



# Transport and tourism, an inseparable alliance: the importance of the transport sector

Fabrizio Antolini<sup>1</sup>

Accepted: 21 January 2022 / Published online: 16 February 2022  
© The Author(s), under exclusive licence to Springer Nature B.V. 2022

## Abstract

Tourism is based on the physical movement of people, and it is therefore of fundamental importance to have a transport system that is functional and that can facilitate travel to tourist destinations. However, transport is also important in itself because it ensures the freedom of movement for people and reduces social distances, in turn promoting growth and economic development. For this reason, it is necessary to design a transport and infrastructure system that is functional and promotes the accessibility of tourist destinations. Nodal analysis, applied to tourism flows in Italy, highlights the contradiction of a transport system which has enforced the policy of large hubs, in a country where there are many tourist destinations. Nevertheless, the nodal analysis methodology applied to the tourist flows show the need to strengthen the connection between the Adriatic and Tyrrhenian coasts, as well as the connection with some regions of the south, such as the Basilicata region. Moreover, it would be appropriate to enhance the railway line on the Adriatic dorsal in order to reach some tourist regions with greater ease. In the same way, the geographical configuration of Italy makes an enhancement of the ports highly desirable, creating an intermodal system.

**Keywords** Tourism and transport · Accessibility · Tourism industry · GNI · GPD · Intermodal system

## 1 Introduction

Tourism increasingly contributes to the economic growth and development of many countries. The distinction between growth and development is particularly important when referring to tourism since this sector is transversal in nature and at the same time requires infrastructure capable of improving the accessibility to places. Development is freedom (Sen 2014, p. 9), and the transport system is extremely important in improving the freedom of individuals, whose social integration is improved through the reduction of territorial distances. Physical mobility is definitely the first element of freedom.

---

✉ Fabrizio Antolini  
Fantolini@unite.it

<sup>1</sup> Department of Business Communication, University of Teramo, Campus Aurelio Saliceti, Via Renato Balzarini 1, Teramo, Italy

Precisely because it inevitably requires the physical movement of people over territories, tourism should be adequately considered in planning the infrastructure and organizing transport services. In those countries where tourism is more developed or where you want to increase tourist flows, an integrated transport system is essential for the coherent management of tourist flows. Knowing the tourist use of infrastructure and means of transport could be extremely useful information for effectively programming infrastructure build and improving accessibility to places. Instead, these same means of transport, as well as infrastructure, are developed by looking at the movement of goods, rather than the transport of passengers, particularly those travelling for tourism. Furthermore, the demand for transport contributes significantly to both the tourism industry and tourism demand and is therefore able to start a virtuous circle in terms of growth and economic development. In measuring the long-term net wealth increase, economists should analyze the trend of the GNI (Gross National Income), and in particular its difference to GDP (Gross Domestic Product). Transport and infrastructure expenditures are the most important factor in determining this difference, because of their capital depreciation.

The tourism industry itself is entitled to weigh the various economic activities through coefficients capable of identifying the contribution provided by the sector to income growth. The analysis of tourist flows should therefore be enhanced through the identification of arrival "nodes", to understand if there is a complementarity with the transport system, and if it can be considered functional to their territorial mapping. In this respect, the "nodal analysis" proposed by Nyusten and Dacey (1961) is appropriate and can be applied to Italy because of the greater availability of statistical information. The development of integrated transport services, namely airports, ports, trains, and highways must represent a priority if the tourism industry is to be developed. Often, however, the opposite has occurred, at least in Italy, a country in which a transport policy based on large hubs has been preferred, while the creation of a sufficiently integrated second-level mobility system has been neglected. This situation seems to contrast with the fact of tourist presences territorially distributed throughout the national territory.

The article is structured as follows:

The first part highlights the importance of the transport sector for the tourism industry as well as its contribution to determining the level of long-term wealth growth measured by the GNI. In this part, a model of tourism demand will be presented, and it will be analyzed how public investment contributes to increasing wealth (NNI) in the most relevant European countries.

The second part introduces the analysis of arrival flows, and the ranked popularity of tourist flows in the Italian regions using the nodal analysis methodology, which suggests a different use of transport modes.

The third part analyzes, for Italy, the level of convergence between the main nodal tourist points identified and the current transport system, in order to highlight inconsistencies and possible lines of intervention in an economy that aims to enhance tourism as a lever for economic growth.

## 2 Transportation and the tourism industry

Tourism is a transversal sector that affects many economic activities, although it is mainly concentrated in the service sector. Despite being a fragmented sector, Satellite Accounting (CTS) succeeds in measuring the direct and indirect contribution that tourism activities

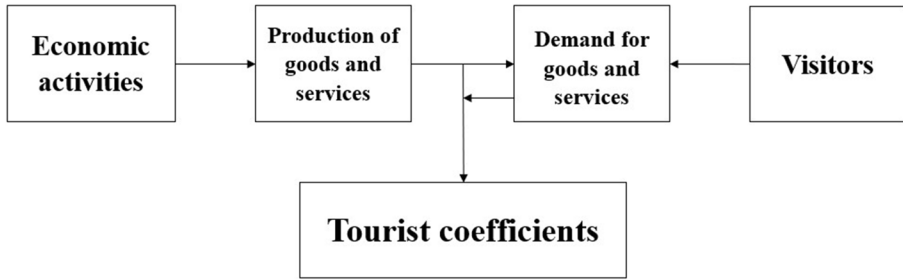


Fig. 1 Coefficients provided for the partially tourist economic activity

generate to the gross domestic product (Jones and Munday 2008; UNWTO 2008; Eurostat 2014; Istat 2017a, 2017b). In fact, only some tourist activities are exclusively tourist-dependent, since they would cease to exist without tourist flows, while others are only partially, since they would still be able to continue their economic activity, in the absence of tourist demand. Examples of economic activities that can be considered completely tourist-dependent are the accommodation sector and travel agencies (Antolini 2014; Eurostat 2020), however, also includes air passenger transport. Among the partially tourist economic activities, we find catering, trade, and passenger transport in its various forms. Transportation therefore falls within the tourism industry, although its importance is weighted with specific coefficients (tourism coefficients) according to its mode, determining the contribution of the entire sector to the growth of income produced in a different way (Fig. 1).

Because tourist coefficients identify the production component attributable to tourist demand, they are defined as starting from the following relation (Lim 1997; Qiu and Zhang 1995; Uysal 1998; Cho 2010):

$$D_{ij} = f(Pop_i, Y_i, PD_{ij}, D_n) \tag{1}$$

and applying the *ln* transformation

$$\ln D_{ij} = \beta_1 \ln Pop_i + \beta_2 \ln Y_i + \beta_{3T} \ln PD_{ij,T} + \beta_{3H} \ln PD_{ij,H} + \sum_k \alpha_k D_k \tag{2}$$

where  $D_{ij}$  is tourist demand from location  $i$  for location  $j$ .  $Pop_i$  is the population in the place (region/province)  $i$  of departure which, all things being equal, influences the flow of visitors to the destination region  $j$ . This variable is very important for the spatial flow analysis, and it can also be used as an indicator of the effectiveness of the transport network.  $Y_i$  is the per capita households' disposable income in the place of departure which expresses their economic capacity, determining the demand for travel.

$PD$  is the price of the tourist product (Chen 2012; Xu 2010) or the cost of the holiday for the set of different goods and services demanded by the visitor, distinguished as the cost of transport ( $PD_{ij,T}$ ) and the living expenses of the holiday ( $PD_{ij,H}$ ). This distinction is important since the expense of transport assumes a more rigid pattern than the expense of the holiday. In addition, while the expense of transportation is necessary and nondeferrable, the living expenses of the holiday consist only of the cost of food and accommodation, while the other types of expenditure are more variable (e.g., shopping expenses).

**Table 1** Average expenditure by trip (1 night or over) and category (absolute values, 2016)

Country	Transport	Restaurants/Caf�	Accommodation	Durable and valuable goods	Total expenditure
Germany	169.81	n/a	19.40	23.88	469.76
France	98.40	65.04	102.54	21.88	363.13
Spain	68.16	60.19	64.12	3.34	247.73
Greece	81.29	110.92	57.39	1.50	324.64
Italy	101.61	n/a	134.43	1.07	363.30
UK	n/a	n/a	n/a	n/a	n/a

Source: Eurostat data

**Table 2** Average expenditure by trip (1 night or over) and category (% values, 2016)

Country	Transport	Restaurants/Caf�	Accommodation	Durable and valuable goods	Total expenditure
Germany	36.14	n/a	42.00	5.08	100.00
France	27.09	17.91	28.23	6.02	100.00
Spain	27.51	24.29	25.88	1.34	100.00
Greece	25.04	34.16	17.67	0.46	100.00
Italy	27.96	n/a	37.00	0.29	100.00
UK	n/a	n/a	n/a	n/a	n/a

Source: Eurostat data

Finally, we can provide one or more dummy variables ( $D_k$ ) to capture the effect on demand of qualitative aspects such as the hospitality of the places, the level of accessibility, as well as their attractiveness (Candela and Figini 2005).

In the following tables, the six European countries with a relevant volume of night-spent and high level of Gross Domestic Product—considering their competitive position with respect to Italy—are analyzed to investigate the composition of the average expenditure during the trip. Because the amounts in Table 1 are at current prices, they indirectly show the cost of living in different places and therefore their level of tourism competitiveness.

The concept of tourist demand illustrated in Tables 1 and 2 (UK data are not available here, but are present in the tables below) refers, however, only to the private expense of visitors, be they households or individuals. If we consider the total tourist demand, specified in formulas reported in (1) and (2) must be augmented, adding both the amount of expenses incurred by companies for the modernization of their accommodation establishments and the public component of expenditure made for the enhancement and expansion of infrastructure and means of transport for tourism purposes. The latter category of expenditure, however, can currently only be determined in its generality, not with specific reference to the tourism sector.

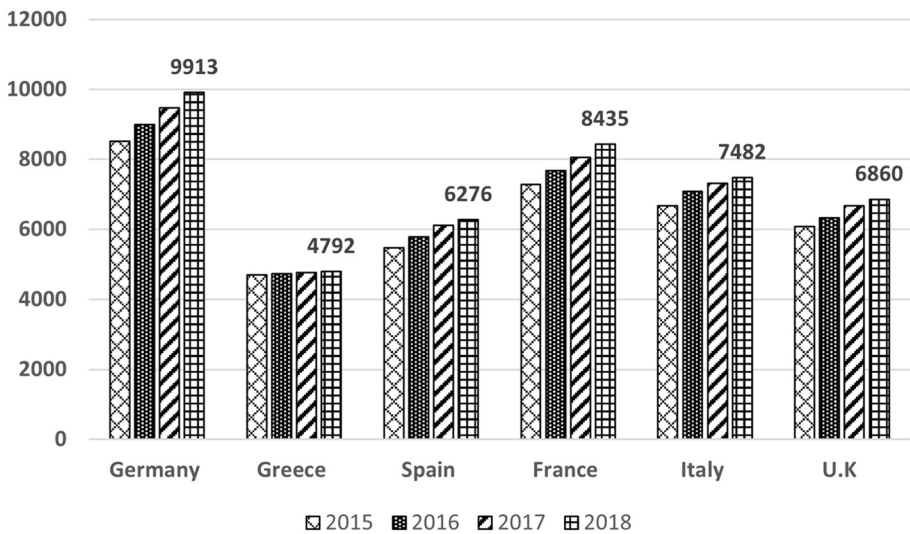
## 2.1 Transport expenditure and increase in wealth

As capital expenditure, transport expenditure most affects the share of depreciation generated. Although the methodology for calculating depreciation across countries is different, it

**Table 3** GNI and NNI (US Dollars: per capita values)

Country	2015		2016		2017		2018	
	NNI	GNI	NNI	GNI	NNI	GNI	NNI	GNI
Germany	40.25	48.77	42.82	51.81	44.89	54.37	46.07	55.98
Spain	29.46	34.93	31.62	37.40	33.50	39.62	34.36	40.63
France	34.44	41.72	36.08	43.76	37.67	45.72	38.85	47.28
U.K	35.47	41.55	36.76	43.08	38.77	45.44	39.39	46.25
Greece	22.25	26.94	23.09	27.82	24.39	29.15	25.40	30.19
Italy	29.97	36.65	32.95	40.03	34.69	42.01	35.76	43.24

Source: OECD data, National Accounts

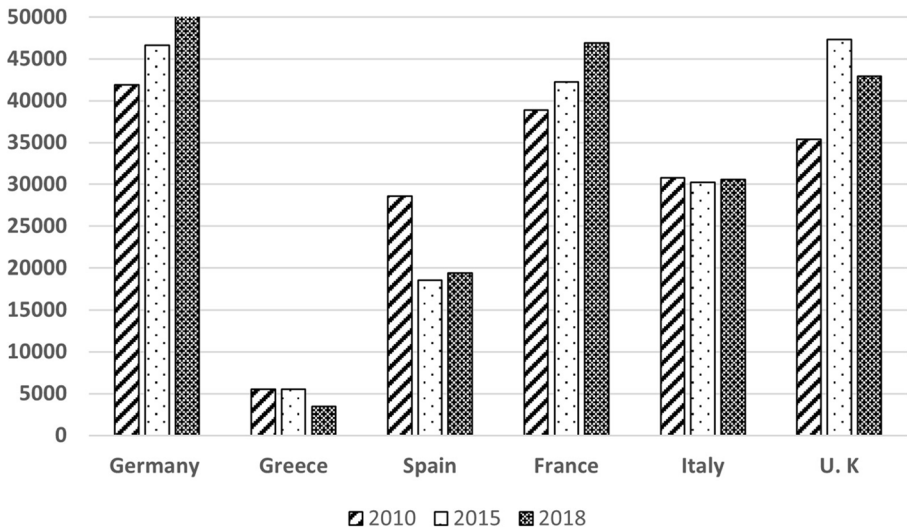


**Fig. 2** Difference between GNI and NNI (US Dollars; per capita values). Source: OECD data

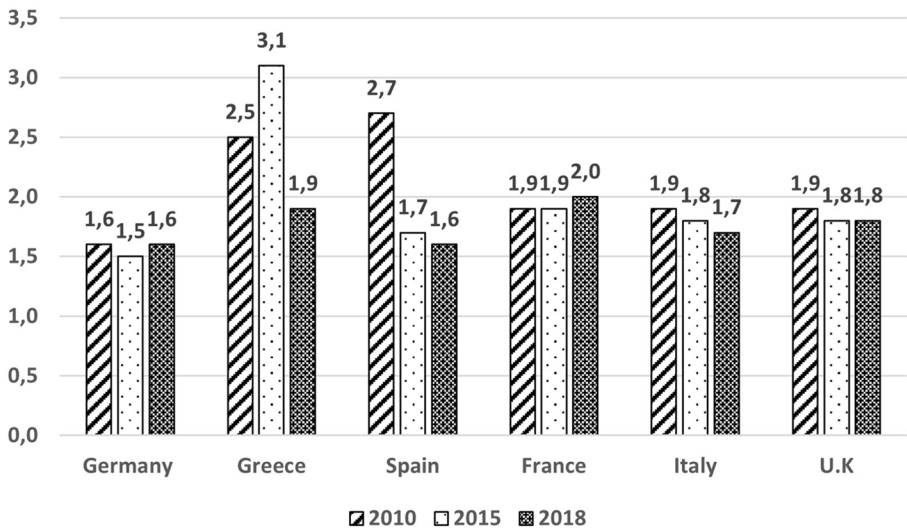
determines the difference between GDP and NDP (Net Domestic Product) (OECD 2015). The latter economic aggregate is defined as GNI minus the depreciation of physical assets due to their use and obsolescence. Consider that NDP (or NNI: Net National Income) is the economic aggregate used to measure the increase in wealth of a country in the long run (Barnes 2001; Spant 2003 ESA 2010). With the increase in the share of depreciation, the gap between NNI and GDP increases, where the latter aggregate is instead used to measure economic well-being (Antolini 2016).

Table 3 shows the per capita GNI (or GDP) and NNI, while Fig. 2 shows their absolute difference for the six European countries considered.

Germany records higher values for both aggregates (NNI and GNI). In addition, the amount of depreciation, indirectly represented by the difference between these two aggregates, remains constant over time and is always greater than in other countries, followed by France, Italy, the UK, Spain, and Greece.



**Fig. 3** Transport expenditures in the countries most visited by tourists (Millions of Euros). *Source* Eurostat data



**Fig. 4** Transport expenditures in the countries most visited by tourists (% GDP). *Source* Eurostat data

If we want to measure transport costs and carry out a comparative analysis, it is necessary to use the COFOG (Classification of Government Functional Expenditure) (Allen and Tommasi 2001). Transport costs (or expenditure) are shown in Figs. 3 and 4, in absolute value and as a percentage of GDP.

Germany and France are the countries that record an increasing trend for this type of expenditure, whereas in other countries the trend is decreasing. Greece, on the other hand,

showed a fluctuating trend in 2015; the sharp increase recorded in transport costs was because of the investments made for the organization of the Olympics Games.

Further analyzing Figs. 3 and 4, we argue that the trend for the two proposed measures—the expenditure in absolute value and as a percentage of GDP—is not always convergent. This situation indirectly describes the different GDP trends due to the economic crisis and its impact on the economies of the six countries, considering that the expenditure for transport and infrastructure does not have a pro-cyclical trend (Cafiso et al. 2016). The fact remains that since transport and infrastructures are decisive for the development of tourism, it would be extremely useful to know the degree of infrastructural use and the means of transport for tourism purposes, both for existing and future infrastructure (Hickman 2012).

## 2.2 Knowing the tourism of the infrastructures: methodology

Infrastructure and transport, as previously described, although part of the tourism industry is not used exclusively for tourism (Bronzini et al. 2011). Knowing their use for this specific purpose, however, may be important for an efficient planning of the transport service-related infrastructure (Banca d'Italia 2011, 2012).

The tourist coefficients, due to the way in which they are constructed, could be used as a proxy for measuring the use of means of transport for tourism purposes. If we limit the analysis to Italy, the country for which tourist coefficients are available, very different values emerge if we compare the travel data contained in Fig. 5 with the tourist coefficients of Fig. 2. Air transport—which Eurostat conventionally includes in the tourism industry in the strict sense—is used in Italy by only 19% (of total trips), while the value of the tourist coefficient of this mode of transport is equal to 98.4%. We can draw the same conclusion

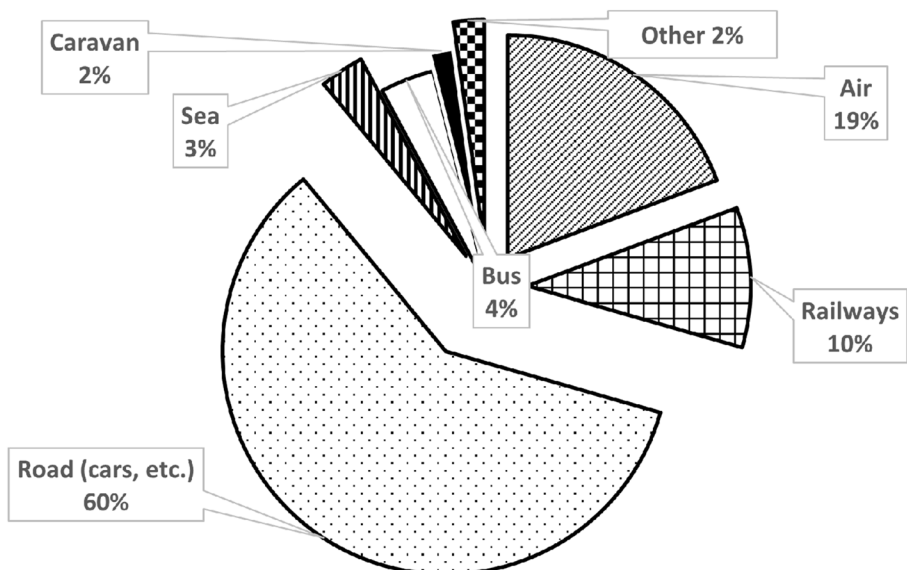
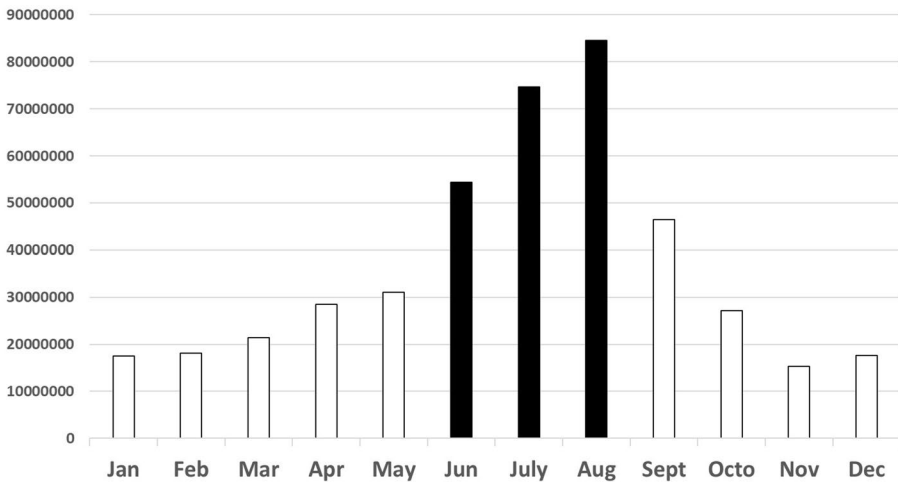


Fig. 5 Main transport mean (% trips). Source Istat data



**Fig. 6** Nights spent in Italy monthly data—Year 2019. *Source* Istat data

by analyzing the expenditure data of Table 2 in which, again referring to Italy, transport expenditure is almost 28% of the total expenditure.

A further methodology for defining the use of infrastructure for tourism purposes could be derived from the analysis of seasonality based on the origin–destination tourist flows. Besides identifying spatial networks, seasonality patterns can be helpful in determining the use of transport for different purposes. Looking at Figure 6 it is possible to note how the Italian tourism model has a component of constant seasonality; each year is characterized by a deep seasonal component in the months of June, July, and August that never changes; in 2019, 48.5% of the total amount of tourist nights were spent in these three months. Of course, the seasonality model described above applies to the national level and is not always relevant for local destinations. For example, tourism in cities of art expresses a less pronounced seasonality, since both tourism flows, and nights spent tend to be spread over the whole year.

In fact, by analyzing the pattern of passenger numbers transported by air, sea, and road during the months of the peak season, we can understand if and to what extent an infrastructure or mode of transport can be defined as tourist-dependent. This operation is easy for air and rail transport since the transit has a contractual nature (i.e., the tickets sold), but it is more difficult for road transport, since not all trips require a payment or road toll for the motorway. In this regard, mobile phone data expressing the movements in the territory during periods of greater tourist seasonality should be provided in the current (official) statistical information (European Commission 2014; Liu and Liu 2016; Vanhoof et al. 2017).

### 3 Analysis of tourist flows and demand for potential mobility

To express the level of attractiveness between the twenty Italian regions, we have simply calculated the percentage of arrivals coming from the region  $i$  going to region  $j$ :



$$A_{ij} = \left( \frac{n_{ij}}{n_i} \right) \rightarrow \text{of those moving from } i, \text{ the share going to } j \quad (3)$$

$A_{ij}$  expresses the pull force of  $j$  toward  $i$  and its geographical pattern is shown in Fig. 7. Piedmont has slightly increased its attractiveness ( $0.5 < A_{ji} < 1$ ) and maintained the pull

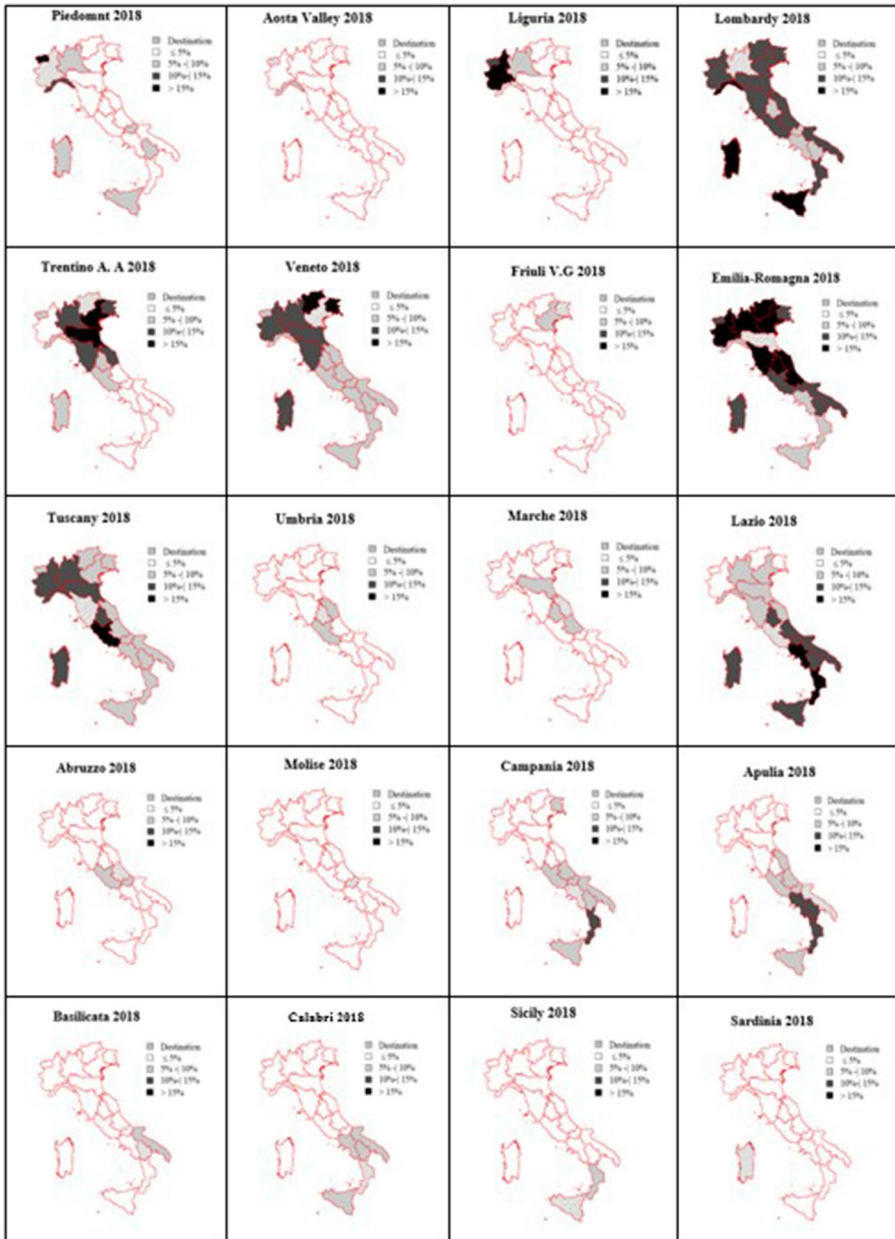


Fig. 7 Attractiveness of Italian regions (% interregional arrivals from the origin). Source Istat data

force in relation to Aosta Valley and Liguria. Liguria has achieved values greater than 1 (in relation to Friuli V.G., Lazio, and Campania) returning to its 2008 position. Lombardy maintained its attractiveness in relation to Liguria, and over the years has slightly increased its position (see the large grey and dark grey area) Trentino A.A. exhibits a remarkable and stable influence even in central Italy (Cafiso et al. 2016).

We can observe a slight stability in the external (out region) attractiveness. The post-2008 economic crisis caused Piedmont's external attractiveness to drop slightly and to remain circumscribed to the closest regions.

#### 4 The nodal analysis of domestic arrivals

This method of analysis of origin–destination flows allow the identification of the so-called "nodal points" of interregional flows. The method (Nyusten and Dacey 1961; Tinkler et al. 1988) aims to identify the existing interconnections between regions in terms of flows, identifying centers of gravity, classified as "dominant", "intermediaries", and "dominated". Let us consider the square matrix ( $N \times N$ ) of the origin–destination interregional tourist flows (Gálvez et al., 2014), with the flow  $n_{ij}$  from the origin region  $i$  (row  $i$ ) to the destination region  $j$  (column  $j$ ). According to this method, the cell  $(i, j)$  containing the highest datum in row  $i$  identifies a nodal point or node if and only if the sum of column  $i$  is smaller than the sum of column  $j$ . In this case, the destination region  $j$  (column  $j$ ) is placed in a position hierarchically higher than the origin region  $i$  (row  $i$ ). Formally, region  $i$  is dominated by destination  $j$  if the following conditions occur (Pearce 1995):

$$\max_k n_{ik} = n_{ij}$$

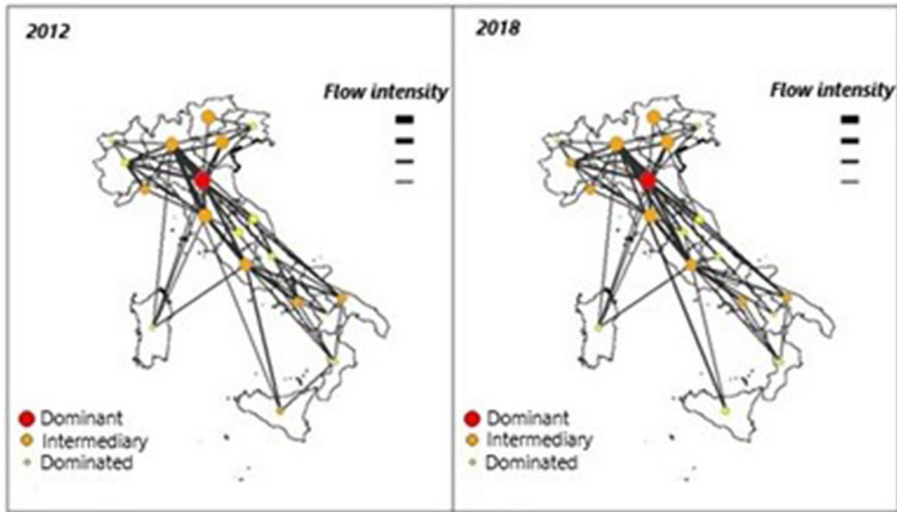
$$\sum_k n_{ki} < \sum_k n_{kj}$$

The first rule can be changed allowing the selection of more than one region (Antolini et al. 2017), as suggested by Giraud and Lambert (2016) who developed the R library *flows*. For example, one can select those flows exceeding a given threshold (in absolute or percentage values), or the  $k$ —the greatest incoming flows to region  $j$ . Furthermore, the latter condition may be more selective, by imposing for example that  $k \sum_k n_{ki} < \sum_k n_{kj}$  for an established value  $k > 1$ . For identifying the dominant regions, in accordance with the *nodal analysis* approach, we applied the following rules:

1.  $\frac{A_{ij}}{\sum_k n_{ki}} > 0.1$  (i.e.: flow from  $i$  to  $j$  must be more than 10% of the total flows from  $i$ )
2.  $\frac{\sum_k n_{kj}}{\sum_k n_{ki}} > 1.2$  (i.e.: total flows to  $j$  must be 20% greater than total flows to  $i$ )

The thickness of the lines is proportional to the size of the incoming flows at the hierarchically superior nodal point, and the size of the circle is proportional to the volume of incoming flows (Fig. 8).

Moreover, the directional flow and the number of arrivals at origin and destination identify a "dominated" and a "dominant" node. The resulting framework, in terms of regional centers of gravity of the related interregional arrivals flows can be very important when compared to the existing infrastructure level. The results of the *nodal analysis* are



**Fig. 8** Nodal analysis of accommodation data (arrivals). *Source* Istat data

particularly useful and are shown in two different figures referring to 2012 and 2018 so as to highlight the fact that although there is a framework of substantial stability, there may still be some marginal changes important for the development of tourism. A dominated or intermediate node therefore assumes its own representative value in its ability to draw reticular relations with other nodes that then represent the centers of gravity connected to its present in other regions. The first consideration to be made concerns the dominant nodes, namely the points from which tourists in Italy head to, according to the methodology adopted here. Keep in mind that our analysis is based on the regional flows, but sometimes we refer to the nodal analysis when considering the single city rather than the regions, as is possible because the origin–destination matrix is at a regional level. Therefore—quite reasonably—the tourist arrivals are mostly concentrated around the most important city of the region. However, the center of gravity of arrivals cannot always be attributed to the regional city capital. In fact, looking at Sicily, the center of gravity is affected by the arrivals concentrated in Palermo and Catania airport. It follows that the barycenter of the region cannot be attributed to any city, and it is why the nodal point in Sicily is in the center of the island.

The dominant nodal point is Emilia Romagna (ER). Among the intermediary nodes, Veneto maintains its flows mainly with Trentino Alto Adige and Friuli Venezia Giulia but there is also a link with Piedmont, where we found a dominated node, showing how this node is sensitive to the connection with Veneto. In terms of the volume of tourism flows the dominant ER (Bologna) node shows the most evident connection with Lombardy (Milan). The ER node is undoubtedly, as a dominant node, the center of gravity of the tourist flows for the entire country, representing an extremely important point of connection. It is important to underline that there are many intermediary points that are linked directly with the ER node. Naturally the most important points are in the north of the country, but some connections seem to be also in the south of Italy. In this latter case the node of Apulia can be distinguished from the other nodes in the south as it is directly connected with that of the ER, whereas many of the southern nodes are only indirectly connected. An important

role is played by the node of Lazio, which evidently is a departure point for tourist flows toward the South. In Lazio the node can be centered on Rome from which can be reached the node of Campania—centered on Naples—and Apulia, Sicily, Calabria, and Sardinia.

Comparing 2012 with 2018, we can see an intensification of the flows on the Bologna–Rome route, in addition to the change of the junction of Piemonte from dominated to intermediate. It is also possible to observe how the line between Milan and Sicily is thicker, indicating the greater flow of tourists on the route. Meanwhile the Lombardy and Tuscany junction, on the other hand (Milan and Florence are the reference cities), seems to have recorded a decrease in relative tourist flows. Overall, the situation of the tourist flows in the south between the two periods remains substantially stable, not denoting a substantial change of the domestic flows as far as their origin–destination matrix is concerned. In Tuscany, Florence can be identified as the “intermediate” nodal point, closely connected with Rome in Lazio. In any case, considering the tourist flows and the relative nodal points, the north is connected to the south just through the intermediate nodes of Milan, Florence, and Rome. These nodes suggest a different use of means of transport, namely air travel for the node in Lombardy (Milan), and rail for the Tuscany (Florence) and Lazio (Rome) nodes. This observation arises by analyzing the routes from Milan to Sardinia and Sicily; however, it is also possible to find an intermediate node in Liguria which facilitates the development of the tourist flow toward Piedmont. In this respect, during the period between 2017 and 2018 there was also a dominated node connected with Piedmont and Lombardy, which is the Aosta Valley. Rome, on the other hand, is the only point in the Lazio region of distribution of tourist flows, that connects Campania and Calabria. Apulia receives tourist flows mainly from the Adriatic ridge, starting from Bologna by rail, and it is the only point of connection with Basilicata and Calabria. This framework provides a partial explanation for the low number of trips made in the southern regions such as Basilicata, Calabria, and to a lesser extent Sicily. While Tuscany, Emilia-Romagna, Lazio, Veneto, Lombardy, and Campania, hosted 53% of the trips. Considering the trips by region of destination and in terms of geographical distribution, the south and the islands register 23.8% of trips; the center 22.9%; the northeast 31.3%; and the northwest 21.9%. Overall, the center-north recorded 76.1% of trips (Istat 2020).

## 5 The focal points for a coherent development of infrastructure for tourism purposes

The nodal points, specifically because they represent the points of greatest influx of tourist arrivals, should be analyzed in the creation of an effective infrastructure and transport system. If, for example, the airport infrastructure is analyzed in terms of its use level it will be essential to observe passengers in transit on scheduled and charter flights at airports (Istat 2020). In Italy, the policy of the major hubs (Lijesen et al. 2001) has been favored over time and, to be an optimal organizational model, it must be able to guarantee a high number of connections both with other flights, trains, and the highway network (Caris et al. 2013; Leung and Buhalis 2018). Italy’s biggest airport for passenger transport is Fiumicino, which has a connectivity index that places it 34<sup>th</sup> in the world (OAG 2020). The flow of total passengers transported (scheduled and charter flights) in the top five Italian airports (Bergamo, Milan-Malpensa, Milan-Linate, Rome-Fiumicino, and Venice-Tessera) constitutes 54.3% of all passengers, which becomes 54.4% if we consider only arrivals. In the south there is only one airport, Catania-Fontanarossa, which in 2018 was in sixth place in

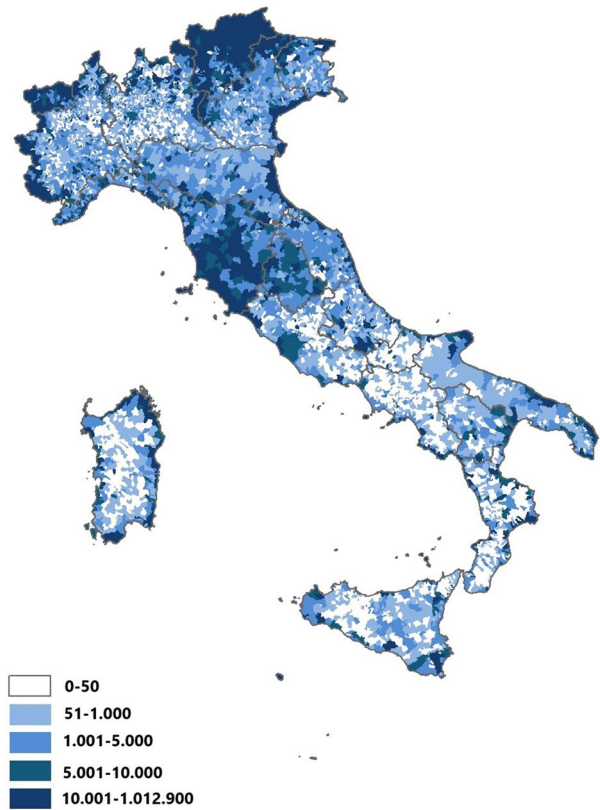
terms of passenger volume; a sum equal to 5.2% of total passengers with an almost similar value (5.3%) if we only consider arrivals. At the regional level, since some regions have more than one airport, the ranking—compared to the previous figures—may be subject to a slight change.

The analysis of the transport system must also focus on rail because, with investments in high-speed transport, it can play a complementary role but also be a particularly useful means of transport for reducing spatial distances. If the two analyses—the nodal and the transport—are overlapped, important indications can be obtained.

For example, consider the node of Emilia Romagna which, despite being recognized as the dominant node, does not have a coherent development at Bologna airport. On the other hand, this highlights the complementarity of train transport since the Bologna node is served by the High Speed/High Capacity (HS/HC) project. Such infrastructure has led to the strengthening of the long-distance transport offer with increasingly frequent and fast connections along the Turin–Milan, Milan–Bologna, Bologna–Florence, and Rome–Naples routes. The development of the network, however, also involved several stations connecting the new HS lines, which have in fact been restructured and integrated, such as Turin Porta Susa, Reggio Emilia, Bologna Centrale, and Roma Tiburtina. It is clear that the south, as is evident from the previous illustrations, is not yet sufficiently involved in this modernization process. In fact, the involvement of the south is limited to the existing stations of Naples and Cosenza, and this does not seem to be able to facilitate the development of tourism in the south, which is substantially less than it should be when one considers the natural beauty and other of the region. Again, through the analysis of the tourist nodal points, it is evident how the connection between the intermediate node in Puglia should be strengthened. It should provide a direct connection with the node of Rome and Campania, where it can only be reached through Foggia Station. The Adriatic ridge has a missing section in the part between Ancona and Venice and instead centers only on Bologna and Milan. The Veneto nodal point is instead relevant for tourism and is a dominant point, suggesting the strengthening of existing lines, particularly on the Ravenna–Venice route. The same node has no direct connections with other intermediate points and can satisfy the overall tourist demand (Tsamboulas et al. 2007). On the other hand, there are many tourist municipalities along this route, and although they are small with a predominantly seaside character, they could give rise to tourist clusters if they were also connected with inland areas (Fig. 9).

In 2017, municipalities of up to 25,000 inhabitants (which represents 95% of their total number) hosted 58.9% of total tourist nights. Municipalities with a population of more than 50,000 inhabitants (there are 144 which represents 1.8% of the total) hosted 29.9% of total nights spent. The size category of municipalities is also included here to throw light on the difficulty that can be encountered in developing the infrastructure of small municipalities. Finally, the connection with the port system must provide for greater political attention if a system of developing inter-port must be realized. Such infrastructure is part of a connection system with railways, roads, ports, and airports in direct connection with the main nodes of the country, toward which tourism flows do not seem to be adequately considered in contrast to our analysis. The intermodal way (Trip and Bontekoning 2002) in countries attempting to develop their tourist industries, cannot be limited to an analysis of the goods flow (Efthymiou and Papatheodorou 2015).

**Fig. 9** Nights spent in tourism accommodation for 1000 inhabitants per municipality—Year 2017. *Source* Istat data



## 6 Conclusions

The importance of infrastructure and proper transport policy is crucial for regional and national economies. They contribute to tourism demand and thus to the growth of the tourism industry, which produces goods and services characteristic of tourism. Of course, the use of infrastructure and transport is not restricted to tourism purposes. In Italy, however, during certain periods of the year characterized by strong seasonality, mobility and therefore the related means of transport are used almost exclusively to allow tourists to reach their chosen destinations. European countries have been affected by the 2008 financial crisis, in very different ways, which includes an impact on transport and infrastructure expenditure, when considering the six European countries with the highest number of tourists. It must also be noted that this type of expenditure is characterized by not being procyclical. For this reason, this type of expenditure when planned, contributes to the growth and development of national and regional economic systems. Analyzing Italy, which is ranked second in the EU in terms of tourist popularity, it is possible to understand how important it is to plan infrastructure and transport considering the directions of tourist flows. The attractiveness of the regions is the primary element to be considered, since it is possible to establish which are the regions where tourists coming from, and which are those where there are the greatest number of tourist destinations. But a more precise analysis is represented by the identification of the nodal points, which instead can identify the points of

reception of tourists throughout the country Cross-referencing this information with that which relates to transport, it is possible to understand the limits of the current transport and infrastructure system in Italy. The lack of a real intermodality and the possibility of having a second-level mobility system able to reach destinations, is in contrast with the policy of the big hubs that has been pursued instead. Italy is also characterized by many municipalities which are tourist destinations, distributed throughout the country. They could have a great advantage in increasing the number of tourists, provided that there is a careful planning of the means of transport as well as investments in infrastructure. The south of the country seems to be particularly lacking in this modernization project and this explains the low tourist flows observed.

**Acknowledgements** All authors contributed to the study conception and design, Material preparation, data collection and analysis. All authors read and approved the final manuscript

## Declarations

**Conflict of interest** The author declares that they have no potential conflicts of interest.

**Human and animal rights** The Research does not involve Human Participants and/or Animals.

## References

- Allen, R., Tommasi, D.: *Managing Public Expenditure: A Reference Book for Transition Countries*. OECD Publishing, Paris (2001). <https://doi.org/10.1787/9789264192607-en>
- Antolini, F.: Misurare i servizi: la criticità delle statistiche del turismo. *Economia Dei Servizi* **2**, 121–138 (2014)
- Antolini, F.: The evolution of national accounting and new statistical information: happiness and gross domestic product, can we measure it? *Soc. Indic. Res.* **129**(3), 1075–1092 (2016)
- Antolini, F., Giusti, A., Grassini, L.: I flussi turistici interregionali: Una nuova metodologia di analisi. *Turistica* **4**, 5–34 (2017)
- Banca d'Italia: Le infrastrutture in Italia, dotazione, programmazione, realizzazione. Conference Paper, n.7, Rome (2011). [https://www.bancaditalia.it/pubblicazioni/collana-seminari-convegni/2011-0007/7\\_infrastrutture\\_italia.pdf](https://www.bancaditalia.it/pubblicazioni/collana-seminari-convegni/2011-0007/7_infrastrutture_italia.pdf). Accessed 25 April 2021
- Banca d'Italia: L'Efficienza della spesa per infrastrutture. Conference paper n.10, Rome (2012). [https://www.bancaditalia.it/pubblicazioni/collana-seminari-convegni/2012-0010/efficienza\\_spesa.pdf](https://www.bancaditalia.it/pubblicazioni/collana-seminari-convegni/2012-0010/efficienza_spesa.pdf). Accessed 25 April 2021
- Barnes, J.I.: Economic returns and allocation of resources in the wildlife sector of Botswana. *South Afr. J. Wildl. Res.* **31**(3–4), 141–153 (2001)
- Bronzini, R., Casadio P., Marinelli G.: Quello che gli indicatori territoriali sulle infrastrutture di trasporto possono, e non possono dire. In: *Proceedings of the Banca d'Italia Conference. Infrastrutture, dotazione, programmazione e realizzazione* (2011)
- Cafiso, G., Cellini, R., Cuccia, T.: Do economic crises lead tourist to closer destinations? Italy at the time of the Great Recession. *Paper Reg. Sci.* **97**(2), 369–386 (2016)
- Candela, G., Figini, P.: *Economia dei sistemi turistici*. McGraw-Hill, Milan (2005)
- Caris, A., Macharis, C., Janssens, G.K.: Decision support in intermodal transport: a new research agenda. *Comput. Ind.* **64**(2), 105–112 (2013)
- Chen, Y.: The fifth UNWTO/PATA forum on tourism trends and outlook. *Anatolia* **23**(3), 437–438 (2012)
- Cho, V.: A study of the non-economic determinants in tourism demand. *Int. J. Tour. Res.* **12**(4), 307–320 (2010)
- Efthymiou, M., Papatheodorou, A.: Intermodal passenger transport and destination competitiveness in Greece. *Anatolia* **26**(3), 459–471 (2015)
- Eurostat.: *European System of Accounts (ESA)* Luxembourg (2010)
- European Commission.: *Feasibility Study on the Use of Mobile Positioning Data for Tourism Statistics. Consolidated Report Eurostat* (2014). <https://ec.europa.eu/eurostat/documents/747990/6225717/MP-Consolidated-report.pdf>. Accessed 25 April 2021
- Eurostat.: *European Implementation Manual on Tourism Satellite Accounts (TSA), Final draft 1* (2014). [https://ec.europa.eu/eurostat/documents/747990/748067/TSA\\_EIM\\_FINAL\\_VERSION.pdf/896f9dab-b9fa-45c1-b963-3028a73b71c6](https://ec.europa.eu/eurostat/documents/747990/748067/TSA_EIM_FINAL_VERSION.pdf/896f9dab-b9fa-45c1-b963-3028a73b71c6). Accessed 25 April 2021

- Eurostat.: Average expenditure per trip by expenditure categories (2020). <https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do>. Accessed 25 April 2021
- Gálvez, T., Muro, J., Such-Devesa, M.: Measuring and analyzing domestic tourism: the importance of an origin and destination matrix. *Tour. Econ.* **20**(3), 451–472 (2014). <https://doi.org/10.5367/te.2013.0286>
- Giraud, T., Lambert, N.: Cartography: create and integrate maps in your R workflow. *J. Open Sour. Softw.* **1**(4), 54 (2016). <https://doi.org/10.21105/joss.00054>
- Hickman, R.: Examining transport futures with scenario analysis and MCA. *Transp. Res. Part A Policy Pract.* **46**(3), 560–575 (2012)
- Istat.: Conto satellite del turismo per l'Italia, Rome (2017a). <https://www.istat.it/it/archivio/207454>. Accessed 25 April 2021
- Istat.: Il movimento turistico in Italia, Rome (2017b). <https://www.istat.it/it/files/2018/11/report-movimento-turistico-anno-2017b.pdf>. Accessed 25 April 2021
- Istat.: Viaggi e vacanze, Rome (2020). [https://www.istat.it/it/files//2021/04/Report\\_viaggiVacanze\\_2020.pdf](https://www.istat.it/it/files//2021/04/Report_viaggiVacanze_2020.pdf). Accessed 25 April 2021
- Jones, C., Munday, M.: Tourism satellite accounts and impact assessments: some considerations. *Tour. Anal.* **13**(1), 53–69 (2008)
- Leung, R., Buhalis, D.: Smart hospitality—interconnectivity and interoperability towards an ecosystem. *Int. J. Hosp. Manage.* (2018). <https://doi.org/10.1016/j.ijhm.2017.11.011>
- Lijesen, M.G., Rietveld, P., Nijkamp, P.: Hub premiums in European civil aviation. *Transp. Policy* **8**(3), 193–199 (2001)
- Lim, C.: Review of international tourism demand models. *Ann. Tour. Res.* **24**(4), 835–849 (1997)
- Liu, P., Liu, Y.: Smart tourism via smart phone. In: Proceedings of International Conference on Communications, Information Management and Network Security (2016)
- Nyusten, J.D., Dacey, M.F.: A graph theory interpretation of nodal regions. *Reg. Sci. Assoc. Papers Proc.* **7**, 29–42 (1961)
- OECD.: New standards for compiling national accounts: what's the impact on GDP and other macro-economic indicators? Statistics in Brief (20) (2015). <https://www.oecd.org/sdd/na/new-standards-for-compiling-national-accounts-SNA2008-OECD2015.pdf>. Accessed 25 April 2021
- Official Aviation Guide (OAG): Connectivity index (2020). <https://www.oag.com/oag-megahubs-2019>. Accessed 25 April 2021
- Pearce, D.G.: Tourism today. A geographical analysis. *J. Travel Res.* **34**(2), 75–75 (1995)
- Qiu, H., Zhang, J.: Determinants of tourist arrivals and expenditures in Canada. *J. Travel Res.* **34**(2), 43–49 (1995)
- Sen, A.: *Lo sviluppo è libertà. Perché non c'è crescita senza democrazia.* Edizioni Mondadori Business & Economics, Milan (2014)
- Spant, R.: Why net domestic product should replace gross domestic product as a measure of economic growth. *Int. Prod. Monit.* **7**, 39–43 (2003)
- Tinkler K.J., Nyusten, J.D., Dacey M.F.: Nyusten-Dacey's Nodal Analysis. Institute of mathematical geography, Monograph Series, Monograph n.7, Ann Arbor, Michigan (1988)
- Trip, J.J., Bontekoning, Y.: Integration of small freight flows in the intermodal transport system. *J. Transp. Geogr.* **10**(3), 221–229 (2002)
- Tsamboulas, D., Vrenken, H., Lekka, A.-M.: Assessment of a transport policy potential for intermodal mode shift on a European scale. *Transp. Res. Part A Policy Pract.* **41**(8), 715–733 (2007)
- UNWTO.: Tourism Satellite Account: Recommended Methodological Framework 2008. Studies in Methods Series F No. 80/Rev. 1 (2008)
- Uysal, M.: The determinants of tourism demand: a theoretical perspective. I. In: Ioannides, D., Debbage, K.G. (eds.), *The Economic Geography of the Tourist Industry: A Supply-Side Analysis*, pp. 79–95. Routledge, New York (1998)
- Vanhoof, M., Hendrickx, L., Puussaar, A., Verstraeten, G., Ploetz, T., Smoreda, Z.: Exploring the use of mobile phone data for domestic tourism trip analysis. *Mobilités et (r)évolutions numériques.* **31**(3/4), 335–372 (2017). <https://doi.org/10.4000/netcom.2742>
- Xu, J.B.: Perceptions of tourism products. *Tourism Manage.* **31.5**(2010), 607–610 (2010)