but also contributes to the narrative on the effects of demand spill-over driven by cultural participation. Interestingly, the complementarity effect prevails for those communities with insufficient development in tourism supply and a disadvantaged socioeconomic structure. In this regard, cooperation seems to be present between small and less known communities. In these areas, hospitality infrastructure lacks for guests (e.g. accommodation and restaurants). Yet, a predominant substitution effect highlights competition for the more developed and well-known communities. To provide further insights, we computed the average marginal effects for complementarity and substitution communities using probabilistic outcomes: 0.206 and −0.164, respectively. Drawing on data from Melis et al. (2016) for the average expenditure per person per day on cultural events during the low season, we

assessed the estimated effects' magnitude (detailed results are provided in Table 8). In general, if the average visitor spends €100 per day/visit and there is complementarity, we anticipate a 20% increase in average expenditure. Conversely, a decrease of 16% is expected in the case of substitution.

The empirical results also highlight that the Gennargentu-Mandrolisai Mountain Community has significant opportunities to grow as a recognised cultural destination. Notably, tangible cultural heritage contribute directly and indirectly to the local economy through sales revenue, employment opportunities, and local business development. Although intangible cultural heritage does not generate direct revenue through monetary transactions, it highly contributes to the overall attractiveness and authenticity of the destination, enhancing visitor positive experiences. Besides, through loyalty and word-of-mouth, they foster long-term socioeconomic and environmental sustainability for the hosting communities.

The findings further support coopetition as one of the market strategies that can sustain small and remote communities. This strategy facilitates the financing of sunk costs, which small- and medium-sized agents may struggle to independently manage (Falk, 2017). The theoretical and analytical framework provides valuable insights to the local institutions to identify adequate policies that exploit these effects and allow the development of this internal area throughout the year. Starting from the cluster of the most mature communities, also in terms of a hospitality perspective, one should try to create a network involving the lesser-known communities. To this aim, tailored policies should favour collaboration to achieve common objectives of increasing visitors' attraction and sustainable economic growth. An example of this kind is promoting multiple cultural routes that lead visitors to call on different sites and experience different local cultures.

There are many actions to combine the territory's vast potential with an adequate response from the reference market. Indeed, the pursuit of cultural activity, respectful of the environment and local communities, offers an opportunity to regain possession of one's identity and to enhance one's specific characteristics with a view to sustainable development. Brandano and Mastrangioli (2020) highlight that inner areas must learn how to improve their uniqueness to distinguish themselves from other competing communities.

Besides, less accessibility is synonymous with quality of life and well-being for locals and guests. Synergic policies aimed at enhancing the vast inner area cannot ignore investments in infrastructures (e.g. requalification of existing dwellings), which would support hospitality facilities for an authentic visitor experience. An economically vital territory would encourage the resident population to remain in these areas and perhaps invest in other sustainable economic activities linked to their identity, thus feeding a virtuous cycle that could bring significant win–win outcomes.

The proposed methodology offers a promising integration for crafting tailored policies to address the distinctive challenges encountered by inner areas, emphasising the crucial role of cultural amenities in shaping targeted strategies. Yet, some limitations warrant discussion. Firstly, the specificity of the case study may hinder the extrapolation of results to other events. Additionally, the databases employed in this research are relatively underutilised, restricting the potential for comparative

follow-up based on existing studies. Despite these constraints, valuable insights have been provided within the defined scope of the investigation. Hence, a fundamental element is to monitor specific data constantly through the joint use of sampling surveys, carried out with standard methodology and big data technologies (such as mobile phone positioning, web scraping, and open applications). These systematic data collections help to obtain valuable information from survey participants and application users on preferences, cultural sites, and places visited. In this manner, it would be possible to assess services and infrastructure needs as a significant basis to enhance communities' synergies to achieve win–win outcomes. Future research may benefit from addressing these limitations and expanding the scope to enhance the generalisability of findings across different spatial contexts and databases.

Appendix

See Tables 5, 6, 7, and 8.

Table 5 Odds ratio results based on Eq. (1)

	Aritzo	Atzara	Austis	Belvi	Desulo	Gadoni	Meana_sardo	Ortueri	Sorgono	Teti	Tonara
Sardinian	1.047 (0.0326)	1.087** (0.0387)	1.100*** (0.0389)	1.072** (0.0378)	1.107*** (0.0354)	1.147*** (0.0396)	1.017 (0.0340)	1.148*** (0.0426)	1.013 (0.0319)	1.010 (0.0435)	1.107** (0.0443)
Italian	1.654*** (0.0540)	0.974 (0.0371)	1.007 (0.0380)	0.930* (0.0352)	0.980 (0.0335)	1.004 (0.0370)	0.888*** (0.0318)	0.985 (0.0390)	1.000 (0.0336)	0.968 (0.0444)	0.865*** (0.0370)
European	1.010 (0.0324)	0.988 (0.0363)	0.938* (0.0344)	1.014 (0.0369)	1.009 (0.0333)	1.020 (0.0364)	0.955 (0.0329)	1.000 (0.0383)	0.977 (0.0317)	0.973 (0.0432)	0.940 (0.0388)
Age	0.999 (0.00389)	0.992* (0.00445)	0.999 (0.00445)	0.998 (0.00443)	1.004 (0.00405)	1.002 (0.00432)	1.001 (0.00428)	0.991* (0.00461)	1.000 (0.00401)	1.006 (0.00556)	1.001 (0.00512)
Gender	1.009 (0.0112)	0.982 (0.0126)	0.990 (0.0126)	1.012 (0.0128)	1.009 (0.0117)	1.003 (0.0124)	0.990 (0.0121)	0.988 (0.0131)	0.992 (0.0114)	0.990 (0.0157)	1.008 (0.0148)
Spending	0.997 (0.00962)	1.002 (0.0111)	1.016 (0.0111)	0.973** (0.0106)	1.010 (0.0101)	0.997 (0.0106)	1.005 (0.0106)	0.997 (0.0114)	0.997 (0.00989)	1.000 (0.0137)	1.012 (0.0128)
Easter	0.723*** (0.0493)	0.604*** (0.0512)	0.692*** (0.0562)	0.759*** (0.0586)	0.706*** (0.0490)	0.615*** (0.0491)	0.664*** (0.0509)	0.499*** (0.0438)	0.880* (0.0587)	0.626*** (0.0621)	0.584*** (0.0537)
Mid-August	1.247*** (0.0631)	0.835** (0.0674)	0.926 (0.0691)	0.959 (0.0752)	0.976 (0.0699)	1.509*** (0.106)	1.088 (0.0829)	1.039 (0.0866)	0.916 (0.0649)	0.989 (0.0878)	1.088 (0.0941)
All-saints	1.270*** (0.114)	0.989 (0.0984)	0.713*** (0.0690)	0.977 (0.0968)	1.679*** (0.113)	1.087 (0.106)	0.673*** (0.0618)	1.002 (0.104)	0.865 (0.0779)	1.136 (0.127)	0.552*** (0.0599)
Christmas	1.010 (0.0656)	1.254*** (0.0892)	1.079 (0.0796)	1.130* (0.0822)	1.134* (0.0753)	1.255*** (0.0860)	1.241*** (0.0856)	1.230*** (0.0935)	1.011 (0.0669)	1.574*** (0.123)	1.060 (0.0825)
New Years's eve	1.078 (0.0766)	1.185** (0.0934)	1.275*** (0.0982)	1.082 (0.0867)	1.142* (0.0826)	1.143* (0.0875)	1.231*** (0.0925)	1.227** (0.101)	1.093 (0.0788)	1.323*** (0.121)	1.069 (0.0942)
*e*_aritzo		0.970 (0.0926)	1.089 (0.0998)	1.144 (0.103)	1.055 (0.0887)	1.444*** (0.119)	1.201** (0.104)	1.290*** (0.120)	1.057 (0.0871)	1.248** (0.130)	0.855 (0.0878)
*e*_bis_aritzo		1.121** (0.0574)	1.364*** (0.0660)	1.106** (0.0565)	1.065 (0.0497)	1.224*** (0.0590)	1.003 (0.0507)	1.033 (0.0566)	1.039 (0.0478)	1.256*** (0.0734)	0.948 (0.0543)
*e*_atzara	0.964 (0.0663)		1.118 (0.0846)	1.207** (0.0891)	1.129* (0.0777)	1.214*** (0.0868)	1.131* (0.0825)	1.264*** (0.0983)	1.121* (0.0759)	1.486*** (0.123)	0.982 (0.0809)
*e*_austis	1.103* (0.0640)	1.045 (0.0695)		0.993 (0.0663)	1.069 (0.0635)	1.082 (0.0684)	1.106 (0.0691)	1.013 (0.0694)	1.116* (0.0661)	0.694*** (0.0637)	1.395*** (0.103)

Table 5 (continued)

	Aritzo	Atzara	Austis	Belvi	Desulo	Gadoni	Meana_sardo	Ortueri	Sorgono	Teti	Tonara
*e*_belvi	0.925 (0.0525)	1.158** (0.0716)	1.302*** (0.0777)		1.139** (0.0641)	1.084 (0.0656)	1.086 (0.0656)	1.098 (0.0717)	2.391*** (0.124)	0.598*** (0.0539)	1.222*** (0.0850)
*e*_desulo	0.874** (0.0499)	1.160** (0.0718)	1.568*** (0.0893)	1.157** (0.0711)		1.030 (0.0631)	1.803*** (0.0983)	1.213*** (0.0791)	1.175*** (0.0643)	1.269*** (0.0863)	1.698*** (0.107)
*e*_gadoni	0.995 (0.0663)	1.247*** (0.0918)	1.235*** (0.0903)	1.152* (0.0861)	1.270*** (0.0855)		1.075 (0.0797)	1.485*** (0.114)	1.035 (0.0694)	3.056*** (0.222)	0.772*** (0.0609)
*e*_meana_sardo	1.017 (0.0639)	0.969 (0.0703)	1.157** (0.0798)	1.017 (0.0720)	1.087 (0.0686)	1.035 (0.0706)		1.061 (0.0767)	1.107 (0.0700)	0.545*** (0.0573)	1.632*** (0.127)
*e*_ortueri	1.147* (0.0865)	1.251*** (0.104)	1.219** (0.102)	1.087 (0.0932)	1.103 (0.0860)	1.017 (0.0859)	1.093 (0.0906)		1.131 (0.0871)	1.488*** (0.142)	1.267*** (0.116)
*e*_sorgono	1 (.)	1 (.)	1 (.)	1.839*** (0.101)	1 (.)	1 (.)	1 (.)	1 (.)		1 (.)	1 (.)
*e*_teti	1 (.)	1 (.)	1 (.)	1 (.)	1 (.)	4.394*** (0.271)	1 (.)	1 (.)	1 (.)		1 (.)
*e*_tonara	0.927 (0.0542)	1.233*** (0.0792)	1.153** (0.0748)	1.132* (0.0741)	1.027 (0.0628)	1.069 (0.0686)	1.188*** (0.0746)	1.277*** (0.0878)	1.055 (0.0616)	0.425*** (0.0395)	
*e_bis*_tonara	0.865** (0.0570)	0.758*** (0.0601)	0.842** (0.0646)	0.653*** (0.0538)	1.316*** (0.0813)	1.801*** (0.110)	0.676*** (0.0522)	0.573*** (0.0488)	0.813*** (0.0561)	0.566*** (0.0589)	
Supply_index	1.309*** (0.00622)	0.865*** (0.00439)	0.927*** (0.00473)	0.842*** (0.00422)	0.736*** (0.00337)	0.853*** (0.00414)	0.766*** (0.00369)	0.529*** (0.00283)	1.376*** (0.00686)	4.222*** (0.0482)	5.359*** (0.0603)
lnsig2u	0.00452*** (0.00531)	0.000112*** (0.000205)	0.000118*** (0.000242)	0.000140*** (0.000260)	0.00794*** (0.00566)	0.0112*** (0.00642)	0.000109*** (0.000213)	0.00000939*** (0.0000279)	0.0111*** (0.00563)	0.0741*** (0.0109)	0.0596*** (0.00953)
Aic	192,635.5	155,674.8	157,071.8	157,945.7	183,493.8	167,362.8	166,572.9	144,853.3	186,130.6	113,330.5	126,678.0
Bic	192,865.3	155,914.5	157,311.5	158,195.4	183,733.5	167,612.5	166,812.6	145,093.1	186,380.3	113,580.2	126,907.8
N	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955

Odds ratio; standard errors in parentheses $*p<0.10$, $**p<0.05$, $***p<0.01$

Table 6 Robustness check: estimation results without the supply index

	Aritzo	Atzara	Austis	Belvi	Desulo	Gadoni	Meana_sardo	Ortueri	Sorgono	Teti	Tonara
Sardinian	1.052 (0.0324)	1.083** (0.0385)	1.097*** (0.0388)	1.066* (0.0375)	1.093*** (0.0344)	1.141*** (0.0393)	1.009 (0.0334)	1.108*** (0.0389)	1.018 (0.0315)	1.015 (0.0378)	1.086** (0.0359)
Italian	1.630*** (0.0527)	0.976 (0.0370)	1.008 (0.0380)	0.933* (0.0351)	0.984 (0.0330)	1.006 (0.0370)	0.892*** (0.0316)	0.993 (0.0372)	0.996 (0.0328)	0.965 (0.0383)	0.885*** (0.0314)
European	1.012 (0.0321)	0.987 (0.0362)	0.937* (0.0343)	1.012 (0.0367)	1.006 (0.0326)	1.018 (0.0362)	0.954 (0.0326)	0.995 (0.0361)	0.979 (0.0312)	0.992 (0.0381)	0.964 (0.0329)
Age	0.999 (0.00385)	0.992* (0.00444)	0.999 (0.00445)	0.998 (0.00441)	1.003 (0.00398)	1.002 (0.00431)	1.001 (0.00423)	0.991* (0.00436)	1.000 (0.00393)	1.005 (0.00475)	1.001 (0.00419)
Gender	1.009 (0.0111)	0.982 (0.0126)	0.989 (0.0126)	1.012 (0.0128)	1.009 (0.0115)	1.003 (0.0124)	0.990 (0.0120)	0.989 (0.0124)	0.993 (0.0112)	0.997 (0.0135)	1.010 (0.0121)
Spending	0.996 (0.00952)	1.002 (0.0110)	1.016 (0.0111)	0.973** (0.0106)	1.009 (0.00987)	0.997 (0.0106)	1.005 (0.0105)	0.997 (0.0108)	0.997 (0.00967)	0.995 (0.0116)	1.004 (0.0104)
Easter	0.703*** (0.0474)	0.622*** (0.0526)	0.701*** (0.0569)	0.785*** (0.0604)	0.756*** (0.0516)	0.635*** (0.0505)	0.705*** (0.0534)	0.615*** (0.0511)	0.849** (0.0557)	0.678*** (0.0594)	0.654*** (0.0497)
Mid-August	1.270*** (0.0636)	0.832** (0.0670)	0.924 (0.0689)	0.954 (0.0746)	0.968 (0.0683)	1.498*** (0.104)	1.077 (0.0813)	1.013 (0.0802)	0.925 (0.0647)	1.011 (0.0798)	1.092 (0.0810)
All-saints	1.219** (0.108)	1.010 (0.100)	0.721*** (0.0698)	1.002 (0.0989)	1.624*** (0.108)	1.112 (0.108)	0.705*** (0.0641)	1.099 (0.108)	0.831** (0.0739)	0.982 (0.0979)	0.553*** (0.0514)
Christmas	1.048 (0.0675)	1.223*** (0.0868)	1.065 (0.0785)	1.096 (0.0795)	1.074 (0.0704)	1.220*** (0.0834)	1.181** (0.0807)	1.076 (0.0778)	1.056 (0.0690)	1.592*** (0.111)	1.174** (0.0790)
New Years's eve	1.085 (0.0764)	1.176** (0.0924)	1.270*** (0.0977)	1.072 (0.0856)	1.122 (0.0799)	1.133 (0.0865)	1.209** (0.0900)	1.159* (0.0899)	1.102 (0.0783)	1.257*** (0.102)	1.065 (0.0803)
*e*_aritzo		0.953 (0.0908)	1.079 (0.0989)	1.119 (0.101)	1.016 (0.0842)	1.413*** (0.117)	1.157* (0.0993)	1.158* (0.102)	1.089 (0.0885)	1.280*** (0.118)	0.956 (0.0844)
*e_bis_* aritzo		1.110** (0.0566)	1.356*** (0.0655)	1.092* (0.0555)	1.041 (0.0479)	1.210*** (0.0580)	0.984 (0.0493)	0.982 (0.0511)	1.056 (0.0479)	1.241*** (0.0644)	0.996 (0.0491)
*e*_atzara	0.990 (0.0675)		1.108 (0.0838)	1.181** (0.0869)	1.086 (0.0737)	1.190** (0.0848)	1.092 (0.0790)	1.138* (0.0839)	1.152** (0.0769)	1.454*** (0.108)	1.059 (0.0755)

Table 6 (continued)

	Aritzo	Atzara	Austis	Belvi	Desulo	Gadoni	Meana_sardo	Ortueri	Sorgono	Teti	Tonara
*e*_austis	1.067 (0.0613)	1.062 (0.0704)		1.011 (0.0674)	1.104* (0.0645)	1.101 (0.0693)	1.136** (0.0702)	1.075 (0.0698)	1.073 (0.0626)	0.645*** (0.0540)	1.092 (0.0671)
*e*_belvi	0.925 (0.0521)	1.153** (0.0711)	1.299*** (0.0775)		1.125** (0.0625)	1.078 (0.0651)	1.074 (0.0643)	1.042 (0.0650)	2.330*** (0.118)	0.573*** (0.0480)	1.029 (0.0612)
*e*_desulo	0.918 (0.0520)	1.125* (0.0694)	1.543*** (0.0878)	1.115* (0.0683)		0.996 (0.0609)	1.684*** (0.0909)	1.032 (0.0641)	1.237*** (0.0668)	1.359*** (0.0840)	1.715*** (0.0911)
*e*_gadoni	1.073 (0.0710)	1.189** (0.0873)	1.205** (0.0881)	1.089 (0.0811)	1.145** (0.0760)		0.983 (0.0723)	1.153** (0.0839)	1.130* (0.0749)	3.040*** (0.192)	1.041 (0.0739)
*e*_meana_sardo	0.988 (0.0615)	0.983 (0.0712)	1.165** (0.0803)	1.034 (0.0729)	1.116* (0.0694)	1.050 (0.0715)		1.105 (0.0759)	1.067 (0.0665)	0.519*** (0.0506)	1.215*** (0.0776)
*e*_ortueri	1.146* (0.0856)	1.246*** (0.103)	1.217** (0.102)	1.083 (0.0925)	1.096 (0.0841)	1.014 (0.0854)	1.086 (0.0891)		1.130 (0.0857)	1.373*** (0.117)	1.211** (0.0950)
*e*_sorgono	1 (.)	1 (.)	1 (.)	1.822*** (0.100)	1 (.)	1 (.)	1 (.)	1 (.)		1 (.)	1 (.)
*e*_teti	1 (.)	1 (.)	1 (.)	1 (.)	1 (.)	4.136*** (0.254)	1 (.)	1 (.)	1 (.)		1 (.)
*e*_tonara	0.988 (0.0573)	1.187*** (0.0760)	1.131* (0.0733)	1.082 (0.0705)	0.949 (0.0572)	1.026 (0.0657)	1.105 (0.0687)	1.054 (0.0686)	1.134** (0.0653)	0.559*** (0.0494)	
*e_bis*_tonara	0.834*** (0.0544)	0.779*** (0.0616)	0.853** (0.0654)	0.675*** (0.0554)	1.377*** (0.0834)	1.842*** (0.112)	0.716*** (0.0547)	0.688*** (0.0556)	0.783*** (0.0531)	0.600*** (0.0558)	
lnsig2u	0.00485*** (0.00522)	0.000121*** (0.000248)	0.000127*** (0.000237)	0.000153*** (0.000287)	0.00486*** (0.00545)	0.0120*** (0.00640)	0.0000267*** (0.0000671)	0.0000508*** (0.0000927)	0.00439*** (0.00536)	0.000217** (0.000713)	0.00754*** (0.00609)
aic	196,023.7	156,483.3	157,289.4	159,109.5	188,044.7	168,422.1	169,613.9	160,397.6	190,592.6	143,633.1	174,117.7
bic	196,243.5	156,713.0	157,519.2	159,349.2	188,274.4	168,661.8	169,843.6	160,627.4	190,832.3	143,872.8	174,337.4
N	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955

Odds ratio; standard errors in parentheses *$p<0.10$, **$p<0.05$, ***$p<0.01$

Table 7 Robustness check: estimation results with the supply index and the T_index

	Aritzo	Atzara	Austis	Belvi	Desulo	Gadoni	Meana_sardo	Ortueri	Sorgono	Teti	Tonara
Sardinian	0.0487 (0.0313)	0.0853** (0.0357)	0.100*** (0.0358)	0.0709** (0.0353)	0.103*** (0.0320)	0.139*** (0.0346)	0.00939 (0.0344)	0.121*** (0.0388)	0.0199 (0.0327)	0.0553 (0.0476)	2.515 (.)
Italian	0.502*** (0.0329)	−0.0236 (0.0381)	0.0179 (0.0381)	−0.0689* (0.0378)	−0.0174 (0.0342)	0.00780 (0.0369)	−0.142*** (0.0368)	−0.0355 (0.0414)	−0.0168 (0.0347)	-0.101** (0.0508)	15.37 (422,341,168.5)
European	0.00628 (0.0323)	−0.0101 (0.0368)	−0.0587 (0.0370)	0.0160 (0.0364)	0.0104 (0.0330)	0.0224 (0.0357)	−0.0592* (0.0355)	−0.0156 (0.0400)	−0.0340 (0.0336)	-0.0603 (0.0491)	5.094 (431,656,666.6)
Age	−0.000937 (0.00391)	−0.00793* (0.00449)	−0.00147 (0.00450)	−0.00234 (0.00444)	0.00361 (0.00404)	0.00182 (0.00432)	0.00110 (0.00440)	−0.00936* (0.00488)	−0.000187 (0.00417)	0.00762 (0.00607)	-0.175 (776,616.6)
Gender	0.00948 (0.0112)	−0.0190 (0.0128)	−0.0119 (0.0129)	0.0119 (0.0127)	0.00885 (0.0116)	0.00295 (0.0124)	−0.00794 (0.0126)	−0.0107 (0.0140)	−0.00647 (0.0119)	-0.00917 (0.0174)	-0.892 (2,334,785.1)
Spending	−0.00289 (0.00969)	0.00235 (0.0110)	0.0160 (0.0111)	−0.0272** (0.0109)	0.00976 (0.00998)	−0.00302 (0.0106)	0.00382 (0.0108)	−0.00760 (0.0120)	−0.00186 (0.0103)	0.00536 (0.0150)	1.341 (1,802,221.3)
Easter	−0.323*** (0.0688)	−0.522*** (0.0850)	−0.421*** (0.0822)	−0.293*** (0.0775)	−0.366*** (0.0698)	−0.507*** (0.0801)	−0.332*** (0.0779)	−0.514*** (0.0890)	−0.133* (0.0691)	-0.717*** (0.111)	5.723 (38,257,729.8)
Mid-August	0.220*** (0.0510)	−0.182** (0.0808)	−0.0817 (0.0755)	−0.0429 (0.0786)	−0.0243 (0.0716)	0.412*** (0.0700)	0.0897 (0.0785)	0.0249 (0.0878)	−0.0805 (0.0728)	0.0399 (0.0996)	9.842 (124,860,452.9)
All-saints	0.196** (0.0899)	0.00640 (0.0996)	−0.286*** (0.0977)	−0.00503 (0.0990)	0.529*** (0.0673)	0.104 (0.0973)	−0.525*** (0.0954)	−0.0831 (0.110)	−0.249*** (0.0923)	-0.168 (0.124)	23.27 (.)
Christmas	−0.00158 (0.0652)	0.236*** (0.0712)	0.105 (0.0745)	0.132* (0.0728)	0.134** (0.0664)	0.238*** (0.0686)	0.177** (0.0714)	0.140* (0.0807)	−0.0116 (0.0679)	0.521*** (0.0875)	-13.16 (.)
New Years's eve	0.0672 (0.0714)	0.177** (0.0789)	0.270*** (0.0779)	0.0864 (0.0802)	0.140* (0.0723)	0.142* (0.0766)	0.176** (0.0779)	0.144* (0.0872)	0.0772 (0.0739)	0.334*** (0.102)	-0.605 (.)
*e*_aritzo		−0.0150 (0.0956)	0.137 (0.0926)	0.152* (0.0903)	0.0684 (0.0840)	0.387*** (0.0828)	0.106 (0.0894)	0.148 (0.0987)	0.00252 (0.0844)	0.169 (0.116)	7.259 (48,108,792.6)
*e_bis_* aritzo		0.119** (0.0512)	0.330*** (0.0489)	0.105** (0.0511)	0.0663 (0.0468)	0.208*** (0.0482)	−0.0189 (0.0520)	0.00587 (0.0575)	0.0237 (0.0474)	0.225*** (0.0655)	0.613 (127,796,688.0)
*e*_atzara	−0.0586 (0.0691)		0.156** (0.0764)	0.202*** (0.0739)	0.134* (0.0688)	0.210*** (0.0715)	0.0587 (0.0753)	0.149* (0.0824)	0.0754 (0.0695)	0.394*** (0.0925)	-16.07 (.)
*e*_austis	0.129** (0.0582)	0.0344 (0.0666)		−0.0169 (0.0669)	0.0594 (0.0593)	0.0681 (0.0633)	0.159** (0.0649)	0.0516 (0.0730)	0.181*** (0.0606)	-0.185* (0.102)	11.81 (27,300,406.0)

Table 7 (continued)

	Aritzo	Atzara	Austis	Belvi	Desulo	Gadoni	Meana_sardo	Ortueri	Sorgono	Teti	Tonara
*e*_belvi	−0.0730 (0.0570)	0.148** (0.0619)	0.274*** (0.0603)		0.132** (0.0563)	0.0815 (0.0606)	0.0971 (0.0622)	0.108 (0.0683)	0.926*** (0.0529)	-0.463*** (0.0977)	-29.90 (.)
*e*_desulo	−0.111* (0.0573)	0.143** (0.0619)	0.440*** (0.0575)	0.141** (0.0615)		0.0232 (0.0613)	0.665*** (0.0573)	0.199*** (0.0700)	0.227*** (0.0560)	0.532*** (0.0754)	-30.07 (.)
*e*_gadoni	−0.0472 (0.0671)	0.241*** (0.0736)	0.277*** (0.0740)	0.162** (0.0748)	0.257*** (0.0674)		−0.0364 (0.0762)	0.291*** (0.0804)	−0.0584 (0.0691)	1.129*** (0.0814)	-9.906 (.)
*e*_meana_sardo	0.0356 (0.0630)	−0.0326 (0.0726)	0.143** (0.0696)	0.0161 (0.0708)	0.0835 (0.0631)	0.0330 (0.0683)		0.0202 (0.0770)	0.153** (0.0644)	-0.424*** (0.116)	-18.15 (.)
*e*_ortueri	0.118 (0.0756)	0.242*** (0.0832)	0.257*** (0.0842)	0.102 (0.0857)	0.115 (0.0778)	0.0378 (0.0845)	−0.0151 (0.0859)		0.0919 (0.0785)	0.504*** (0.105)	-19.10 (.)
*e*_sorgono	0 (.)	0 (.)	0 (.)	0.611*** (0.0552)	0 (.)	0 (.)	0 (.)	0 (.)		0 (.)	0 (.)
*e*_teti	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	1.507*** (0.0617)	0 (.)	0 (.)	0 (.)		0 (.)
*e*_tonara	0.0283 (0.0586)	0.169*** (0.0643)	0.0145 (0.0655)	0.0830 (0.0654)	−0.00751 (0.0611)	0.0202 (0.0642)	0.424*** (0.0660)	0.534*** (0.0757)	0.293*** (0.0594)	-0.243** (0.103)	
*e_bis*_tonara	−0.124* (0.0665)	−0.296*** (0.0794)	−0.230*** (0.0776)	−0.448*** (0.0826)	0.260*** (0.0620)	0.571*** (0.0614)	−0.300*** (0.0789)	−0.390*** (0.0875)	−0.176** (0.0712)	-0.716*** (0.117)	
Supply_index	0.234*** (0.00486)	−0.126*** (0.00518)	−0.0154*** (0.00523)	−0.152*** (0.00512)	−0.290*** (0.00467)	−0.136*** (0.00496)	−0.397*** (0.00528)	−0.876*** (0.00636)	0.256*** (0.00517)	1.188*** (0.0112)	619.1 (84,649,918.5)
T_index	0.182*** (0.00426)	−0.0832*** (0.00466)	−0.264*** (0.00464)	−0.0858*** (0.00462)	−0.0744*** (0.00422)	−0.0968*** (0.00445)	0.489*** (0.00544)	0.672*** (0.00652)	0.395*** (0.00474)	0.869*** (0.00758)	-278.1 (.)
lnsig2u	−5.510*** (1.327)	−9.184*** (1.801)	−8.911*** (1.884)	−9.121*** (1.793)	−4.833*** (0.713)	−4.537*** (0.601)	−11.46*** (3.714)	−12.02*** (2.174)	−3.806*** (0.274)	-2.914*** (0.248)	-2.198 (315,860.8)
aic	190,768.8	155,360.0	153,831.9	157,604.0	183,185.2	166,894.7	156,987.2	131,051.7	178,439.3	94,648.6	24.00
bic	191,008.6	155,609.7	154,081.6	157,863.7	183,434.9	167,154.4	157,236.9	131,301.5	178,699.0	94,908.3	143.9
N	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955	160,955

Marginal effects; standard errors in parentheses *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Table 8 Assessment of the estimated effects. Source: own elaboration based on data from Melis et al. (2016) and average estimated logit marginal effects

Category	Expenditure per day per person	Complementarity	Substitution
Food and beverages	23.9	4.92	−0.80
Eno-gastronomic	13.8	2.84	−0.46
Souvenir	6.7	1.38	−0.23
Local products	9.3	1.91	−0.31
Total	61.4	12.64	−2.07

All values are expressed in euros

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Declarations

Conflict of interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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