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Measuring tourism seasonality across European countries

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A R T I C L E I N F O

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A B S T R A C T

This paper will propose a general approach for the analysis and measurement of seasonality in tourism, based on an analysis of the pattern of seasonal swing, as a preliminary step for the assessment of seasonal amplitude. The seasonality of tourism demand across European countries will be analyzed and clusters of countries identified, which are based on a similarity of their seasonal pattern. After discussing the limitations of the most frequently used indices employed in the tourism literature, a new index for measuring seasonality in tourism will be suggested in order to measure seasonal amplitude. The latter takes into account the ordinal and cyclical structures of seasonal variations. The results demonstrate a strong connection between seasonal patterns and the spatial distribution throughout European countries, which may orient future policy actions for dealing with seasonality on a European level.

1. Introduction

The objective of this paper is to present a methodological framework for analyzing seasonality in tourism, in which an analysis of the pattern of seasonal fluctuations will have been performed prior to the measurement of its amplitude. This approach is based on a comparison of seasonal patterns by means of measuring the distance between seasonal factors; thereafter a clustering approach will be used in order to identify clusters of countries, which are based on similarities between their patterns. The seasonal amplitude will then be evaluated via the use of a new index, which takes into account the ordinal and cyclical structure of time periods. From a wider perspective, a classification of seasonal profiles in tourism will also be proposed, one which is based on the key characteristics of patterns, such as the number of seasonal peaks and their intensity.

Although tourism seasonality has been widely investigated (in terms of causes, impacts and policy implications), considerably less attention has been devoted to the measurement of seasonality and seasonal pattern classification (Croce & Wöber, 2010; Duro, 2016; Koenig-Lewis & Bischoff, 2004). Only a few authors have attempted to compare different measures of seasonality by highlighting their merits and pitfalls (Lundtorp, 2001, pp. 23–50). Moreover, the existing literature, with only a few exceptions (Amelung, Nicholls, & Viner, 2007; Bender, Schumacher, & Stein, 2005; Charles-Edwards, 2004; Coshall, Charlesworth, & Page, 2015), has not focused on the spatial dimension of seasonality. And little research has addressed the problem of whether seasonality in tourism-related aggregates varies in nature and intensity on a spatial basis (Charles-Edwards & Bell, 2015; Coshall et al., 2015).

On the European level, overnight stays in hotels and similar establishments in the 28 member countries of the EU, from 2005 to 2016, experienced a growth of approximately 23%: from 1.51 to 1.86 billion, and this growth was considerably higher for non-residents (+35.2%), compared to residents (+12.5%) (Eurostat, 2017a). Nonetheless, a strong seasonal behaviour characterizes the distribution of overnight stays over a one year period. This poses several challenges related to the sustainability of the tourism industry as well as the impact of tourism from economic, socio-cultural and environmental perspectives (Cisneros-Martínez, McCabe, & Fernández-Morales, 2018). The application of the aforementioned approach, over a 10 year period, will attempt to produce in-depth, longitudinal research on the European level in order to improve our understanding of seasonality in tourism.

Given these premises, this paper posits certain questions, which arise from various research challenges. From a general point of view:

- What are the main features of seasonality which require particular attention from an empirical perspective?
- How can seasonal patterns be classified in order to recognize their features on the basis of current classifications?
- Can the current measures of seasonal amplitude capture all the compelling features of seasonality?

In the specific context of tourism seasonality throughout European countries, this study will provide answers to questions, such as:

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- What are the main patterns of seasonality on the European level?
- Is there a spatial dimension to seasonality in Europe?
- What has been the trend in seasonality throughout the last decade?

In order to provide answers to these questions, a methodological framework for the analysis of tourism seasonality has been proposed and applied to an evaluation of seasonality in overnight stays in hotels and similar establishments across European countries from 2005 to 2016. Specific features of seasonal fluctuations have been highlighted, also taking into account the spatial distribution of countries under consideration and the specific tourism segment under analysis (i.e. residents and non-residents in hotels and similar establishments). A longitudinal analysis of seasonality in a large-scale geographical context may provide new insights for recognizing its main causes and for designing counter-seasonal strategies, as well as for evaluating the effectiveness of these counter-seasonal policies.

2. Background

2.1. Seasonality in tourism research

The analysis of seasonality in tourism is a complex task, particularly as it involves the determination of causes and consequences. According to Butler (2001), seasonality can be defined as “a temporal imbalance in the phenomenon of tourism, which may be expressed in terms of the number of visitors, traffic on the highways, employment and admission to attractions” (Butler, 2001, p. 5–21). Although the idea of seasonality can be said to be one of the simplest ideas in many natural and human phenomena – related to the different intensity of solar rays and its effects on the environment and human habits (Ulijaszek & Strickland, 2009) – its analysis and measurement is still a challenging task. Climate and weather are relevant factors for analyzing tourist behaviour in the tourism sector (Scott, McBoyle, & Schwartzentruber, 2004; Ridderstaat et al., 2014; Li, Song, & Li, 2017; Li, Goh, et al., 2017), as are institutional factors, related to work and holiday periods; all these play an important role in determining tourist seasons (Hartmann, 1986; Hinch & Jackson, 2000). Additional causes of seasonality, recognized by Butler (1994), include social pressure and fashion, sporting seasons and inertia or tradition.

Seasonal fluctuations of tourism-related aggregates have been recognized as an issue since the very beginning of tourism studies (BarOn, 1975), mainly due to their implications from economic, environmental and socio-cultural perspectives. The economic effects of seasonality are related to the inefficient use of tourism resources, the overcrowding of destinations and attractions during peak demand periods, and lack of capacity (Getz & Nilsson, 2004). Moreover, increases in prices in the peak season, with a negative impact on a consumer's perception of value, and seasonality in the labour market (Ashworth & Thomas, 1999; Ball, 1988; Lundmark, 2006), have been recognized as a major, economic impact on tourism seasonality. The effects of seasonality on the environment are mainly related to damage to vegetation and disturbance to fauna (due to tourism pressure in the peak season), water supply and waste management, to mention but a few (Cuccia & Rizzo, 2011; Ioannides & Petersen, 2003; Lusseau & Higham, 2004; Martín-Martín, Jiménez-Aguilera, & Molina-Moreno, 2014). Finally, the socio-cultural effects of seasonality affect the community which is being visited by tourists when substantial numbers make use of a destination's resources and cause overcrowding, thereby having a negative impact on residents (Deery, Jago, & Fredline, 2012). Departing from causes of seasonality, six basic supply and demand strategies for reducing it have been identified (Weaver & Oppermann, 2000). These include: strategies to increase demand in off-season or shoulder periods, to reduce demand in peak periods, and to redistribute demand between peak season and off seasons. On the supply side, there are strategies to increase the supply in off-season or low demand periods, to reduce supply in high seasons, and to redistribute supply from a peak season to a low season period.

Despite the availability of a number of reviews relating to tourism seasonality, (Baum & Lundtorp, 2001; Koenig-Lewis & Bischoff, 2005), few authors have focused their attention on the spatial features of seasonality (Amelung et al., 2007; Bender et al., 2005; Butler, 2001; Charles-Edwards, 2004; Coshall et al., 2015). For example, Getz and Nilsson (2004) highlighted a predominance of summer seasonal peaks in the northern hemisphere, whereas the winter seasonal peak prevails in tropical destinations. On the other hand, Yacoumis (1980) has recognized tourism seasonality as a general issue which varies only in the intensity of seasonal peaks; he has also suggested that seasonality should be analyzed on different levels: national, regional and sectoral. Nonetheless, a deeper knowledge of the spatial features of seasonality is required in order to assess the impact of policy interventions, in addition to improving our understanding or the causes and consequences of tourism seasonality (Ahas, Aasa, Mark, Pae, & Kull, 2007). To date, there have been few large-scale, geographical analyses of patterns of tourism seasonality (Coshall et al., 2015), which may highlight the role of the spatial and institutional causes of seasonality.

2.2. Pattern of tourism seasonality

Seasonality is generally characterized by a well structured pattern, rather than random irregularities, and seasonal fluctuations are determined by well-defined causes of different origin and intensity (Granger, 1979). Subsequently, one of the key-features of seasonal fluctuation is related to its regularity, in addition to the shape of seasonal fluctuations, that is, the distribution of the phenomenon under consideration in a well-defined time period. From an empirical perspective, there have been several attempts to classify seasonal patterns in tourism. Several authors have identified different profiles of seasonality in tourism (Butler & Mao, 1997; Candela & Figini, 2012; Chen & Pearce, 2012; López-Bonilla, López-Bonilla, & Sanz-Altamira, 2006). An initial, more common, profile is characterized by a single peak season: this is typical of many coastal destinations in the Mediterranean, which experience an intense peak of tourists in the summer (Fernández-Morales, 2003; Vergori, 2012). A second profile presents a peak season and a shoulder season, namely a minor peak which falls between the high and the off season, usually determined by specific tourist segments which are more likely to visit the destination out of the peak periods (Candela & Figini, 2012). A third profile is characterized by two main peaks, generally involving summer and winter seasons. This latter kind of seasonality may indicate the capability of the destination to meet different tourist needs, and it is typical of mountain resorts (Butler & Mao, 1997; López-Bonilla et al., 2006). Finally, a fourth profile identifies those destinations which do not experience strong seasonal peaks, since they tend to have relatively low fluctuations in tourism-related time series. This is the case, for example, of many cultural cities, which are generally characterized by a low degree of tourism seasonality (Butler, 2001; Cuccia & Rizzo, 2011; Figini & Vici, 2012; Hall & Page, 2003). Of course, the pattern of seasonal fluctuations can also derive from a combination of these main categories, in relation to the specific tourist target being considered, the generating region, and the destination's characteristics.

Although the classification proposed by Butler and Mao (1997), still remains the main reference for tourist seasonal patterns (Vergori, 2017), only a few authors (Chen & Pearce, 2012; Croce & Wöber, 2010; Hadwen, Arthington, Boon, Taylor, & Fellows, 2011; Koenig-Lewis & Bischoff, 2003) have attempted to develop methods which are capable of classifying seasonal patterns in tourism. Despite the development of a variety of methods for comparing and classifying time series, only a few examples of seasonal pattern classifications can be found in the tourism literature. For example, Koenig-Lewis & Bischoff (2003; 2004) have used Principal Component Analysis in order to examine seasonal patterns of occupancy data in Wales. The proposed approach allowed for the identifying of groups of establishments with similar seasonal patterns. López-Bonilla et al. (2006) have used the distribution of seasonal factors to distinguish high season, average season and low season in order to classify seasonal patterns in Spanish regions as one-peak, two-peaks, multiple peaks or no peaks. Croce and Wöber (2010) have used Pearson's correlation coefficient and multi-dimensional scaling to compare and classify seasonal patterns of bed-nights for 20 European cities, by identifying clusters of European cities, which were based on similarities within the seasonal pattern.

Similarly, Hadwen et al. (2011) have analyzed the seasonal patterns of tourist visits to protected areas, according to different climatic zones, thus considering an external factor for classifying seasonal patterns, after which they checked the differences in seasonal fluctuations. Finally, Chen and Pearce (2012) have analyzed seasonal patterns in five Asian countries for the period 2000–2006 by studying the differences between monthly tourist arrivals and average monthly arrivals; they identified six groups of seasonal patterns. However, their approach is based mainly on a visual examination of the pattern of seasonality, and the reference categories proposed may not be applicable to highlighting the main differences in seasonality in other spatial and temporal contexts.

2.3. Measuring seasonality

One of the main foci in the analysis of seasonality in tourism is its measurement in terms of an analysis of inequality in the distribution of a given phenomenon (e.g. tourist arrivals) during a specific time period (months of the year), regardless of its pattern. Various methods for measuring seasonality have been used to quantify its extent, and several authors have provided detailed descriptions of the main indices used in tourism literature, which have also highlighted their merits and pitfalls (Koenig-Lewis & Bischoff, 2005; Lundtorp, 2001, pp. 23–50). *Seasonal range*, *Seasonality ratio*, and the *Coefficient of Seasonal Variation* are all generally derived from seasonal factors, the latter which comprise the seasonal component of the phenomenon under consideration. These three indices provide information relating to the range of seasonal factors during periods throughout the year or the variability in seasonal factors in a given time period.

Two of the most common indices used to measure seasonality in tourism are the *Gini concentration index* and the *Theil index*. After the seminal work by Wanhill (1980), many examples of applications of the Gini index may be found in tourism seasonality research: these include the works of Cisneros-Martínez and Fernández-Morales (2015); Croce and Wöber (2010); Fernández-Morales, Cisneros-Martínez, and McCabe (2016); Fernández-Morales and Mayorga-Toledano, (2008); Kulendran and Wong (2005); Rosselló-Nadal, Riera-Font, and Sansó-Rosselló (2004); Þórhallsdóttir and Ólafsson (2017); Tsitouras (2004); and Vergori (2017). Recent examples of applications of the Theil index may be found in Duro (2016) and in Rosselló-Nadal and Sansó-Rosselló (2017). However, despite their widespread use in seasonality measurement, the theoretical arguments in support of these indices are mainly derived from the literature on income inequality measurement (Cowell, 2011; Sen, 1973; Shorrocks, 1980; Yitzhaki & Schechtman, 2013). The latter regards a context which is not directly comparable to one for which the phenomenon being studied is distributed across time periods and characterized by a well-defined ordered structure. Indeed, none of these indices takes into account the ordinal and cyclical structure of time periods. That is, two patterns: one, in which the phenomenon under consideration (e.g. tourist arrivals) is concentrated into two contiguous months (e.g. August and July), and the other, in which the amount of the phenomenon is concentrated into two very distant periods (e.g. August and January), would both produce the same value of all these indices, due to the so-called *anonymity* property.

Whilst recognizing the shortcomings of the currently used measures of seasonal amplitude in several empirical contexts, Lo Magno et al. (2017) have recently proposed a new index for the measurement of seasonality which explicitly takes into account the cyclic ordering of the months. It would appear appropriate to introduce this index for the measurement of seasonality in tourism, and to compare the results with those derived from more classic measures in order to reveal the similarities and differences between the different approaches.

3. Study context, data and methods

3.1. Tourism seasonality in Europe

The continent of Europe is the world's most visited regional destination (UNWTO, 2017). The direct contribution of travel and tourism industry to GDP in Europe has been estimated to have been approximately €624.3 billion in 2016, which is equal to 3.5% of GDP. This contribution generated about 14 billion jobs (3.7% of total employment) with a total impact of approximately 10% of GDP (World Travel & Tourism Council, 2017). Despite many challenges related to issues of security, this impact is expected to continue to grow in the near future, thus characterizing tourism as one of the major activities in the European Union. This is not only in economic terms but also from a social development perspective. However, several challenges to tourism in Europe have been recognized, particularly that of seasonality, due in part to its economic and environmental impact (European Commission, 2007).

The importance of tourism seasonality in European policy has been confirmed by specific programs of the European Commission (Centre for Strategy & Evaluation Services, 2013); encouraging an extension of the tourist season has been identified as one of the most important actions to stimulate competitiveness in the European tourism sector (European Commission, 2010; 2015). One example of this policy is the CALYPSO initiative, a preparatory action which was adopted by the European Parliament in 2008 for a three-year period. Its main aim is to promote out-of-season exchanges of tourists, belonging to four target groups: young and elderly people, people with reduced mobility and low-income families. Other examples of counter seasonal actions promoted at the European level may also be found in programs related to the challenges of marine and coastal tourism. Here, seasonality is identified as one of the mayor threats to sustainability, with severe consequences within economic, social and environmental perspectives. Although some examples of best practices have been reported by the CSES (Center for Strategy & Evaluation Services, 2013), a longitudinal, in-depth analysis of seasonality in tourism on the European level is for the large part missing.

From a statistical point of view, the relevance of seasonality on a European level has been confirmed by a specific section of the European Commission, the *Virtual Tourism Observatory*. This collects and disseminates tourism data with the aim of providing policy makers and companies with an accessible tool for the analysis of the main tourism-related aggregates. A specific section of the *Virtual Tourism Observatory* is dedicated to seasonality, in which the Gini index of *nights spent at tourist accommodation establishments* is used for comparing European countries in terms of seasonality. Moreover, an analysis of seasonality from the demand side (travel propensity) and from the supply side (occupancy at accommodation establishments) is provided in articles which are published annually (Eurostat, 2017b, 2017c). These figures show that in 2016 nearly 33% of annual nights in the tourist accommodation sector of the 28 Member Countries of the EU were recorded in two peak months, July and August, thereby confirming the very topical question of seasonality in European tourism.

3.2. Data

European Regulation (EU) No. 692/2011 (European Parliament, 2011), concerning European statistics relating to tourism, aims at establishing a common framework for the collection of statistical information relating to tourism throughout the European Union. This Regulation recognizes that “monthly data is needed in order to measure the seasonal influences of demand on tourist accommodation capacity and thereby help public authorities and economic operators develop more suitable strategies and policies for improving the seasonal spread of holidays and tourism activities" (European Parliament, 2011, p. 17). Bearing in mind this aim, data to be transmitted by the Member States, with specific reference to monthly data on internal tourism concerns: a) the number of nights spent by residents and non-residents at tourist accommodation establishments; b) the arrivals of residents and non-residents at tourist accommodation establishments; and c) the net occupancy rate of bed places and bedrooms. The three categories used for classifying different types of accommodation are: hotels and similar accommodation; holidays and other short-stay accommodation; and camping grounds, recreational vehicle parks and caravan sites/mobile homes.

Collated and integrated data are provided by Eurostat, the statistical office of the European Union in the tourism section of the database, which is available on the Eurostat website. Residents' and non-residents' monthly series of overnight stays in hotels and similar establishments have been included in the research described in this paper from a set of 21 European countries from 2005 to 2016 (Eurostat, 2017a). Countries were selected for analysis according to several considerations: first, the selected countries account for 89.4% of total overnight stays in hotels and similar establishments of the 28 Member Countries of the EU in 2016. Countries which make a paltry contribution to European tourism (e.g. Iceland, Luxembourg, Liechtenstein, Montenegro, Macedonia) were excluded from the analysis. Ireland, UK and Greece were also excluded from the analysis due to a lack of data in the Eurostat databanks, and according to the recommendations that Eurostat itself made for these countries in terms of data comparability (Kovacev, 2016, p. 10). Other limitations affecting official tourism statistics have been discussed elsewhere (Aroca, Brida, & Volo, 2016; Parroco, Vaccina, De Cantis, & Ferrante, 2012; Pratt & Tolkach, 2018). The *Hotels and similar establishments* category was considered due to its higher degree of reliability and comparability: it is based, in the majority of cases, on census data due to administrative constraints in many countries; the latter obliges hotels managers to register each and every guest. The disaggregation into *residents* and *non-residents* is considered an important element in evaluating seasonality in tourism, as, in most cases, it is characterized by a different behaviour in terms of seasonal fluctuations (Cisneros-Martínez, & Fernández-Morales, 2015; Croce & Wöber, 2010).

3.3. Comparing seasonal patterns

An initial step required for the analysis of seasonal fluctuations is generally the decomposition of the series under analysis into: a trend-cycle component, a seasonal component and a residual component (Dagum, 2004). In order to remove the influence of the trend-cycle component from the analysis of seasonal fluctuations, several methods have been proposed (Planas, 1998). All these methods permit the so-called seasonal factors to be derived, and this should comprise the only seasonal component of the series (Dagum, 1975). Seasonal factors are usually centred on the value 100 or 0: the former indicates a multiplicative seasonal component where values greater (or smaller) than 100 would indicate a seasonal component above (or below) the trend-cycle component. The latter represents an additive seasonal component, where positive values would be associated with periods with seasonality above the trend-cycle component and vice versa for negative values. The simplest method for eliminating the influence of the (deterministic) trend-cycle component is to consider the ratio between each monthly value and the annual average monthly value. However, the most common approach for measuring seasonality in a tourism time series involves estimating seasonal factors, using the so-called "ratio-to-moving average" (Joy & Thomas, 1928; Lim & McAleer, 2001). For simplicity and using the approach described in this paper for any given country, multiplicative seasonal factors $\{z_t\}$ for residents' and non-residents' series of monthly overnight stays in hotels and similar establishments $\{y_t\}$ were derived as a ratio to 13-term, centred, moving averages $\{MA_t\}$ (with weights equal to 0.5 for the two more extreme observations), namely:

$$z_t = \frac{y_t}{MA_t}100 \tag{1}$$

where

$$MA_t = \frac{0.5y_{t-6} + \sum_{k=1}^{11} y_{t-6+k} + 0.5y_{t+6}}{12} \tag{2}$$

According to Kuznets (1932), when analyzing seasonality, it is possible to focus on several aspects, such as: (a) the pattern of seasonal swing, that is, the distribution of seasonal factors within the months of any given year; (b) the amplitude of seasonal swing through a measure of the synthesis of seasonal factors in a given year; (c) the persistency or the variations in seasonal patterns through some measures of variability of the seasonal pattern over several years; and (d) the persistence or the variations in seasonal amplitude through some measures of variability of seasonal amplitude covering several years. These features could be analyzed with reference to a single destination (for example, comparing different market targets or evaluating changes over time) or to compare several tourism destinations.

Since similar results, in terms of seasonal amplitude, can derive from very different seasonal patterns, pattern analysis should be performed prior to the analysis of seasonal amplitude. This will involve two steps: the first regards the stability of seasonal fluctuations for every series, which is checked by an analysis of the ranking of months, according to a seasonal factor value, for the different years under consideration. Kendall's *W* multiple rank correlation coefficient has been used for this purpose (Kendall & Smith, 1939), although other, more complex, approaches have been proposed in the time series literature (Canova & Hansen,1995). In the second step, comparisons among seasonal patterns for all the selected European Countries are performed and several algorithms are proposed for comparing the time series (Corduas & Piccolo, 2008). One of the criteria determining the selection of the different proposed method is related to the selection of a particular distance measure. Specifically, the choice of distance measure depends on the features of the series under comparison, and on the research aims. For example, motion capture data typically requires invariance to warp (i.e., local non-linear accelerations), whereas genetic data generally requires invariance to uniform scaling (i.e. linear "stretching") (Batista, Wang, & Keogh, 2011).

Given the structure of the data used in this work, the Euclidean distance can be an effective measure for comparing seasonal series (Morse & Patel, 2007). The data comprise seasonal factors which are all centred at the value 100 and with the same periodicity (monthly series). However, when specific invariance properties are desired (e.g. scale invariance, warping invariance, phase invariance, etc.), other distance measures can be used. In the approach described in this paper, for every pair of countries (*i,j*), a value of the distance between the series of seasonal factors $\{z_t\}$ over all the considered periods (having excluded the first and the last years, due to missing observations, determined by the application of moving averages) has been derived, as follows:

$$d_{ij} = \sum_{t=1}^{T} \sqrt{(z_{i,t} - z_{j,t})^2} \tag{3}$$

Having obtained a measure of the distance between each pair of series under analysis, seasonal patterns can be classified according to a hierarchical classification by using Ward's method (Maechler et al., 2017; Ward, 1963). Analysing the seasonal pattern of the obtained clusters permits us to identify different seasonality profiles, which are classified according to the number of peak periods and seasonal amplitude. Moreover, the obtained clusters are displayed on a map in order to check for the presence of geographical factors, which may explain similarities among the identified clusters, such as a proxy of climatic, institutional, and tourism-product determinants.

3.4. Measuring seasonal amplitude

Having analysed the different patterns, seasonal amplitude measures can be used in order to quantify the degree of seasonality for the same country over different years under consideration and between countries. In order to take into account the cyclical order of time periods, which characterizes seasonal patterns, the seasonality index proposed by Lo Magno et al. (2017) has been used in this study. This index is based on the solution of an appropriately defined transportation problem, a well known linear optimization problem in which the goal of the solution is to minimize the cost of transferring units from a set of warehouses to a set of customers, thereby satisfying the constraints imposed by the available resources and requested demands (Hillier & Lieberman, 2014). Applying this to the minimization problem, which is set for calculating the seasonality index, the roles of warehouses and customers have been adopted by the months (or any time period), for which the observed value is over and under the average respectively. Furthermore, the constraints of the linear problem ensure that seasonality will be eliminated after the transfers, namely, a uniform distribution will be obtained. The minimum cost which is required for eliminating seasonality is the value of the *absolute seasonality index*, and it is assumed as the basis for constructing a corresponding relative measure.

Following this approach, let $\mathrm{M} = \{1, 2, \ldots, N\}$ be the set of N time periods, for which seasonal factors are given (e.g. months of a given year). The observed values of the variable are represented by the vector $\mathbf{P} = \{z_1, z_2, \ldots, z_N\}$, for which all the values are assumed to be non-negative. The total amount of the observed phenomenon is $Z = \sum_{n=1}^{N} z_n$ and the observed average is $\mu = Z/N$. We assume that the pattern $\mathbf{P}_0(Z, N) = (Z/N, Z/N, \ldots, Z/N)$ with length N indicates an absence of seasonality.

The absolute seasonality index can be derived as the minimum cost which is required for transforming a generic N-dimensional pattern $\mathbf{P}$, with a total amount Z, into a pattern $\mathbf{P}_0(Z, N)$. The transformation occurs by transferring the phenomenon from over-average months to under-average months, and each transfer has a cost which depends on the amount transferred and the distance between the origin and the destination month. An appropriate definition of the unitary transfer costs enables us to take into account the cyclical order of the months: with the months equidistantly located on a circumference, the distance between two months is defined as the shorter arc which connects those months. Thus, the distance between February and October is 4 and not 8. The distance matrix between time periods, together with the circular representation of the months of the year, are reported in Appendix A.

In order to specify the transportation problem, the over-average and under-average periods need to be identified. The over-average months are given by the set $\mathrm{A} = \{i \in M: z_i > \mu\}$, whereas the under-average months are represented by the set $\mathrm{B} = \{j \in M: z_j < \mu\}$. For each month $i \in \mathrm{A}$ the surplus $a_i = x_i - \mu$ is defined; similarly a deficit $b_j = \mu - x_j$ is defined for each month $j \in \mathrm{B}$. The value a_i represents the amount which has to be transferred from month i to the other months in B, while b_j is the amount which month j has to receive from the set of months in A. It holds that $\sum_{i\in \mathrm{A}} a_i = \sum_{j\in \mathrm{B}} b_j$.

The transportation problem for measuring seasonality can be defined as:

$$
\begin{aligned}
&\min c = \sum_{i\in \mathrm{A}} \sum_{j\in \mathrm{B}} c_{ij} x_{ij} \\
&\text{s.t.:} \\
&\sum_{j\in \mathrm{B}} x_{ij} = a_i, \quad \forall\ i \in \mathrm{A} \\
&\sum_{i\in \mathrm{A}} x_{ij} = b_j, \quad \forall\ j \in \mathrm{B} \\
&x_{ij} \geq 0, \quad \forall\ i, j: i \in \mathrm{A} \wedge j \in \mathrm{B}
\end{aligned} \tag{4}
$$

where c is the total cost for eliminating seasonality, the $|\mathrm{A} \times \mathrm{B}|$ variables x_{ij} represent the transfers (the decision variables of the problem), and c_{ij} is the unitary transfer cost from month i to month j (see Appendix A). The first set of $|\mathrm{A}|$ constraints ensures that surplus a_i is transferred from each month $i \in \mathrm{A}$; the second set of $|\mathrm{B}|$ constraints ensures that the deficit b_j is received by each month $j \in \mathrm{B}$; and the third set of $|\mathrm{A} \times \mathrm{B}|$ constraints guarantees that all the transfers are non-negative. An optimal solution always exists for a transportation problem (Hillier & Lieberman, 2014), which can be found by using the simplex algorithm (Dantzig, 1963).

The optimal solution is given by the $|\mathrm{A} \times \mathrm{B}|$ values x_{ij}^*, and the corresponding minimum cost c^* is an absolute measure of seasonal concentration, namely:

$$S_A = c^* = \sum_{i\in \mathrm{A}} \sum_{j\in \mathrm{B}} c_{ij} x_{ij}^* \tag{5}$$

It has been demonstrated (Lo Magno et al., 2017) that, given the cost matrix $\mathbf{C}$ and holding constant Z, the maximum value of the absolute index is given by:

$$S_{\mathrm{MAX}}(\mu, \mathbf{C}) = \mu \max_{i\in \mathrm{M}} \left\{ \sum_{j\in \mathrm{M}} c_{ij} \right\} \tag{6}$$

Thus, the maximum value depends on the mean value of the phenomenon of interest and on the maximum value of the row sum in the cost matrix. The maximum value of S_A is achieved when the total amount of the phenomenon of interest is concentrated into one month, while the value of S_A is zero for a uniform distribution.

Having identified the value S_{MAX}, it is possible to derive a *Relative Seasonality Index*:

$$S_R(\mu, \mathbf{C}) = \frac{S_A(\mathbf{P}, \mathbf{C})}{S_{MAX}(\mu, \mathbf{C})} \tag{7}$$

S_R is bounded in the interval [0,1] and it may be used for comparing patterns with a different total amount of the phenomenon of interest.

For $\lambda > 0$, the following set of properties can be derived; they provide a clearer description of the differences between S_A and S_R:

- **Property 1.** $S_A(\lambda\mathbf{P}, \mathbf{C}) = \lambda S_A(\mathbf{P}, \mathbf{C})$
- **Property 2.** $S_A(\mathbf{P}, \lambda\mathbf{C}) = \lambda S_A(\mathbf{P}, \mathbf{C})$
- **Property 3.** $S_R(\lambda\mathbf{P}, \mathbf{C}) = S_R(\mathbf{P}, \mathbf{C})$
- **Property 4.** $S_R(\mathbf{P}, \lambda\mathbf{C}) = S_R(\mathbf{P}, \mathbf{C})$

Properties 1 and 2 state that scale transformations of $\mathbf{P}$ or $\mathbf{C}$ multiplicatively affect S_A by the same scale transformation coefficient λ. On the contrary, Properties 3 and 4 reveal that S_R is insensitive to the scale transformations. From Property 3 it follows that, similar to many other inequality indices, that which effectively affects S_R is the relative distribution of the phenomenon. Finally, from Property 4 we learn that, although many cost matrices could be chosen, S_R does not change for all the infinite number of matrices which can be obtained by multiplying a given matrix $\mathbf{C}$ by λ. Demonstrations of these properties may be found in Lo Magno et al. (2017).

Once the *Relative Seasonality Indices* for all the years under consideration have been derived, the seasonal amplitude of different countries can be compared in terms of its development over the time period under consideration, as well as comparisons within and between clusters. In order to show similarities and differences from the results obtained, they have been compared to those deriving from the application of the Gini concentration index and the Theil index for the last analysed year, 2015.

Table 1
Overnight stays in hotels and similar establishments made by residents (data in thousands) for selected years (2005–2016) and % of change 2005–2016.

Country	2005	2008	2011	2014	2016	% change 2005–2016
Belgium	4313.4	5421.5	6464.8	6926.1	7062.7	63.7%
Bulgaria	3956.9	5304.0	5166.8	6219.2	7454.8	88.4%
The Czech Republic	8601.2	9686.1	9852.8	11,715.9	14,623.6	70.0%
Denmark	5330.1	6280.6	6478.0	7298.9	8384.0	57.3%
Germany	162,529.5	173,612.5	189,391.9	202,138.3	213,924.2	31.6%
Spain	106,367.1	113,011.5	111,140.7	104,689.9	113,484.9	6.7%
France	125,215.6	130,640.6	134,935.0	128,341.1	133,631.7	6.7%
Croatia	2861.9	2946.2	2412.5	2112.1	2390.6	−16.5%
Italy	136,969.8	138,044.5	139,896.8	127,567.7	133,641.0	−2.4%
Cyprus	1040.2	1146.9	1154.8	816.7	785.1	−24.5%
Hungary	6622.4	7794.3	7414.6	9419.0	10,863.2	64.0%
Malta	246.9	335.0	317.4	352.5	345.1	39.8%
The Netherlands	14,362.6	17,563.1	17,847.6	19,757.0	21,455.3	49.4%
Austria	19,382.8	21,901.6	23,179.6	23,481.6	24,840.8	28.2%
Poland	12,424.0	17,300.3	20,785.0	24,982.0	31,405.2	152.8%
Portugal	11,515.9	12,860.8	13,639.7	14,442.2	15,240.8	32.3%
Romania	14,075.8	16,563.9	14,325.1	13,813.1	16,833.4	19.6%
Finland	10,394.4	11,344.8	11,654.9	11,170.7	11,655.5	12.1%
Sweden	17,517.9	20,042.2	21,528.1	23,652.2	26,472.8	51.1%
Norway	12,349.0	13,327.9	14,304.4	15,007.1	15,995.6	29.5%
Switzerland	14,645.6	15,855.4	15,778.7	15,957.5	16,270.7	11.1%

Source: Eurostat, 2017a.

Table 2
Overnight stays in hotels and similar establishments made by non-residents (data in thousands) for selected years (2005–2016) and % of change 2005–2016.

Country	2005	2008	2011	2014	2016	% change 2005–2016
Belgium	10,296.9	11,119.8	11,370.7	12,081.8	10,316.5	0.2%
Bulgaria	11,471.1	11,640.8	12,286.8	13,764.0	15,864.8	38.3%
The Czech Republic	16,607.5	17,740.8	18,027.0	19,970.8	21,869.1	31.7%
Denmark	4789.2	4505.1	5363.3	6481.6	6678.5	39.5%
Germany	38,880.0	45,555.7	51,389.8	61,255.2	65,867.4	69.4%
Spain	139,194.2	155,363.5	175,474.9	190,653.6	216,461.7	55.5%
France	72,823.8	71,734.5	67,309.3	73,552.9	70,245.4	−3.5%
Croatia	18,415.2	17,604.6	18,054.4	18,891.9	20,873.8	13.4%
Italy	101,468.0	110,491.7	120,014.0	127,373.7	131,178.7	29.3%
Cyprus	13,899.1	13,151.0	12,933.0	12,872.9	14,115.3	1.6%
Hungary	9126.5	8488.5	8774.4	10,653.1	11,846.9	29.8%
Malta	7217.6	7416.7	7181.2	8182.7	8351.1	15.7%
The Netherlands	15,196.1	15,084.0	16,701.6	20,218.4	23,056.8	51.7%
Austria	56,690.3	60,468.7	59,147.0	61,829.8	65,243.8	15.1%
Poland	7856.3	7939.3	8397.4	10,667.2	12,918.2	64.4%
Portugal	23,981.9	26,428.8	26,233.0	33,230.3	38,265.9	59.6%
Finland	3886.5	4757.9	4713.8	4795.2	4973.2	28.0%
Romania	3357.6	3250.6	2977.7	3503.5	4399.6	31.0%
Sweden	5382.2	5830.4	6363.1	7421.4	8842.6	64.3%
Norway	4761.1	4893.8	4898.9	5428.0	6626.9	39.2%
Switzerland	18,298.1	21,478.3	19,707.6	19,737.5	19,261.9	5.3%

Source: Eurostat, 2017a.

4. Results

4.1. Tourism demand and trend in hotels and similar establishments in European Countries

By considering annual values of overnight stays in hotels and similar establishments for the 21 selected countries, in absolute terms Germany displays the highest values of overnight stays made by residents (approximately 214 million in 2016), followed by France and Italy (133.64 and 133.63 million respectively) and Spain (113.48 million) (Table 1); all the other countries have much lower values. Even considering that European countries have different population sizes, those in the upper ranks show the highest values regarding the domestic demand for tourism in hotels and similar establishments, with approximately 3.5 annual overnight stays per resident for Germany and about 2.3 each for France, Italy and Spain. For the same year, Spain scored the highest value of overnight stays made by non-residents with a value of about 216 million, followed by Italy (131.18 million). This is in sharp contrast to the following countries: France (70.25 million), Germany (65.87 million) and Austria (65.24 million) (Table 2).

A marked contrast is revealed from an analysis of the results in Tables 1 and 2 on the European level in terms of absolute values and the trend of overnight stays in hotels and similar establishments. The residents series for east European countries (such as: Bulgaria, Czech Republic, Hungary and Poland) (Table 1) show a considerable increase in overnight stays for the period 2005–2016 with a growth rate greater than 60%. A similar trend in domestic demand, but less pronounced, may be observed for western European and north European countries (such as: Belgium, Netherlands, Germany, Denmark, Sweden and Norway); overnight stays made by residents in hotels and similar establishments in Finland ‘only’ grew by 12% between 2005 and 2016. Positive values for growth change can be observed for almost all the other European countries but generally with less pronounced values, compared to the growth experienced by east European countries. Cyprus, Croatia and Italy are the only countries which have experienced a decrease in overnight stays made by residents for the period

2005–2016, with percentage changes equal to −24.5%, −16.5%, and −2.4% respectively. An analysis of the change in overnight stays between 2008 and 2011 reveals the impact of the financial crisis in 2008 on tourism made by residents of many of the countries under consideration in this paper (Papatheodorou, Rosselló, & Xiao, 2010; Smeral, 2009).

It has already been mentioned that, in terms of the trend of overnight stays made by non-residents, Spain and Italy predominate in absolute values, although direct comparisons must take into account the different classification systems adopted by each member country (ECC-NET, 2009). Nonetheless, a remarkable increase during the time period under consideration (2005–2016) may be observed for countries, such as Germany (+69.4%), Poland (+64.4%), Sweden (+64.3%), and Portugal (+59.6%). However, almost all the countries in this study displayed a marked growth rate in the same period, excluding France which displayed a marginal decrease of −3.5% of overnight stays made by non-residents.

Regarding the composition of tourism demand, Malta, Cyprus and Croatia predominate markedly in overnight stays made by non-residents, compared to those made by residents. However, Bulgaria, Portugal, Austria, Czech Republic, Belgium, Spain and Switzerland have a ratio of overnight stays made by non-residents to those made by residents, which is greater than 1. On the other hand, Finland, Germany and Sweden are the countries in which overnight stays made by residents particularly prevail, compared to those made by non-residents (with a ratio equal to approximately 0.3). And a similar situation may be observed for Romania, Norway, Poland, and France. Finally, Italy, Netherlands, Hungary and Denmark show a ratio of about 1. Nonetheless, the composition of overnight stays varied during the time period under consideration, especially for east European countries, which experienced marked growth rates resulting from internal demand.

4.2. Seasonal patterns across European Countries

Having derived seasonal factors as ratio-to-moving averages, an analysis of seasonal patterns can be performed. A preliminary evaluation of pattern stability has been made by means of an analysis of the ranking of months for all the years considered. In Table 3, the results of Kendall's *W* multiple rank correlation coefficient show very high values which, in almost all cases, approximate to one, thereby indicating a very high degree of the pattern stability of seasonal swings. Only the series related to the residents in Cyprus and Malta show values lower than 0.9, and this may also be due to the low value of resident population, which in turn determines a lower pattern stability due to small changes in travel propensity. In all other cases, it can be concluded that

Table 3
Kendall's W multiple rank correlation coefficient among ranking of months for seasonal factors of overnight stays in hotels and similar establishments, made by residents and non-residents for selected European Countries, years 2006–2015.

	Kendall's W			Kendall's W	
Country	Residents	Non-residents	Country	Residents	Non-residents
BE	0.950	0.926	MT	0.780	0.996
BG	0.978	0.959	NL	0.961	0.970
CZ	0.982	0.965	AT	0.978	0.967
DK	0.972	0.992	PL	0.943	0.988
DE	0.981	0.964	PT	0.959	0.990
ES	0.964	0.995	RO	0.979	0.976
FR	0.975	0.968	FI	0.981	0.978
HR	0.976	0.992	SE	0.954	0.976
IT	0.969	0.991	NO	0.959	0.959
CY	0.817	0.995	CH	0.971	0.952
HU	0.945	0.992			

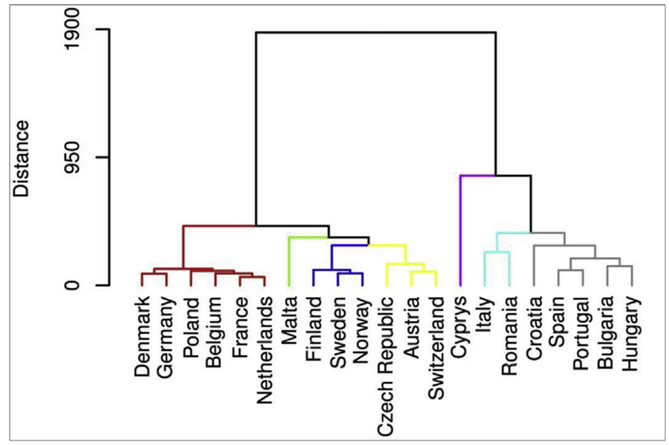

Fig. 1. Dendrogram and clusters of seasonal patterns for overnight stays made by residents in hotels and similar establishments.

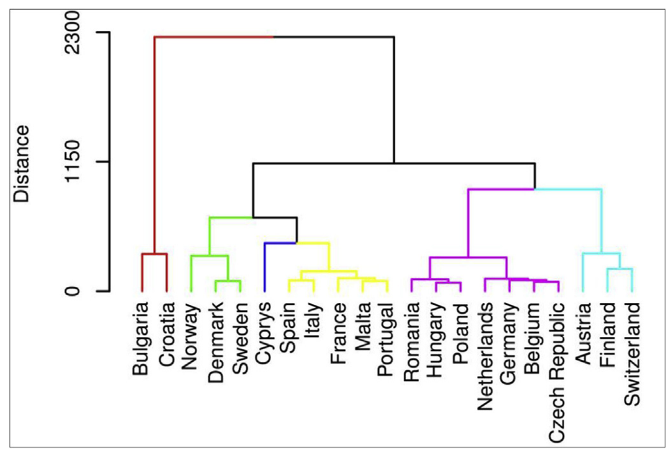

Fig. 2. Dendrogram and clusters of seasonal patterns for overnight stays made by non-residents in hotels and similar establishments.

the pattern of seasonality in European countries remained almost unchanged in the 10 year time period being considered. This stability is particularly surprising, taking in to account the relevant demographic changes in European populations, as well as the economic and social changes occurring in the same time period.

In order to group the countries studied in this paper according to a pattern of seasonality, Figs. 1 and 2 have been compiled to show the dendrograms for residents' and non-residents' seasonal factors series, together with the resulting clusters. A preliminary analysis of seasonal factors has highlighted marked differences among the series under consideration, with a maximum value in peak season for the residents' series for Cyprus equal to 385 and a minimum in the off season equal to 35.6. Those non-residents with the highest value were observed in Bulgaria, with a value of 328, with Croatia having a minimum value equal to 6. On the other hand, the lowest seasonal value for the residents' series was observed in the Netherlands, with a maximum value of 132.3 in the peak season; the highest off season value was observed in Poland with a minimum value of 77.5. Similarly, for the non-residents' series, Belgium exhibited the lowest peak with a maximum value of 125.4, and Germany displayed the highest off season value, that of the lowest seasonal factor equal to 65.7. Paradoxically and despite its persistent nature, tourism seasonality displays a high degree of variability according to the specific country and tourist segment under consideration.

Several considerations can be made from an analysis of the dendrograms in Figs. 1 and 2: two main groups immediately appear at the highest value for distance among seasonal patterns for the residents'

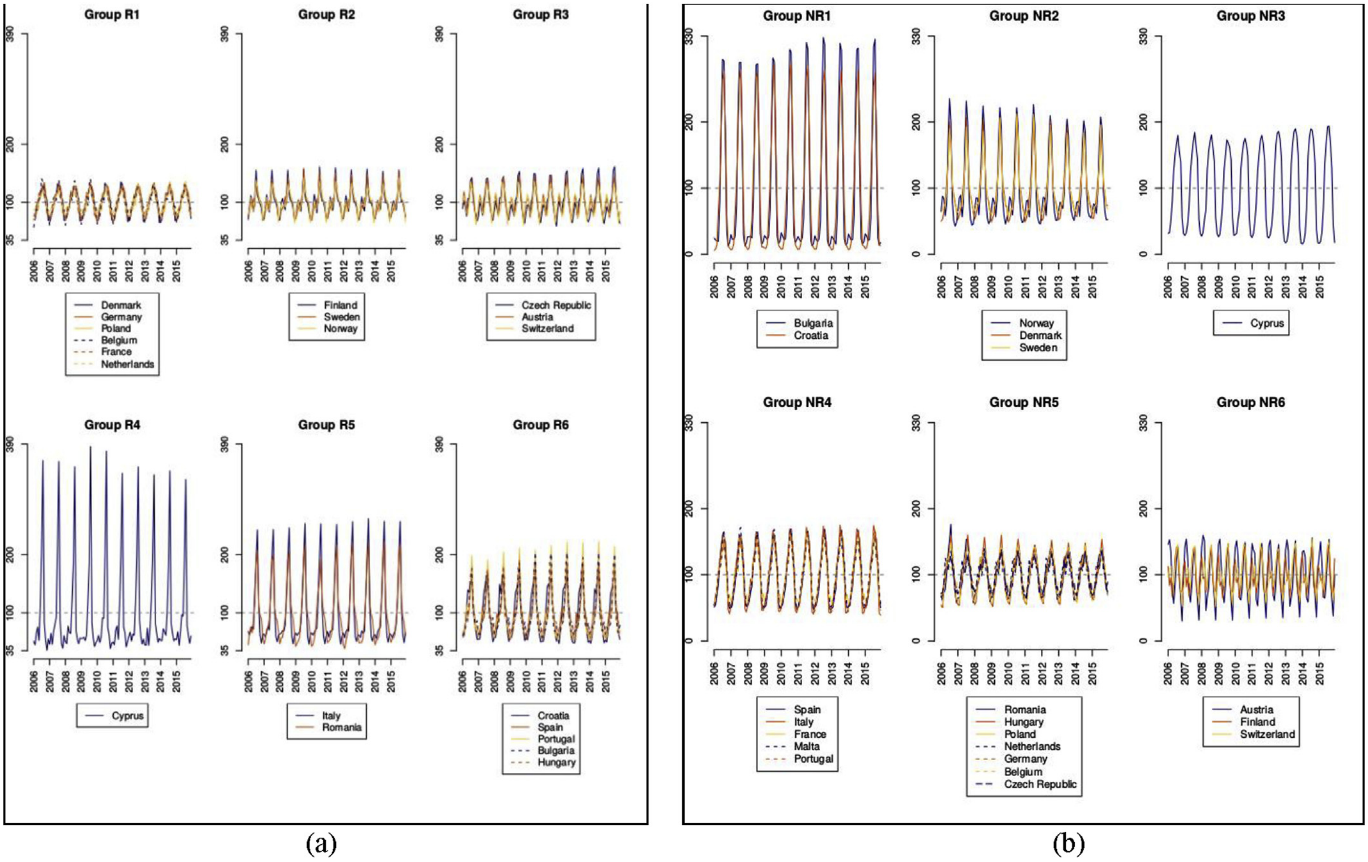

Fig. 3. Cluster patterns for seasonal factors of overnight stays made by residents (a) and non-residents (b) in hotels and similar establishments, for selected European Countries, years 2006–2015.

and non-residents' series. At the top of the dendrograms, countries with strong peaks are separated from those with less intense peaks. This holds for the residents' series, in which Cyprus, Italy, Romania, Croatia, Spain, Portugal, Bulgaria and Hungary are separated from the remaining countries, and for Bulgaria and Croatia, if the non-residents' series is considered. In order to improve an evaluation of the similarities and differences among seasonal patterns, seven groups were identified for the residents' series and six groups for the non-residents' series. As highlighted in Fig. 3a and b, these groups show a high degree of similarity among countries belonging to the same cluster and well differentiated patterns among clusters.

By excluding Malta, which displays a rather irregular pattern as already highlighted in the analysis of pattern stability for the residents' series (its residents' series pattern is reported in Appendix B), the distinctive feature which emerges from an analysis of the clusters in Fig. 3a and b seems to be the seasonal range, and the intensity of seasonal peaks. This is of greater intensity for countries belonging to Clusters 4, 5 and 6 for the residents' series, and for those belonging to Clusters 1, 2 and 3 for the non-residents' series, compared to the other clusters. However, another compelling feature is the pattern of seasonal swing. The considered patterns can be traditionally classified into one peak and two-peaks, but, within these groups, there are very different situations according to the intensity of seasonal peaks.

Clusters 1, 4, 5 and 6 for the residents' series are uni-modal but with a different intensity of seasonal peak; Clusters 2 and 3 are bimodal, with a relatively higher intensity of the winter peak for Cluster 3 when compared to Cluster 2. The situation is similar for the non-residents' series, but, in this case, only cluster 6 can be classified as a *two peaks cluster*.

In order to explore the link between seasonality and geographical factors, clusters of seasonal patterns for residents' (a) and non-residents' (b) series are mapped in Fig. 4. The analysis of the spatial distribution of clusters highlights a strong geographical component of seasonality. Specifically, Cluster 1 of the residents' series comprises west European countries, with an uni-modal seasonal pattern, characterized by a non-intense peak of seasonality. Cluster 6 comprises many Mediterranean countries, such as Spain, Portugal, and Croatia, but also Bulgaria and Hungary fall within this group. The tourism habits of residents in terms of holiday period seems to also be markedly similar for countries belonging to Cluster 6, with a higher seasonal peak compared to Cluster 1. Finally, of the uni-modal patterns, Italy and Romania, and even more so Cyprus, constitute the clusters with the highest seasonal peak.

A clear, spatial characterization of seasonality is also evident for bi-modal clusters of residents' series. Cluster 3 (comprising Austria, Czech Republic and Switzerland) are closely located in mountain regions as potential determinants of their bi-modal pattern. However, common institutional factors may determine the strong degree of similarity of seasonal patterns. Similar considerations hold for Cluster 2 which comprises all the Scandinavian countries, which are likely to share not only similar, climatic and environmental conditions but also cultural habits and institutional factors.

A spatial characterization of seasonal pattern is also revealed for non-residents' series (see Fig. 4b) but the spatial distribution of clusters is only partially similar to that observed for the residents' series. This indicates differences in the determinants of seasonality which are related to the source markets of interest for the two series. A high degree of similarity is confirmed for west European countries, belonging to Cluster 5, but, in this case, France has not been included, more resembling Spain, Portugal and Italy in terms of seasonal pattern. Similarities in the demands of non-residents' tourism as well as the tourism product offered (typically, cultural and sun-and-sand tourism) may account for this composition.

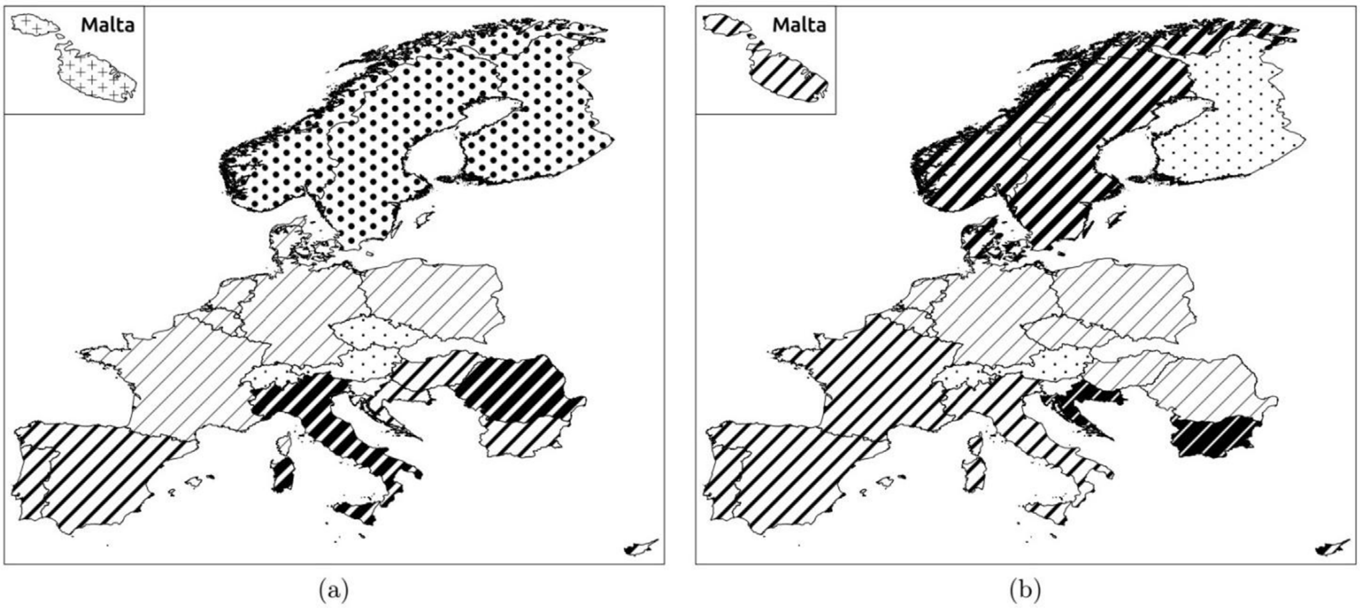

Fig. 4. Pattern clusters of seasonal factors of overnight stays made by residents (a) and non-residents (b) in hotels and similar establishments, for selected European Countries, years 2006–2015.

Sweden and Norway non-residents' series are separated from Finland, having more in common with Denmark in this regard. Despite the fact that a spatial characterization also holds in this case, the determinants of these differences (compared to the residents' series) may highlight important considerations related to the tourism market structure of these countries; this would be so in order to orient counter-seasonal policies. Austria and Switzerland are also characterized by a bi-modal seasonal pattern for non-residents' series, as is the case with Finland. Similarities in tourism products, marketing strategies and the composition of tourism demand may explain the characterization of seasonality as regards this group of countries. Moreover, the observed pattern at the aggregate level is the result of several seasonal profiles which depend on the specific tourist segment under consideration, from supply (tourism product) and demand (tourist profiles) points of view. Finally, Croatia and Bulgaria appear to share similarities with their non-residents' series, with a more pronounced summer peak. The difference in seasonality pattern with neighbouring countries, such as Hungary, may suggest strategies for the development of counter-seasonal policies.

4.3. Seasonal amplitude across European Countries

Having performed an analysis of seasonality patterns, an analysis of seasonal amplitude may be conducted. The aim of this is to evaluate the degree of seasonal imbalance within each cluster, and to make considerations regarding comparisons among countries belonging to different clusters. Tables 4 and 5 report the results of the relative seasonality index for residents' and non-residents' series respectively. An initial comment relates to the general degree of stability of seasonal amplitude for almost all the countries throughout all the years under consideration, with only little or no variation. Nonetheless, there are some situations in which a general tendency toward an increase or a decrease in seasonal amplitude may be recognized. This concerns the residents' series relating to Poland, Bulgaria, Portugal and the Czech Republic and the non-residents' series for Belgium, Italy, Portugal and Cyprus; they all express a slight increase in imbalance during the time period being considered. On the other hand, the residents' series for Cyprus exhibits a decrease in seasonal amplitude, as well as the non-residents' series for Hungary, Poland and Romania.

However, the most evident variability in relative seasonality indices relates to differences among countries, both within the same cluster and between clusters. Having grouped similar patterns in the analysis, it is indeed possible to determine which countries will express a higher degree of seasonal amplitude, both within and between clusters. In 2015, Denmark had the highest degree of seasonal concentration, followed by Germany and Belgium within Cluster 1 of residents' series. Croatia and Portugal displayed a higher degree of imbalance for Cluster 6, compared to the other countries of their cluster. And, regarding the bi-modal seasonal patterns of countries belonging to Cluster 3, the Czech Republic showed a much higher degree of seasonal concentration, when compared to Austria and Switzerland. The non-residents' series relating to Hungary, Romania and Poland are the most seasonal countries within Cluster 5, whereas Italy shows a higher seasonal imbalance, as compared to the other countries in Cluster 4.

In terms of comparison between clusters, the residents' series relating to Cyprus displays the highest degree of imbalance whereas the non-residents' series for Bulgaria and Croatia show a much higher degree of seasonality, compared to the other countries. Of the uni-modal clusters relating to the residents' series, a decreasing order of seasonal amplitude can be established for Cluster 4, 5, 6 and 1. Regarding the non-residents' series, Cluster 1 shows the greater imbalance, followed by Clusters 3, 2, 4 and 5. By observing the bi-modal patterns, the general degree of imbalance is relatively similar to Cluster 2 and 3 of the residents' series, and the results of the non-residents' series are comparable to those related to Cluster 6 (the only bi-modal pattern).

In concluding, the results of the three indices for 2015 are reported in Tables 6 and 7. Here the proposed *Relative Seasonality Index* (S_R) is compared to the more classic indices used for measuring seasonal concentration in tourism, namely the Gini concentration index (G) and the Theil index (T). Generally, a high degree of agreement is evident in the rankings of countries produced by the indices under consideration. For example, it can be observed that all the three indices classify Cyprus (for the residents' series) and Bulgaria (for the non-residents' series) as the countries with the highest degree of seasonality. According to intra-cluster rankings, the indices being considered produce the same results for the residents' series, whereas only small differences appear in the case of Clusters 5 and 6 for the non-residents' series. However, more important differences appear for both residents' and non-residents' series if the overall rankings are considered. This occurs with Austria and Switzerland for the residents' series, in which the bi-modal pattern of these series has not been adequately measured by the Gini and the

Table 4
Relative Seasonality Index for seasonal factors of overnight stays in hotels and similar establishments made by residents according to cluster membership of selected European Countries, years 2006–2015.

Cluster	Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cluster 1	Belgium	0.135	0.112	0.109	0.108	0.111	0.111	0.093	0.105	0.093	0.104
	Denmark	0.111	0.114	0.110	0.113	0.118	0.127	0.118	0.121	0.113	0.115
	Germany	0.114	0.114	0.110	0.119	0.120	0.119	0.109	0.112	0.111	0.109
	France	0.093	0.091	0.093	0.101	0.101	0.100	0.095	0.097	0.097	0.095
	The Netherlands	0.102	0.090	0.093	0.098	0.098	0.092	0.096	0.102	0.096	0.090
	Poland	0.065	0.065	0.066	0.082	0.080	0.082	0.083	0.096	0.096	0.100
Cluster 2	Finalnd	0.100	0.102	0.101	0.108	0.102	0.103	0.101	0.106	0.103	0.099
	Sweden	0.088	0.093	0.099	0.120	0.116	0.111	0.102	0.107	0.106	0.110
	Norway	0.088	0.083	0.084	0.100	0.097	0.090	0.085	0.084	0.092	0.101
Cluster 3	Austria	0.070	0.074	0.070	0.070	0.072	0.077	0.070	0.072	0.072	0.072
	The Czech Republic	0.097	0.114	0.103	0.124	0.122	0.126	0.119	0.127	0.144	0.143
	Switzerland	0.070	0.066	0.071	0.073	0.068	0.067	0.063	0.066	0.061	0.062
Cluster 4	Cyprus	0.370	0.362	0.341	0.379	0.372	0.351	0.344	0.360	0.336	0.323
Cluster 5	Italy	0.258	0.273	0.270	0.275	0.276	0.278	0.279	0.287	0.279	0.282
	Romania	0.237	0.241	0.256	0.291	0.251	0.269	0.303	0.287	0.283	0.273
Cluster 6	Bulgaria	0.177	0.170	0.171	0.181	0.212	0.233	0.220	0.202	0.195	0.204
	Spain	0.169	0.171	0.172	0.189	0.184	0.190	0.184	0.185	0.193	0.193
	Croatia	0.206	0.226	0.217	0.213	0.227	0.233	0.229	0.244	0.243	0.233
	Hungary	0.173	0.159	0.167	0.193	0.172	0.158	0.169	0.182	0.173	0.173
	Portugal	0.177	0.171	0.185	0.210	0.190	0.216	0.234	0.236	0.235	0.225

Theil indices. The latter classify these countries in an intermediate position of the ranking whereas they occupy final positions, according to the relative seasonality index values. On the contrary, Belgium, which is classified as 17th by the Gini and the Theil index, occupies 13th position if the relative seasonality index is considered. The reason for this result is related to seasonal pattern: for Austria and Switzerland, it is bi-modal with peaks concentrated into two distinct periods in the year, thereby determining a reduction in the value of the relative seasonal index. This feature is not well captured by the Gini and the Theil indices, which are insensitive to the distribution of seasonal factors varying across the months of any given year.

Similar considerations hold for the non-residents' series, in which Austria has been classified with similar Gini and the Theil index values to France, whereas a much lower value would be obtained if the relative seasonality index had been considered. Whilst Finland and the Netherlands share similar values for the G and T coefficients, Finland displays a much lower degree of seasonality according to the relative seasonality index. It is clear that any consideration related to the evaluation of the degree of seasonality could be misleading if the timing characterizing seasonal fluctuations is not fully taken into account.

5. Discussion and conclusion

The authors of this paper have proposed a general approach for the analysis and measurement of seasonality in tourism which allows for: a description of seasonal patterns as an initial step of analysis and, in a second step, a measurement of seasonal amplitude, taking into account the cyclical structure of time periods. This approach stresses that two main aspects are of great importance when analyzing tourism seasonality: the shape of the demand pattern and the intensity or amplitude of the phenomenon (Croce & Wöber, 2010); these two characteristics are inter-related.

Seasonality has long been a topic in the field of tourism studies and it is still one of the most distinctive characteristics of the tourism industry. In Europe, the tourism market presents different patterns and different degrees of seasonality in different countries, in which several states are competitors for the same demand segments, competing for intra- and extra-European tourism. Nonetheless, in-depth analyses of tourism seasonality at the European level are conspicuous by their absence and – when present in the literature – they are limited to various specific, regional or national contexts.

Indeed, the level of tourism demand at a given destination (e.g. national countries), as measured by a specific tourism indicator, namely overnight stays in hotels and similar establishments, at a certain time interval (month), may depend on a variety of factors. Environmental, institutional, social and cultural factors interact among themselves in determining the observed level of the considered indicator of tourism demand at a certain destination. These interactions are related to the characteristics of the tourism segment considered, as well as to the region of origin and destination. Push and pull factors causing seasonality (Lundtorp, Rassing, & Wanhill, 1999) interact among themselves with results, in terms of the direction of the relationship, and intensity which are difficult to determine. Moreover, even the intensity and the sign of the relationship may depend on the level of other factors. For example, institutional factors which are typical of a particular tourist region of origin may influence tourist flows differentially, depending on the specific tourist segments being considered. Typically, older adult and the retired are less influenced by school breaks than other tourist segments. The seasonality of tourist flows to a given destination depends on this complex interplay of factors. We have,

Table 5
Relative Seasonality Index for seasonal factors of overnight stays in hotels and similar establishments made by non-residents according to cluster membership of selected European Countries, years 2006–2015.

Cluster	Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cluster 1	Bulgaria	0.541	0.529	0.522	0.531	0.530	0.564	0.572	0.565	0.550	0.547
	Croatia	0.539	0.536	0.534	0.529	0.536	0.536	0.525	0.517	0.519	0.514
Cluster 2	Denmark	0.248	0.242	0.235	0.242	0.256	0.252	0.238	0.229	0.210	0.220
	Sweden	0.213	0.216	0.200	0.226	0.241	0.248	0.212	0.198	0.199	0.212
	Norway	0.282	0.280	0.266	0.264	0.272	0.287	0.250	0.253	0.252	0.265
Cluster 3	Cyprus	0.309	0.323	0.319	0.320	0.316	0.327	0.354	0.385	0.396	0.392
Cluster 4	Spain	0.237	0.226	0.231	0.239	0.241	0.239	0.249	0.247	0.234	0.233
	France	0.185	0.173	0.173	0.193	0.202	0.201	0.191	0.194	0.191	0.197
	Italy	0.218	0.221	0.217	0.228	0.234	0.247	0.243	0.249	0.250	0.259
	Portugal	0.190	0.194	0.189	0.200	0.211	0.226	0.233	0.235	0.225	0.223
	Malta	0.207	0.220	0.208	0.210	0.224	0.206	0.210	0.199	0.198	0.193
Cluster 5	Belgium	0.077	0.076	0.073	0.078	0.085	0.092	0.078	0.086	0.085	0.102
	The Czech Republic	0.109	0.090	0.088	0.111	0.113	0.119	0.098	0.096	0.104	0.116
	Germany	0.122	0.109	0.109	0.113	0.123	0.118	0.113	0.111	0.111	0.116
	Hungary	0.196	0.179	0.174	0.182	0.177	0.160	0.159	0.157	0.140	0.153
	The Netherlands	0.114	0.092	0.099	0.116	0.116	0.125	0.124	0.121	0.116	0.119
	Poland	0.180	0.161	0.157	0.169	0.169	0.171	0.157	0.153	0.154	0.150
	Romania	0.196	0.184	0.147	0.143	0.155	0.151	0.163	0.155	0.153	0.151
Cluster 6	Austria	0.112	0.110	0.114	0.110	0.111	0.109	0.107	0.110	0.103	0.105
	Finland	0.077	0.074	0.063	0.072	0.067	0.066	0.063	0.064	0.063	0.065
	Switzerland	0.089	0.088	0.088	0.084	0.097	0.098	0.089	0.099	0.100	0.109

therefore, decided to consider residents' and non-residents' tourist segments separately in this study. The assumption is that they could demonstrate different seasonality profiles, being influenced by the regions of destination and origin. The territorial level being considered (national, regional and local) may also play a role in the destination and origin regions. In this work, we have opted for a compromise between ease of analysis, temporal detail (monthly data) and study context (21 European Countries). All these factors led us to adopt a country-level perspective.

Given these premises, particular and novel issues highlighted in this study merit attention. The general aim of the paper regards the evaluation of seasonality across European countries and to perform a comparison, which is based on two key-aspects of seasonality: its pattern and its amplitude. From a methodological perspective, this study has proposed a two-step framework in which a classification of seasonal patterns of considered countries is performed. This is by means of a clustering approach, based on the Euclidean distance between seasonal factors, and a new index for measuring seasonality in tourism; the latter overcomes some of the limitations of the most commonly-used index, namely the anonymity property. The proposed index allows for flexibility in the determination of the cost matrix, which may be adapted to different situations and study contexts.

Whilst simple in nature and easily replicable, this innovative procedure has the advantage of being logical whilst empirically distinguishing the two stages of pattern identification and measurement of seasonal amplitude. This obviates inappropriate considerations regarding the intensity of seasonal amplitude in the absence of having first considered its pattern.

From an applied perspective, we observed a strong and persistent seasonal pattern in overnight stays during a ten-year period regarding the European countries being analysed. Nonetheless, seasonality patterns differ among countries and in relation to the specific aggregate considered, i.e. the tourism practices of residents and non-residents. The application of cluster analysis to a seasonal factors' series enabled a classification of the main seasonality patterns of European countries; it also highlighted a strong spatial seasonality component, which may depend on climatic and institutional factors, as well as the characteristics of tourism products and marketing strategies. An analysis of the similarities of seasonal patterns may be particularly useful in identifying competitors and potential markets for counter-seasonal policies. From this point of view, the approach proposed in this paper may be seen as a tool for monitoring and benchmarking an analysis for supporting tourism development strategies (Croce & Wöber, 2010).

The analysis of seasonal amplitude revealed little or no variation in seasonality in the considered time period, rendering tourism seasonality as a constant management challenge (Pike & Page, 2014). The index proposed in this study incorporates the factor of timing, which characterizes seasonal fluctuations, into the analysis. Beyond providing a more appropriate measurement of seasonal amplitude, this approach highlights the importance of evaluating the impact of seasonality, not only in terms of inequality among seasonal factors over a given time period but also by considering the temporal distribution as a key element of seasonal fluctuations.

The marked degree of pattern and seasonality amplitude stability observed on the European level elicits several reflections regarding the validity and effectiveness of policy and marketing initiatives, which are oriented towards a rebalancing of tourism demand. Moreover, this approach suggests future paths of research: what determines the regular

Table 6
Relative Seasonality Index (S_R), Gini concentration index (G), and Theil index (T)relating to the seasonal factors of overnight stays in hotels and similar establishments made by residents for selected European Countries, year 2015.

Cluster	Country	S_R	G	T	Within Rank			Overall Rank		
					S_R	G	T	S_R	G	T
Cluster 1	Belgium	0.1044	0.1044	0.0174	3	3	3	13	17	17
	Denmark	0.1149	0.1153	0.0210	1	1	1	10	10	10
	Germany	0.1091	0.1119	0.0204	2	2	2	12	11	12
	France	0.0952	0.0985	0.0154	5	5	5	17	19	19
	The Netherlands	0.0895	0.0932	0.0137	6	6	6	18	20	20
	Poland	0.1001	0.1034	0.0173	4	4	4	15	18	18
Cluster 2	Finland	0.0995	0.1076	0.0202	3	2	2	16	15	13
	Sweden	0.1104	0.1102	0.0207	1	1	1	11	13	11
	Norway	0.1012	0.1073	0.0186	2	3	3	14	16	16
Cluster 3	Austria	0.0720	0.1105	0.0195	2	2	2	19	12	14
	The Czech Republic	0.1431	0.1557	0.0399	1	1	1	9	9	9
	Switzerland	0.0623	0.1091	0.0189	3	3	3	20	14	15
Cluster 4	Cyprus	0.3230	0.3458	0.2329	1	1	1	1	1	1
Cluster 5	Italy	0.2820	0.2976	0.1592	1	1	1	2	2	2
	Romania	0.2732	0.2714	0.1227	2	2	2	3	3	3
Cluster 6	Bulgaria	0.2043	0.2154	0.0845	3	3	3	6	6	6
	Spain	0.1928	0.2024	0.0655	4	4	4	7	7	7
	Croatia	0.2329	0.2346	0.0861	1	1	2	4	4	5
	Hungary	0.1728	0.1786	0.0590	5	5	5	8	8	8
	Portugal	0.2249	0.2327	0.0893	2	2	1	5	5	4
Cluster 7	Malta	0.0541	0.0839	0.0125	1	1	1	21	21	21

behaviour of tourism seasonality, despite the marked changes in absolute terms, which was observed for all the countries under consideration? Why do residents typically choose the same holiday period? What are the social, cultural and institutional factors exerting strong influences on the tourist decision-making processes, which characterize the demand of European tourism?

For those who are interested in social phenomena, it is common to observe changes in human behaviours and attitudes, but, quite surprisingly, this is not the case here. Departing from the general causes of seasonality, various particular features which characterize European tourism demand can be highlighted. It is interesting to note how climatic and environmental factors only partially influence tourism decisions. Indeed, climatic conditions in many countries, including those bordering the Mediterranean, would allow for greatly extended 'sun and sand' or cultural holiday periods. The persistent concentration observed with the majority of countries and the spatial clustering of seasonal patterns suggest only a partial influence of climatic factors in determining seasonal fluctuations in tourism demand. Initially, institutional factors (related to school and work timetables) and socio-cultural factors seem to be more causal in determining tourism seasonality. This may regard the generating and the destination regions; these factors are generally hard to modify or influence via simple marketing and promotion strategies. The authors of this paper contend that the role of the public sector in reducing tourism seasonality, for example, through changes in holiday periods, should receive greater attention (Pike & Page, 2014). Nonetheless, these actions should be accompanied by diversification strategies in the tourism product, since different seasons create demand for different products, requiring alternative presentation, packaging and pricing (Baum & Hagen, 1999).

Inevitably, there are limitation to this study: the first relates to the specific tourism segment and tourism indicator considered, namely overnight stays in hotels and similar establishments. A more comprehensive analysis of other accommodation categories may highlight different patterns of seasonality, both in terms of pattern and amplitude. This point is also related to the need for a harmonization of tourism statistics among European Countries, as well for sector-specific analyses, which may suggest counter-seasonal strategies in relation to specific tourism markets. A second limitation relates to the geographical scale being considered. Yacoumis (1980) has suggested that it is necessary to analyze seasonality on three levels: national, regional and sectoral. Although the application of a new approach proposed in this paper covers a 10 year time frame and 21 European countries, a region-specific analysis for each European country may assist in identifying the underlining determinants of aggregate patterns, and suggest targeted marketing policies. Regrettably, no regional data are provided on a monthly basis on a European level and thus a detailed regional analysis of seasonality is not yet possible. However, given the availability of regional monthly data for several European countries, as a future line of research, the methodology proposed could be implemented at regional level in order to highlight region-specific features

Table 7
Relative Seasonality Index (S_R), Gini concentration index (G), and Theil index (T) for seasonal factors of overnight stays in hotels and similar establishments made by non-residents for selected European Countries, year 2015.

Cluster	Country	S_R	G	T	Within Rank			Overall Rank		
					S_R	G	T	S_R	G	T
Cluster 1	Bulgaria	0.5468	0.5586	0.5591	1	1	1	1	1	1
	Croatia	0.5140	0.5154	0.4617	2	2	2	2	2	2
Cluster 2	Denmark	0.2198	0.2150	0.0731	2	2	2	8	8	8
	Sweden	0.2117	0.2057	0.0714	3	3	3	9	9	9
	Norway	0.2649	0.2729	0.1264	1	1	1	4	4	4
Cluster 3	Cyprus	0.3918	0.3887	0.2709	1	1	1	3	3	3
Cluster 4	Spain	0.2326	0.2358	0.0890	2	2	2	6	6	6
	France	0.1971	0.2010	0.0649	4	4	4	10	11	11
	Italy	0.2586	0.2669	0.1124	1	1	1	5	5	5
	Portugal	0.2226	0.2256	0.0835	3	3	3	7	7	7
	Malta	0.1931	0.1933	0.0595	5	5	5	11	12	12
Cluster 5	Belgium	0.1021	0.1043	0.0183	7	7	7	20	21	21
	The Czech Republic	0.1161	0.1208	0.0225	6	5	5	17	19	19
	Germany	0.1163	0.1176	0.0216	5	6	6	16	20	20
	Hungary	0.1529	0.1568	0.0380	1	1	1	12	13	13
	The Netherlands	0.1188	0.1250	0.0242	4	4	4	15	18	18
	Poland	0.1499	0.1495	0.0353	3	3	3	14	15	15
	Romania	0.1514	0.1509	0.0363	2	2	2	13	14	14
Cluster 6	Austria	0.1054	0.2016	0.0661	2	1	1	19	10	10
	Finland	0.0648	0.1329	0.0272	3	3	3	21	17	17
	Switzerland	0.1090	0.1364	0.0301	1	2	2	18	16	16

and the causes of tourism seasonality.

Finally, the results of this study do not provide an explanation of the impact of social phenomena on tourism seasonality (the so-called 'institutionalised seasonality'), whose relationships with cultural factors and their link with climate factors varies according to the context under analysis. Subsequently a more in-depth analysis of the causes of seasonality and of its relationship with observed patterns may assist private actors, DMOs, and policy-makers in identifying more effective counter-seasonal actions. In considering the persistent nature of seasonality in the tourism market, its measurement and analysis are still challenging topics in tourism research today.

Appendix A

The matrix used for defining transportation costs is based on the concept of *cyclical distance* between time periods, according to a circular representation of the months of the year (Figure A.1).

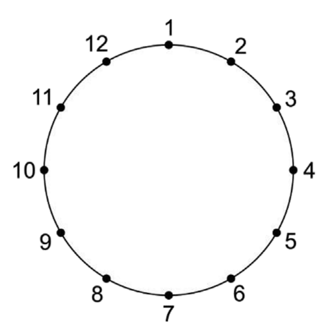

Fig. A.1. Circular representation of the months of the year.

According to this perspective, the cyclical distance $\{c_{ij}\}$ between i and j can be defined as:

$$c_{ij} = \begin{cases} |i-j| & \text{if } |i-j| \le \frac{N}{2} \\ N - |i-j| & \text{otherwise} \end{cases} \tag{8}$$

The cost matrix deriving from this definition is:

$$C = \begin{bmatrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 5 & 4 & 3 & 2 & 1 \\ 1 & 0 & 1 & 2 & 3 & 4 & 5 & 6 & 5 & 4 & 3 & 2 \\ 2 & 1 & 0 & 1 & 2 & 3 & 4 & 5 & 6 & 5 & 4 & 3 \\ 3 & 2 & 1 & 0 & 1 & 2 & 3 & 4 & 5 & 6 & 5 & 4 \\ 4 & 3 & 2 & 1 & 0 & 1 & 2 & 3 & 4 & 5 & 6 & 5 \\ 5 & 4 & 3 & 2 & 1 & 0 & 1 & 2 & 3 & 4 & 5 & 6 \\ 6 & 5 & 4 & 3 & 2 & 1 & 0 & 1 & 2 & 3 & 4 & 5 \\ 5 & 6 & 5 & 4 & 3 & 2 & 1 & 0 & 1 & 2 & 3 & 4 \\ 4 & 5 & 6 & 5 & 4 & 3 & 2 & 1 & 0 & 1 & 2 & 3 \\ 3 & 4 & 5 & 6 & 5 & 4 & 3 & 2 & 1 & 0 & 1 & 2 \\ 2 & 3 & 4 & 5 & 6 & 5 & 4 & 3 & 2 & 1 & 0 & 1 \\ 1 & 2 & 3 & 4 & 5 & 6 & 5 & 4 & 3 & 2 & 1 & 0 \end{bmatrix} \quad (9)$$

Appendix B

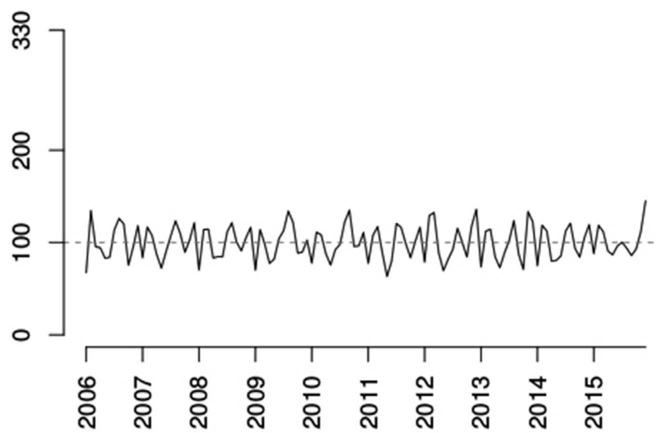

Fig. B.1. Seasonal factors of overnight stays made by residents in hotels and similar establishments in Malta, years 2006–2015.

References

Ahas, R., Aasa, A., Mark, Ü., Pae, T., & Kull, A. (2007). Seasonal tourism spaces in Estonia: Case study with mobile positioning data. *Tourism Management, 28*(3), 898–910. http://dx.doi.org/10.1016/j.tourman.2006.05.010.

Amelung, B., Nicholls, S., & Viner, D. (2007). Implications of global climate change for tourism flows and seasonality. *Journal of Travel Research, 45*(3), 285–296. http://dx.doi.org/10.1177/0047287506295937.

Aroca, P., Brida, J. G., & Volo, S. (2016). Tourism statistics. Correcting data inadequacy. *Tourism Economics, 23*(1), 99–112. http://dx.doi.org/10.5367/te.2015.0500.

Ashworth, J., & Thomas, B. (1999). Patterns of seasonality in employment in tourism in the UK. *Applied Economics Letters, 6*(11), 735–739. http://dx.doi.org/10.1080/135048599352312.

Ball, R. M. (1988). Seasonality: A problem for workers in the tourism labour market? *Service Industries Journal, 8*(4), 501–513. http://dx.doi.org/10.1080/02642068800000068.

BarOn, R. V. (1975). *Seasonality in tourism — a guide to the analysis of seasonality and trends for policy making. Technical series No. 2.* London: The Economist Intelligence Unit Ltd.

Batista, G. E., Wang, X., & Keogh, E. J. (2011). A complexity-invariant distance measure for time series. *Proceedings of the 2011 SIAM international conference on data mining* (pp. 699–710). Society for Industrial and Applied Mathematics. http://dx.doi.org/10.1137/1.9781611972818.60.

Baum, T., & Hagen, L. (1999). Responses to seasonality: The experiences of peripheral destinations. *International Journal of Tourism Research, 1*(5), 299–312. http://dx.doi.org/10.1002/(SICI)1522-1970(199909/10)1:5<299::AID-JTR198>3.0.CO;2-L.

Baum, T., & Lundtorp, S. (2001). Seasonality in tourism: An introduction. In T. Baum, & S. Lundtorp (Eds.). *Seasonality in tourism* (pp. 1–4). Oxford: Pergamon.

Bender, O., Schumacher, K. P., & Stein, D. (2005). Measuring seasonality in Central Europe's tourism - how and for what? *Proceedings of the 10th international conference on information and communication technologies (ICT) in urban planning and spatial development and impacts of ICT on physical space* (pp. 303–309). . url: http://conference.corp.at/archive/CORP2005_BENDER.pdf.

Butler, R. W. (1994). *Seasonality in Tourism: Issues and implications. A. Seaton (Ed.) Tourism: The state of the art (pp. 332–339).* Chichester: Wiley.

Butler, R. W. (2001). Seasonality in tourism: Issues and implications. In T. Baum, & S. Lundtorp (Eds.). *Seasonality in Tourism*. Oxford: Pergamon.

Butler, R. W., & Mao, B. (1997). Seasonality in tourism: Problems and measurement. In P. Murphy (Ed.). *Quality management in urban tourism* (pp. 9–23). Chichester: Wiley.

Candela, G., & Figini, P. (2012). *The economics of tourism destinations.* Berlin, Heidelberg: Springer-Verlag.

Canova, F., & Hansen, B. E. (1995). Are seasonal patterns constant over time? A test for seasonal stability. *Journal of Business & Economic Statistics, 13*(3), 237–252. http://dx.doi.org/10.1080/07350015.1995.10524598.

Centre for Strategy and Evaluation Services (2013). *Enhancing the competitiveness of tourism in the EU. An evaluation approach to establishing 20 cases of innovation and good practice.* Sevenoaks: CSES. url: http://ec.europa.eu/DocsRoom/documents/4670/attachments/1/translations/en/renditions/native.

Charles-Edwards, E. (2004). *Preliminary analysis of the degree and patterns of seasonal mobility within Australia. Discussion paper number 2003/04. Queensland centre for population research, School of geography, Planning and architecture.* Brisbane, QLD: University of Queensland.

Charles-Edwards, E., & Bell, M. (2015). Seasonal flux in Australia's population geography: Linking space and time. Population. *Space and Place, 21*(2), 103–123. http://dx.doi.org/10.1002/psp.1814.

Chen, T., & Pearce, P. L. (2012). Research note: Seasonality patterns in Asian tourism. *Tourism Economics, 18*(5), 1105–1115. http://dx.doi.org/10.5367/te.2012.0163.

Cisneros-Martínez, J. D., & Fernández-Morales, A. (2015). Cultural tourism as tourist segment for reducing seasonality in a coastal area: The case study of Andalusia. *Current Issues in Tourism, 18*(8), 765–784. http://dx.doi.org/10.1080/13683500.2013.861810.

Cisneros-Martínez, J. D., McCabe, S., & Fernández-Morales, A. (2018). The contribution of social tourism to sustainable tourism: A case study of seasonally adjusted programmes in Spain. *Journal of Sustainable Tourism, 26*(1), 85–107. http://dx.doi.org/10.1080/09669582.2017.1319844.

Corduas, M., & Piccolo, D. (2008). Time series clustering and classification by the autoregressive metric. *Computational Statistics & Data Analysis, 52*(4), 1860–1872. http://dx.doi.org/10.1016/j.csda.2007.06.001.

Coshall, J., Charlesworth, R., & Page, S. J. (2015). Seasonality of overseas tourism demand in Scotland: A regional analysis. *Regional Studies, 49*(10), 1603–1620. http://dx.doi.org/10.1080/00343404.2013.859666.

Cowell, F. A. (2011). *Measuring inequality* (3rd ed.). New York: Oxford University Press.

Croce, V., & Wöber, K. (2010). Seasonality in city Tourism: Concepts and measurements. In J. A. Mazanec, & K. W. Wöber (Eds.). *Analysing international city tourism* (pp. 59–77). (2nd ed.). Wien: Springer-Verlag.

Cuccia, T., & Rizzo, I. (2011). Tourism seasonality in cultural destinations: Empirical evidence from Sicily. *Tourism Management, 32*(3), 589–595. http://dx.doi.org/10.1016/j.tourman.2010.05.008.

Dagum, E. B. (1975). Seasonal factor forecasts from ARIMA models. *Bulletin of the International statistical Institute, 46*(3), 203–216.

Dagum, E. B. (2004). Seasonality. *Encyclopedia of statistical sciences*. John Wiley & Sons, Inc..
Dantzig, G. B. (1963). *Linear programming and extensions.* Princeton: Princeton University Press.
Deery, M., Jago, L., & Fredline, L. (2012). Rethinking social impacts of tourism research: A new research agenda. *Tourism Management, 33*(1), 64–73. http://dx.doi.org/10.1016/j.tourman.2011.01.026.
Duro, J. A. (2016). Seasonality of hotel demand in the main Spanish provinces: Measurements and decomposition exercises. *Tourism Management, 52*, 52–63. http://dx.doi.org/10.1016/j.tourman.2015.06.013.
ECC-NET (2009). *Classification of hotel establishments within the EU.* The European Consumer Centres' Network. url: http://ec.europa.eu/consumers/ecc/docs/hotel_establishment_classification_EU_en.pdf.
European Commission (2007). *Communication from the commission - agenda for a sustainable and competitive European tourism. COM(2007), 621, Brussels.* url: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52007DC0621.
European Commission (2010). *Europe, the world's No 1 tourist destination – a new political framework for tourism in Europe. COM 2010, 0352 final, Brussels.* url: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex:52010DC0352.
European Commission (2015). Supporting competitive and sustainable growth in the tourism sector. *COS-TOUR-2015-3-04. Cosme work programme 2015*. url: https://ec.europa.eu/easme/sites/easme-site/files/documents/cos-tour-2015-3-04_call_description.pdf.
European Parliament (2011). Regulation (EU) No 692/2011 of the European parliament and of the Council of 6 July 2011 concerning European statistics on tourism and repealing Council directive 95/57/EC. *Official Journal of the European Union, L192*(54), 17–32.
Eurostat (2017a). *Nights spent at tourist accommodation establishments by residents/non-residents - monthly data.* Data available at: http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tin00171&plugin=1.
Eurostat (2017b). *Tourism trips of Europeans. Eurostat statistics explained.* On-line publication. url: http://ec.europa.eu/eurostat/statistics-explained/index.php/Tourism_trips_of_Europeans.
Eurostat (2017c). *Seasonality in the tourist accommodation sector. Eurostat Statistics Explained.* On-line publication. url: http://ec.europa.eu/eurostat/statistics-explained/index.php/Seasonality_in_the_tourist_accommodation_sector.
Fernández-Morales, A. (2003). Decomposing seasonal concentration. *Annals of Tourism Research, 30*(4), 942–956. http://dx.doi.org/10.1016/S0160-7383(03)00090-2.
Fernández-Morales, A., Cisneros-Martínez, J. D., & McCabe, S. (2016). Seasonal concentration of tourism demand: Decomposition analysis and marketing implications. *Tourism Management, 56*, 172–190. http://dx.doi.org/10.1016/j.tourman.2016.04.004.
Fernández-Morales, A., & Mayorga-Toledano, M. C. (2008). Seasonal concentration of the hotel demand in costa del sol: A decomposition by nationalities. *Tourism Management, 29*(5), 940–949. http://dx.doi.org/10.1016/j.tourman.2007.11.003.
Figini, P., & Vici, L. (2012). Off-season tourists and the cultural offer of a mass-tourism destination: The case of Rimini. *Tourism Management, 33*(4), 825–839. http://dx.doi.org/10.1016/j.tourman.2011.09.005.
Getz, D., & Nilsson, P. A. (2004). Responses of family businesses to extreme seasonality in demand: The case of Bornholm. *Tourism Management, 25*(1), 17–30. http://dx.doi.org/10.1016/S0261-5177(03)00067-0.
Granger, C. (1979). Seasonality: Causation, interpretation, and implications. In A. Zellner (Ed.). *Seasonal analysis of economic time series* (pp. 33–56). NBER.
Hadwen, W. L., Arthington, A. H., Boon, P. I., Taylor, B., & Fellows, C. S. (2011). Do climatic or institutional factors drive seasonal patterns of tourism visitation to protected areas across diverse climate zones in eastern Australia? *Tourism Geographies, 13*(2), 187–208. http://dx.doi.org/10.1080/14616688.2011.569568.
Hall, M. C., & Page, S. J. (2003). *Managing urban tourism.* Harlow: Pearson Education Limited.
Hartmann, R. (1986). Tourism, seasonality and social change. *Leisure Studies, 5*(1), 25–33. http://dx.doi.org/10.1080/02614368600390021.
Hillier, F. S., & Lieberman, G. J. (2014). *Introduction to operations research.* Boston MA: McGraw-Hill.
Hinch, T. D., & Jackson, E. L. (2000). Leisure constraints research: Its value as a framework for understanding tourism seasonability. *Current Issues in Tourism, 3*(2), 87–106. http://dx.doi.org/10.1080/13683500008667868.
Ioannides, D., & Petersen, T. (2003). Tourism 'non-entrepreneurship' in peripheral destinations: A case study of small and medium tourism enterprises on Bornholm, Denmark. *Tourism Geographies, 5*(4), 408–435. http://dx.doi.org/10.1080/1461668032000129146.
Joy, A., & Thomas, W. (1928). The use of moving averages in the measurement of seasonal variations. *Journal of the American Statistical Association, 23*(163), 241–252. http://dx.doi.org/10.1080/01621459.1928.10503019.
Kendall, M. G., & Smith, B. B. (1939). The problem of m rankings. *The Annals of Mathematical Statistics, 10*(3), 275–287. url: http://www.jstor.org/stable/2235668.
Koenig-Lewis, N., & Bischoff, E. E. (2003). Seasonality of tourism in wales: A comparative analysis. *Tourism Economics, 9*(3), 229–254. http://dx.doi.org/10.1177/135481660300900301.
Koenig-Lewis, N., & Bischoff, E. E. (2004). Analyzing seasonality in Welsh room occupancy data. *Annals of Tourism Research, 31*(2), 374–392. http://dx.doi.org/10.1016/j.annals.2003.12.006.
Koenig-Lewis, N., & Bischoff, E. E. (2005). Seasonality research: The state of the art. *International Journal of Tourism Research, 7*(4–5), 201–219. http://dx.doi.org/10.1002/jtr.531.
Kovacev, B. (2016). *Call for participation in BDCOMP – the big data for official statistics competition. Collaborations in research and methodology for official statistics.* url: https://ec.europa.eu/eurostat/cros/system/files/call_bdcomp.pdf.
Kulendran, N., & Wong, K. K. (2005). Modeling seasonality in tourism forecasting. *Journal of Travel Research, 44*(2), 163–170. http://dx.doi.org/10.1177/0047287505276605.
Kuznets, S. (1932). Seasonal pattern and seasonal amplitude: Measurement of their short-time variations. *Journal of the American Statistical Association, 27*(177), 9–20. http://dx.doi.org/10.1080/01621459.1932.10503223.
Li, H., Goh, C., Hung, K., & Chen, J. L. (2017). Relative climate index and its effects on seasonal tourism demand. *Journal of Travel Research,* 1–15. http://dx.doi.org/10.1177/0047287516687409.
Lim, C., & McAleer, M. (2001). Monthly seasonal variations: Asian tourism to Australia. *Annals of Tourism Research, 28*(1), 68–82. http://dx.doi.org/10.1016/S0160-7383(00)00002-5.
Li, H., Song, H., & Li, L. (2017). A dynamic panel data analysis of climate and tourism demand: Additional evidence. *Journal of Travel Research, 56*(2), 158–171. http://dx.doi.org/10.1177/0047287515626304.
López-Bonilla, J. M., López-Bonilla, L. M., & Sanz-Altamira, B. (2006). Patterns of tourist seasonality in Spanish regions. *Tourism and Hospitality Planning & Development, 3*(3), 241–256. http://dx.doi.org/10.1080/14790530601132468.
Lundmark, L. (2006). Mobility, migration and seasonal tourism employment: Evidence from Swedish mountain municipalities. *Scandinavian Journal of Hospitality and Tourism, 6*(3), 197–213. http://dx.doi.org/10.1080/15022250600866282.
Lundtorp, S. (2001). Measuring tourism seasonality. In T. Baum, & S. Lundtorp (Eds.). *Seasonality in tourism.* Oxford: Pergamon.
Lundtorp, S., Rassing, C. R., & Wanhill, S. (1999). The off-season is 'no season': The case of the Danish island of Bornholm. *Tourism Economics, 5*(1), 49–68. http://dx.doi.org/10.1177/135481669900500104.
Lusseau, D., & Higham, J. E. S. (2004). Managing the impacts of dolphin-based tourism through the definition of critical habitats: The case of bottlenose dolphins (Tursiops spp.) in doubtful sound, New Zealand. *Tourism Management, 25*(6), 657–667. http://dx.doi.org/10.1016/j.tourman.2003.08.012.
Maechler, M., Rousseeuw, P., Struyf, A., Hubert, M., Hornik, K., Studer, M., et al. (2017). *Package 'cluster'. Findings groups in Data: Cluster analysis extended Rousseeuw et al.* CRAN. url: https://cran.r-project.org/package=cluster.
Lo Magno, G. L., Ferrante, M., & De Cantis, S. (2017). A new index for measuring seasonality: A transportation cost approach. *Mathematical Social Sciences, 88*, 55–65. http://dx.doi.org/10.1016/j.mathsocsci.2017.05.002.
Martín-Martín, J. M., Jiménez-Aguilera, J. D. D., & Molina-Moreno, V. (2014). Impacts of seasonality on environmental sustainability in the tourism sector based on destination type: An application to Spain's Andalusia region. *Tourism Economics, 20*(1), 123–142. http://dx.doi.org/10.5367/te.2013.0256.
Morse, M. D., & Patel, J. M. (2007). An efficient and accurate method for evaluating time series similarity. *Proceedings of the 2007 ACM SIGMOD international conference on Management of data* (pp. 569–580). ACM. http://dx.doi.org/10.1145/1247480.1247544.
Papatheodorou, A., Rosselló, J., & Xiao, H. (2010). Global economic crisis and tourism: Consequences and perspectives. *Journal of Travel Research, 49*(1), 39–45. doi: https://doi.org/10.1177/0047287509355327.
Parroco, A., Vaccina, F., De Cantis, S., & Ferrante, M. (2012). Multi-destination trips and tourism statistics: Empirical evidences in Sicily. Economics: The Open-Access. *Open-Assessment E-Journal, 6*, 1–27. http://dx.doi.org/10.5018/economics-ejournal.ja.2012-44.
Pike, S., & Page, S. J. (2014). Destination marketing organizations and destination marketing: A narrative analysis of the literature. *Tourism Management, 41*, 202–227. http://dx.doi.org/10.1016/j.tourman.2013.09.009.
Planas, C. (1998). The analysis of seasonality in economic statistics: A survey of recent developments. *Quest, 22*(1), 157–171. url: http://hdl.handle.net/2099/4617.
Pratt, S., & Tolkach, D. (2018). The politics of tourism statistics. *International Journal of Tourism Research,* 1–9. http://dx.doi.org/10.1002/jtr.2181 (on-line).
Ridderstaat, J., Oduber, M., Croes, R., Nijkamp, P., & Martens, P. (2014). Impact of seasonal patterns of climate on recurrent fluctuations in tourism demand: Evidence from Aruba. *Tourism Management, 41*, 245–256. http://dx.doi.org/10.1016/j.tourman.2013.09.005.
Rosselló-Nadal, J., Riera-Font, A., & Sansó-Rosselló, A. (2004). The economic determinants of seasonal patterns. *Annals of Tourism Research, 31*(3), 697–711. http://dx.doi.org/10.1016/j.annals.2004.02.001.
Rosselló-Nadal, J., & Sansó-Rosselló, A. (2017). Yearly, monthly and weekly seasonality of tourism demand: A decomposition analysis. *Tourism Management, 60*, 379–389. http://dx.doi.org/10.1016/j.tourman.2016.12.019.
Scott, D., McBoyle, G., & Schwartzentruber, M. (2004). Climate change and the distribution of climatic resources for tourism in North America. *Climate Research, 27*(2), 105–117. url: http://www.jstor.org/stable/24868738.
Sen, A. (1973). *On economic inequality.* Oxford University Press.
Shorrocks, A. F. (1980). The class of additively decomposable inequality measures. Econometrica. *Journal of the Econometric Society,* 613–625. url: http://www.jstor.org/stable/1913126.
Smeral, E. (2009). The impact of the financial and economic crisis on European tourism. *Journal of Travel Research, 48*(1), 3–13. http://dx.doi.org/10.1177/0047287509336332.
Tsitouras, A. (2004). Adjusted Gini coefficient and 'months equivalent'degree of tourism seasonality: A research note. *Tourism Economics, 10*(1), 95–100. http://dx.doi.org/10.5367/000000004773166619.
Ulijaszek, S. J., & Strickland, S. S. (Eds.). (2009). *Seasonality and human ecology*. Cambridge University Press.
UNWTO (2017). *Sustained growth in international tourism despite challenges.* Press release, PR 17003, 17 January 2017. url: http://www2.unwto.org/press-release/2017-01-17/sustained-growth-international-tourism-despite-challenges.

Vergori, A. S. (2012). Forecasting tourism demand: The role of seasonality. *Tourism Economics, 18*(5), 915–930. http://dx.doi.org/10.5367/te.2012.0153.
Vergori, A. S. (2017). Patterns of seasonality and tourism demand forecasting. *Tourism Economics, 23*(5), 1011–1027. http://dx.doi.org/10.1177/1354816616656418.
Wanhill, S. R. (1980). Tackling seasonality: A technical note. *International Journal of Tourism Management, 1*(4), 243–245. http://dx.doi.org/10.1016/0143-2516(80)90048-1.
Ward, J. H. (1963). Hierarchical grouping to optimize an objective function. *Journal of the American Statistical Association, 58*(301), 236–244. http://dx.doi.org/10.1080/01621459.1963.10500845.
Weaver, D., & Oppermann, M. (2000). *Tourism management.* John Wiley and Sons.
Yacoumis, J. (1980). Tackling seasonality: The case of Sri Lanka. *International Journal of Tourism Management, 1*(2), 84–98. http://dx.doi.org/10.1016/0143-2516(80)90031-6.
Yitzhaki, S., & Schechtman, E. (2013). *The Gini methodology: A primer on a statistical methodology. Springer series in statistics*, *Vol. 272*. New York: Springer Science & Business Media.
Þórhallsdóttir, G., & Ólafsson, R. (2017). A method to analyse seasonality in the distribution of tourists in Iceland. *Journal of Outdoor Recreation and Tourism, 19*, 17–24. http://dx.doi.org/10.1016/j.jort.2017.05.001.

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