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Seasonality in tourist flows: Decomposing and testing changes in seasonal concentration

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Abstract. In this paper, we show that the changes in the timing and magnitude of seasonality in tourist flows can be measured by decomposing the change in the Gini index, a widely used measure of seasonal concentration, into two components. One of them tracks the changes in the timing of fluctuations, examining the extent to which the seasonal pattern is stable and the second captures the changes in the magnitude of seasonal fluctuations. To assess whether changes in the seasonal pattern and magnitude are significant, a technique for testing statistical hypotheses concerning the two components is developed. The decomposition and statistical tests are used to examine changes in the seasonal concentration of tourist arrivals in six tourist destinations in the Veneto region, one of the most important regions in Italy and Europe for tourism, over the decade from 2006 to 2016. Our analysis shows that the magnitude of seasonality significantly decreased in some destinations characterized by diversified tourist products, such as Euganean spas and Lake Garda. The seasonal pattern remained substantially stable for all destinations except Venice, where a non-negligible shift in the seasonal pattern occurred. The policy implications are discussed.

Keywords: concentration indices, Gini index decomposition, tourism seasonality, tourism time series.

JEL codes: C46, C63, L83, Z32

1 Introduction

Tourist flows to a given destination often fluctuate during the year. If these fluctuations recur with similar timing and magnitude from year to year, they are called seasonal fluctuations and are a systematic component of a tourism time series, namely seasonality (Bar-On, 1999). Seasonality

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means that tourist flows tend to be concentrated in certain periods of the year (peak periods), generating an uneven distribution of tourists between the periods (Allcock, 1989). Seasonality is a phenomenon due to both natural and institutional conditions (Bar-On, 1975) and can partly be explained by recurrent changes in the weather over the year (e.g., average temperature, number of hours of daylight, form and intensity of rain/snow). Other causes of seasonality are related to social habits and norms with variations in human activities throughout the year, such as school and work holidays (Koenig-Lewis and Bischoff, 2005).

While tourism generally brings benefits to host communities (e.g., new business opportunities, improved public utilities, additional tax revenues), seasonality may have negative socio-economic consequences due to the concentration of tourists over a relatively short period (Cuccia and Rizzo, 2011). For example, overcrowding in tourist zones may lead to the overuse of resources (e.g., water, power) and infrastructure (e.g., traffic congestion). The pressure on the host community from a huge influx of tourists in just a few months, or even weeks, may generate a feeling of alienation among local residents. Tourist destinations also face economic issues through seasonality. The demand for local labour considerably increases in peak periods, so employers may not be able to recruit specific skills (Fernández-Morales, 2003). Most of these additional jobs are low-wage occupations, with employees in unsatisfactory working conditions and the jobs disappear in the off-peak season, generating unemployment. In addition, while the infrastructure and facilities are often overloaded in the peak season, they are underutilized in the off-peak season, discouraging further investments in the tourism sector (Baum, 1999).

Although many seasonal indices have been used in the literature (see, for example, Table 1 in De Cantis et al., 2011), a typical procedure is to measure the degree of seasonality in terms of seasonal concentration by using a conventional concentration index, such as the Gini or Theil index. Concentration indices are descriptive statistical tools and were originally introduced in the literature on income inequality, but then spread to other areas.. They were used to quantify the level of seasonality in several studies examining the evolution of seasonality in tourist flows (Fernández-Morales, 2003; Fernández-Morales and Mayorga-Toledano, 2008; Fernández-Morales et al., 2016; Duro, 2016; Lee and Kang, 1999, Lau et al. 2017; Rosselló and Sansó, 2017; Sutcliff and Sinclar, 1980). The change over the years in seasonal concentration can be measured by observing the change in the concentration index. However, a basic element of seasonality cannot be monitored by examining solely the change in the concentration index. An essential feature of seasonality is that the intra-year fluctuations occur at the same time from year to year. However, the value of a concentration index does not vary if fluctuations have the same magnitude but a different time. Since a conventional concentration index is invariant to changes in the seasonal pattern, a measure of seasonal stability is needed in addition to a measure of the change in seasonal magnitude when analysing the evolution of seasonality. In this paper, we show that these measures can be obtained by decomposing the change in seasonal concentration. In particular, seasonal concentration in a given year is measured by using the Gini index, a very popular measure of concentration. After measuring seasonal concentration in two different years, the change in seasonal concentration is split into two components. One component is a measure of seasonal stability, which tracks changes in the seasonal pattern. The second measures the change in seasonal magnitude, assuming that the seasonal pattern is stable.

The two components track the changes in the seasonal pattern and magnitude, capturing different aspects of the change in seasonality. Another important issue is to determine whether these changes are significant. For this purpose, a statistical technique for testing hypothesis about the components of the change in seasonal concentration is developed.

The decomposition is used to analyse the evolution of seasonality in tourist arrivals in six mature tourist destinations in one of the most tourism-oriented Italian regions: the Veneto.

The article is organised as follows. Section 2 illustrates the main contribution of the paper in relation to the existing literature on the same topic. Section 3 shows the decomposition of the change in seasonal concentration. Section 4 describes the statistical technique for testing hypotheses about the components of the change in seasonal concentration. The evolution of seasonal concentration in six tourist destinations in the Veneto regions is examined in section 5. Section 6 concludes.

2 Literature review and study rationale

Seasonality has potentially negative socio-economic and environmental impacts on a tourist destination (Butler, 2001), reducing the benefits from tourism (Bar-On, 1999). While labour demand increases in the high-season, creating new employment opportunities, it decreases in the low-season, generating seasonal unemployment. The under-utilization of infrastructure and facilities in the low-season can affect the return on invested capital and discourage new investments (Baum, 1999). If, on the one hand, a huge influx of visitors in the peak periods increases local revenues from taxes, on the other hand the price of goods and services also rises, with residents facing an increase in the cost of living (Cannas, 2012). Local communities often deal with traffic congestion, overcrowding in public places and a lower quality of services in peak periods (Bar-On, 1975), with negative consequences in terms of quality of life for residents. From an environmental point of view, the overuse of natural resources and the pressure on tourist spots due to a huge influx of people in the peak periods are negative aspects of seasonality that lead to public concern about the sustainability of tourism in relation to the carrying capacity of a tourist destination.

Local authorities commonly carry out activities to tackle the negative effects of seasonality, including the private sector, and in this sense the initiatives for the reduction of seasonal concentration can play a major role in mitigating the undesirable consequences of seasonality on tourism destinations.[3] In this context, measuring the changes over time in the seasonal concentration is crucial for local tourism policymakers in order to monitor the evolution of seasonality and to assess the extent to which the initiatives to counter seasonality have been successful. Conventional concentration indices are used to quantify the annual level of seasonal concentration. Duro (2016) measured seasonal concentration in Spanish tourist provinces from 1999 to 2012 by using the Theil index and the coefficient of variation. The Gini index has been used to measure the annual level of seasonal concentration in several studies (Sutcliff and Sinclair, 1980; Lee and Kang, 1998; Lundtrop, 2001; Roselló et al., 2004; Martín-Martín et al., 2014; Lau et al. 2017). Fernández-Morales (2003) analysed the evolution of the seasonal concentration of tourist flows in three Spanish seaside destinations by applying the Gini index to monthly data on the number of nights spent in hotels over the 1980-2001 period. In addition, using the Dagum (1997) three-term decomposition of the Gini index by subgroup, Fernández-Morales split the annual seasonal concentration into three components. After defining three different seasons (peak, shoulder and low), he separated the contribution of disparities into monthly hotel nights in different seasons, namely the net between-season concentration, from the contribution of disparities in hotel nights between months in the same season, i.e. the within-season concentration. The residual component is the transvariation component (Gini, 1916) measuring the degree of overlap among the monthly distributions of hotel nights in different seasons. The transvariation component is necessarily zero in the starting year of the analysis period, as the hotel nights of every month in a higher season are more numerous by definition than those of any month in a lower season, i.e. the monthly distributions of hotel nights of the peak, shoulder and low seasons do not overlap. However, overlapping may occur in any of the subsequent years, as the number of hotel nights in a month included in a season may be more than that of a month classified in a higher season. In this case, the transvariation component of the Gini index is greater than zero, meaning that the initial partition of months into seasons now corresponds to subgroups with overlapping distributions. Fernandez-Morales interpreted a non-zero value of the transvariation component as a signal of seasonal instability and underlined the need for a measure of seasonal stability. We show that such a measure of seasonal stability can be obtained by decomposing the change in seasonal concentration, measured by the change in the Gini index, into two components. One component measures the contribution to

[3] Various initiatives can be implemented to reduce seasonal concentration such as the promotion of alternative tourist attractions to enlarge the tourism product mix of a territory, the use of price discrimination in different seasons to encourage tourist arrivals in the low season, the development of marketing strategies and adequate facilities to capture new market segments (Andriotis, 2005; Fernández-Morales and Mayorga-Toledano, 2008).

the change in seasonal concentration that can be attributed to changes in the magnitude of seasonal fluctuations, assuming that the time of these fluctuations does not vary over the years. This is the seasonal magnitude component, which is unaffected by changes in the seasonal pattern. This component equals zero if the number of tourists in each period of the year has changed in the same proportion, as the relative disparities among periods have remained unchanged. The seasonal magnitude component is positive if the relative disparities in the number of tourists between peak and off-peak periods grew over time, increasing seasonal concentration. The component is negative if the increase (decrease) in the number of tourists was proportionally greater (smaller) in off-peak periods than in peak periods, reducing seasonal concentration.

The second component tracks the changes in the annual ranking of periods by the number of tourists. If there is a re-ranking of periods from the start year to the end year, the seasonal pattern is no longer the same, meaning that seasonality is to some extent unstable. The contribution of re-ranking to the change in seasonal concentration is calculated using the tourist numbers in the end year to exclude the role of changes in seasonal magnitude. Since this component only reveals deviations in the seasonal pattern, it is seen as a measure of seasonal stability. The seasonal stability component equals zero if the ranking of periods remains unchanged since the start year, and is greater than zero if at least two periods exchanged their positions in the ranking. This component reaches the highest value if the ranking of periods in the end year is exactly reversed when compared to the initial ranking, i.e. the highest peak period in the start year is the lowest off-peak period in the end year.

The decomposition separates the contributions of the changes in the time and magnitude of fluctuations, which are the components of the change in seasonal concentration. Since these two components may fully or partly offset each other, the decomposition shows the extent of changes that would otherwise be hidden by a zero or small value of the change in seasonal concentration. For example, suppose that fluctuations have the same magnitude from year to year but occur at different times, the value of the concentration index is the same in both years and hence the change in seasonal concentration is zero. The seasonal pattern has changed but that change is apparently not captured by the change in the concentration index. In this case, the seasonal stability and magnitude components fully offset each other as they have the same absolute value but opposite signs.[4]

Non-zero values of the seasonal stability and magnitude components indicate that seasonality has undergone changes in its distinctive features. A further question that deserves attention is whether

[4] The seasonal magnitude component is negative as tourist numbers have decreased during what were peak periods in the start year and have increased in the initially off-peak periods. The changes in the distribution of tourists among periods are large enough to entail a re-ranking between the periods that were initially around the bottom of the ranking and those around the top. The seasonal stability component is positive since there has been a re-ranking of periods, and exactly offsets the negative contribution of the seasonal magnitude component.

such changes are significant. A statistical testing procedure is needed to assess whether the seasonal pattern and magnitude have significantly changed over the years. Building on the Rey and Sastré-Gutiérrez (2010) test for the significance of a change in inequality over time, we develop a technique for testing hypotheses regarding the components of the change in seasonal concentration. This technique is based on random permutations because conventional methods for testing hypotheses about concentration measures are unsuitable for a sub-annual time series of tourist arrivals (or nights spent) over one year, with a relatively small number of observations which are correlated. Statistical inference for concentration indices is usually conducted using the bootstrap method (Mills and Zandvakili, 1997) or large sample properties derived from asymptotic theory (Zheng and Cushing, 2001). Hypothesis testing for concentration indices based on asymptotic approximations is valid for large samples but may perform less well with small samples (Maasoumi, 1997; Rey, 2004), especially in the case of heavy-tailed distributions (Dufour et al. 2017). The bootstrap technique is also applicable to small samples but relies on the assumption of independence of observations (Mills and Zandvakili, 1997), not applicable to observations from dependent samples. If seasonality is present in a sub-annual time series of tourist arrivals (or nights spent), the sub-annual data of different years are dependent. To test hypotheses about the components of the change in seasonal concentration, a technique taking dependence between data into account is needed. The next two sections present the new decomposition of change of seasonality and introduce the corresponding test for different components.

3 A decomposition of the change in concentration

Let Y stand for a variable representing either the frequency of tourist arrivals or the frequency of nights per stay in a destination. Let $y_{1,t}, \cdots, y_{n,t}$ be the time series of tourists visiting a destination in year t, where n is the number of periods in a year (e.g., $n = 12$ for monthly observations) and $y_{i,t}$ is the tourist frequency of period i in year t. The Gini index measuring the concentration of tourists in t is

$$G_t = \frac{2co\ \ [y_{i,t}, r(y_{i,t})]}{n\bar{y}_t}, \quad (1)$$

where $\bar{y}_t$ is the average tourist frequency per period and $r(y_{i,t})$ is the rank of period i according to the increasing order of tourist frequency.

The change in the concentration of tourists from year t to year $t + k$ is measured by the difference between the Gini index in $t + k$ and the Gini index in t:

$$\Delta G = G_{t+k} - G_t = \frac{2cov[y_{i,t+k}, r(y_{i,t+k})]}{n\bar{y}_{t+k}} - \frac{2cov[y_{i,t}, r(y_{i,t})]}{n\bar{y}_t}. \quad (2)$$

Let $C_{t+k|t}$ stand for the concentration coefficient of tourist frequencies in $t+k$ by sorting periods according to their ranking in t instead of that in $t+k$:

$$C_{t+k|t} = \frac{2cov[y_{i,t+k}, r(y_{i,t})]}{n\bar{y}_{t+k}}. \quad (3)$$

By adding and subtracting $C_{t+k|t}$ to the right-hand side of equation (2), the difference in the Gini index is broken down into two components:

$$\Delta G = \left\{\frac{2cov[y_{i,t+k}, r(y_{i,t+k})]}{n\bar{y}_{t+k}} - \frac{2cov[y_{i,t+k}, r(y_{i,t})]}{n\bar{y}_{t+k}}\right\} + \left\{\frac{2cov[y_{i,t+k}, r(y_{i,t})]}{n\bar{y}_{t+k}} - \frac{2cov[y_{i,t}, r(y_{i,t})]}{n\bar{y}_t}\right\}$$

$$\Delta G = R + M. \quad (4)$$

R in equation (4) is the re-ranking component measuring the change in concentration due to the exchange of positions in the ranking of periods from t to $t+k$. The re-ranking component is analogous to the re-ranking measure used for capturing the re-ranking of income receivers when decomposing the change in income inequality (Jenkins and Van Kerm, 2006). R equals zero if the ranking of periods in $t+k$ is the same as that in t. The component R reaches its highest value, i.e. $2G_{t+k}$, when the ranking of periods in $t+k$ is completely reversed compared to the ranking of periods in t. Since the re-ranking component captures any deviation in the seasonal pattern, R is seen as a measure of seasonal stability. The larger the re-ranking component, the more unstable the seasonal pattern.

The term M in equation (4) is the magnitude component measuring how much tourist frequencies in year $t+k$ are more (or less) concentrated on the periods with the highest ranks in year t. Since M is calculated by holding periods sorted according to their ranking in t, the seasonal pattern is supposed to be the same in t and $t+k$. The magnitude component is positive (negative) when the magnitude of seasonality has increased (decreased) over time. M is equal to zero if the tourist frequency distribution among periods has not changed or if the tourist frequencies of all periods have changed in the same proportion, leaving the relative disparities between tourist frequencies unchanged.

Two numerical examples are shown in figures 1 and 2 to illustrate the components of ΔG. The monthly distribution of tourists in year t is shown in figure 1, where months are ranked in increasing order of tourist frequency. The average monthly frequency is 60,000. August, July and September appear as peak months with the highest ranks, whereas winter months have the smallest tourist frequencies and consequently the lowest ranks.

Figure 1: monthly distribution of tourists in year t, with month ranking.

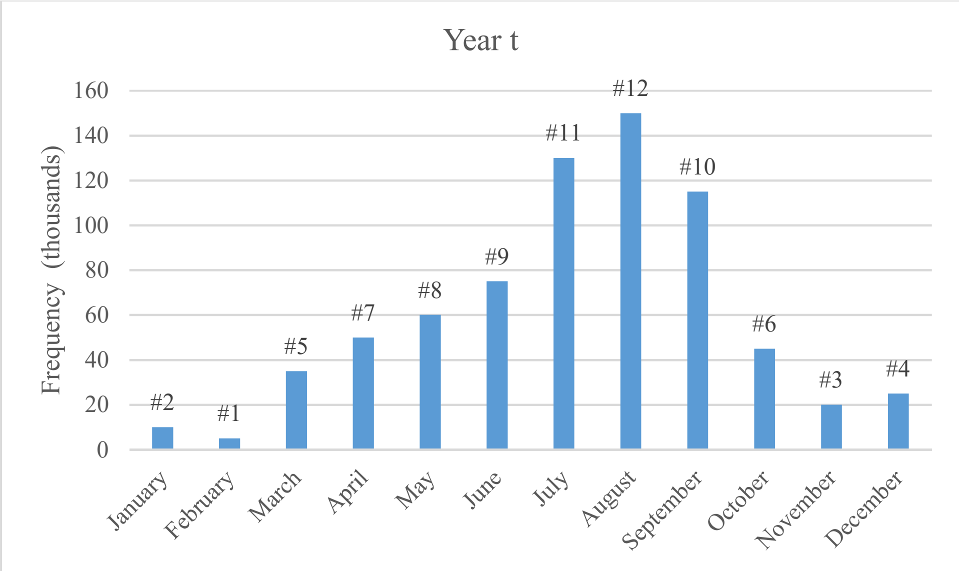
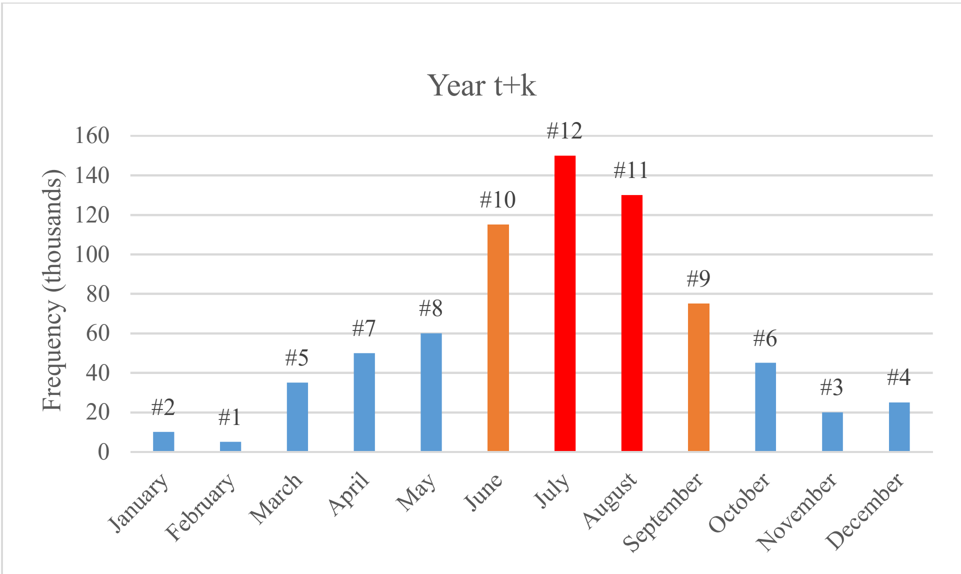


Figure 2A shows the monthly distribution of tourists in year t+k, where the twelve absolute figures in $t + k$ are equal to those in t. However, the ranking of months by tourist frequency has changed from t to $t + k$. August and July have exchanged their frequencies (red bars), switching their ranks in the distribution, and the same applies to September and June (orange bars). The frequencies of the other months (blue bars) in $t + k$ are the same as those in t, and consequently their ranks are unaltered. The Gini index in year t is 0.42477 and is equal to the Gini index in year $t + k$. ΔG is equal to zero, suggesting that seasonality has remained unchanged since year t, but the distribution of tourists has changed. The seasonal fluctuations are not stable over time and the re-ranking component captures the instability of seasonality. R equals 0.01389, measuring the effect of the changes in the ranking of periods on seasonal concentration. However, the increase in concentration due to the re-ranking effect is fully offset by the decrease in concentration captured by the magnitude component M. The magnitude component is negative, $M = -0.01389$, indicating that tourist frequencies in year $t + k$ are less concentrated in the periods with the highest ranks in year t. Indeed, the month with the highest frequency in t has the second highest frequency in $t + k$ and the month with the third highest frequency in t has the fourth highest frequency in $t + k$.

The example above shows that seasonal regularity may change over time even though the Gini index does not change. In such a scenario, the changes in seasonal stability and magnitude can be measured by R and M, respectively.

Figure 2: monthly distribution of tourists in year $t + k$, with month ranking.

A



B

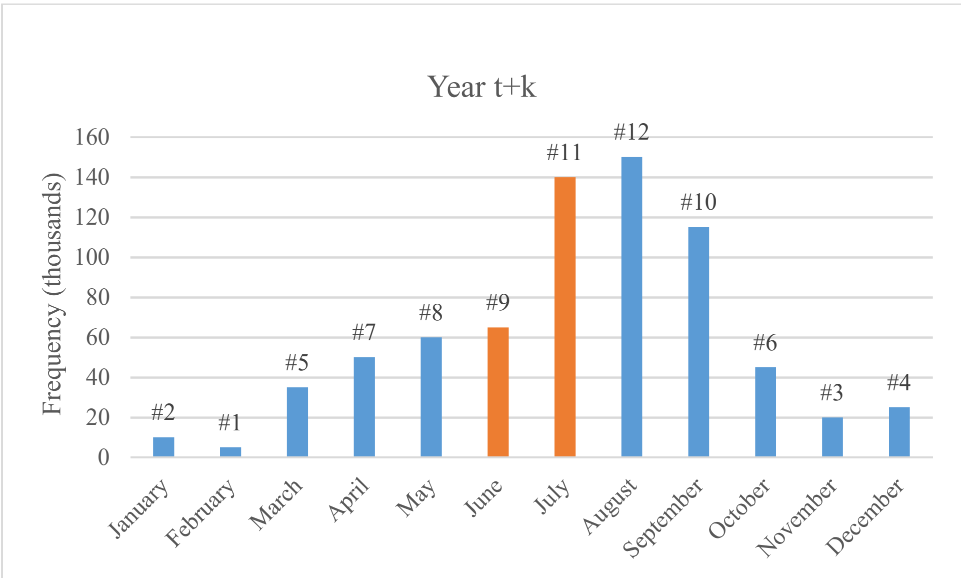


Figure 2B shows the monthly distribution of tourists in year $t + k$, where ten thousand tourists have moved from June to July (orange bars) while the tourist frequencies of the other months (blue bars) are the same as those in year t. This transfer is rank-preserving since the rank of each month has remained the same, but the concentration has increased since the transfer has been made from a month with a lower tourist frequency to a month with a higher tourist frequency. R is equal to zero, while M is 0.00463 and coincides with ΔG. The positive value of M indicates that the magnitude of seasonality has increased over time, while seasonal stability is preserved because the re-ranking component is null.

4 Testing changes in seasonal stability and magnitude

The components of the change in the concentration, as well as the Gini index, are statistical descriptive tools measuring different aspects of tourist distribution. While the Gini index measures seasonality in a single year, R and M track its stability and magnitude over time. However, an interesting question concerns the statistical significance of these measures of seasonal stability and magnitude. The conventional techniques for testing hypotheses regarding inequality measures are based on assumptions, such as the availability of large samples and independence of observations, which do not fit with a sub-annual time series of tourist frequencies (e.g., monthly data) for one year. To test whether R and M are statistically significant, a procedure can be implemented based on the approach suggested by Rey and Sastré-Gutiérrez (2010) for testing the significance of a change in concentration over time. Subsection 3.1 briefly describes the Rey and Sastré-Gutiérrez method and subsection 3.2 introduces a modified version of this method for testing hypotheses about R and M.

4.1 Testing changes in concentration

Rey and Sastré-Gutiérrez (2010) suggested a non-parametric method based on random permutations for testing whether the concentration has changed significantly over time. They developed this method using the Theil index; however their approach can be applied to any other concentration index. Let I_{t+k} and I_t be the values of a concentration index in $t+k$ and t, respectively. The null and alternative hypotheses are:

$$\begin{cases} H_0: & I_{t+k} - I_t = 0 \\ H_1: & I_{t+k} - I_t \neq 0 \end{cases} \tag{5}$$

where $\Delta I = I_{t+k} - I_t$ is the test statistic. The sampling distribution of ΔI under the null hypothesis is built by randomly relabelling the time indices of observations, as shown in table 1. The first and second columns of table 1 show the observed values in t and $t+k$. The third and fourth columns show two mixed distributions, labelled t^* and $t+k^*$, which are obtained by a random assignment of the elements in each pair of observations referring to period i (with $i = 1, \cdots, n$) in years t and $t+k$. Permuting observations within pairs, the two mixed distributions, t^* and $t+k^*$, are obtained by taking the correlation between data referring to the same period into account..[5] According to Rey and Sastré-Gutiérrez (2010), t^* and $t+k^*$ are observed values of a process in which the degree of

[5] A similar approach was suggested by Dufour et al. (2017) to conduct an asymptotically valid permutation test of the change in inequality from pre-tax to post-tax income distribution. Within each pair of pre-tax and post-tax incomes of the same income receiver, the two observations are randomly exchanged to obtain a permuted sample. Permuting observations within pairs allows the correlation between pre-tax and post-tax incomes to be taken into account (Dufour et al., 2017).

concentration should remain unchanged over time. Once a random permutation of the time indices of observations has been performed, the concentration indices for the t^* and $t+k^*$ distributions and the difference between the two indices are calculated. Repeating the random relabelling many times, a distribution for the test statistic under the null hypothesis is built (Rey and Sastré-Gutiérrez, 2010). $\Delta I_j = I_{j,t+k^*} - I_{j,t^*}$ being the difference computed for the j-th random relabelling (with $j = 1, \cdots, J$), a dummy representing the result of the comparison between ΔI_j and the observed ΔI can be defined as follows:

$$d_j = \begin{cases} 1 & if\ |\Delta I_j| \geq |\Delta I| \\ 0 & if\ |\Delta I_j| < |\Delta I| \end{cases}. \tag{6}$$

Let $D = \sum_{j=1}^{J} d_j$ stand for the number of times that the differences obtained by J random permutations equal or exceed the observed ΔI. The pseudo p-value for the test statistic is

$$p(\Delta I|H_0) = \frac{1+D}{1+J}. \tag{7}$$

Once a significance level has been set (e.g., 0.05), it is compared with $p(\Delta I|H_0)$ to check whether concentration has changed significantly between t and $t+k$.

Table 1: Random permutations within the pairs of observations from the $t+k$ and t distributions

t	$t+k$	t^*	$t+k^*$
$y_{1,t}$	$y_{1,t+k}$	$y_{1,t}$	$y_{1,t+k}$
$y_{2,t}$	$y_{2,t+k}$	$y_{2,t+k}$	$y_{2,t}$
$\vdots$	$\vdots$	$\vdots$	$\vdots$
$y_{i,t}$	$y_{i,t+k}$	$y_{i,t}$	$y_{i,t+k}$
$\vdots$	$\vdots$	$\vdots$	$\vdots$
$y_{n,t}$	$y_{n,t+k}$	$y_{n,t+k}$	$y_{n,t}$

4.2 Testing changes in seasonal stability and magnitude

Section 2 shows that there may be changes in seasonal stability and magnitude even when ΔG is zero. Since our purpose is tracking changes in seasonality, testing hypotheses about ΔG may not provide useful information. For this reason, we modify the Rey and Sastré-Gutiérrez method to develop a procedure for testing hypotheses about R and M.

The set of hypotheses about the change in seasonal pattern are

$$\begin{cases} H_0: & R = 0 \\ H_1: & R > 0 \end{cases}, \quad (8)$$

where the test statistic is R. The set of hypotheses about the change in seasonal magnitude are

$$\begin{cases} H_0: & M = 0 \\ H_1: & M \neq 0 \end{cases}, \quad (9)$$

with M as test statistic. R and M are equal to zero if the tourist frequencies are unchanged or have changed in the same proportion between t and $t + k$. To build the permutation distribution of each test statistic under the null hypothesis, we apply a strategy based on random permutations within the n pairs of observations from actual and hypothetical data in $t + k$.

Let $\lambda = \bar{y}_{t+k}/\bar{y}_t$ be the ratio of the average tourist frequency in $t + k$ to that in t. Multiplying every $y_{i,t}$ by λ, the distribution labelled $t + k^{\lambda}$ in the third column of table 2 is obtained. The level of concentration in the $t + k^{\lambda}$ distribution is equal to the level of concentration in t by construction, since the tourist frequency of each period i in the $t + k^{\lambda}$ distribution is obtained by scaling the tourist frequency of the same period in the t distribution. When the $t + k^{\lambda}$ distribution is compared with the distribution in t, the seasonal pattern and magnitude are unchanged over time. In addition, the average tourist frequencies of the $t + k^{\lambda}$ and $t + k$ distributions are equal by construction. The $t + k^{\lambda}$ distribution is the distribution we would observe at time $t + k$ if seasonality were stable and its magnitude the same as that at time t. In our test, the distribution represented by $t + k^{*}$ in the fourth column of table 2 is obtained by a random permutation within each pair of observations for the same period i from the $t + k^{\lambda}$ and $t + k$ distributions $\left(y_{i,t+k^{\lambda}}, y_{i,t+k}\right)$. Unlike the Rey and Sastré-Gutiérrez approach, we obtain a permuted distribution only for time $t + 1$ while the distribution for time t is the actual distribution in t. This is a fundamental point for testing hypotheses about seasonal stability and magnitude as the changes in seasonal pattern and magnitude can be assessed solely by reference to the actual distribution in t. For a given random permutation, the re-ranking and magnitude components are recalculated by replacing the observed distribution at time $t + k$ with the $t + k^{*}$ distribution. If tourist frequencies have changed in the same proportion over time, the $t + k^{*}$ distribution is equal to the $t + k^{\lambda}$ distribution. As a result, the re-ranking and magnitude components are equal to zero, since seasonal stability and magnitude are preserved. Repeating the random permutation J times, with J large, the permutation distributions of the re-ranking and magnitude components under the null hypothesis are built.

R_j being the re-ranking component calculated for the j-th random permutation (with $j = 1, \cdots, J$), the dummy representing the result of the comparison between R_j and the observed R is defined as follows:

$$e_j = \begin{cases} 1 & if\ R_j \geq R \\ 0 & if\ R_j < R \end{cases}. \tag{10}$$

Let $E = \sum_{j=1}^{J} e_j$ stand for the number of times that the re-ranking components obtained by J random permutations equal or exceed the observed R. The pseudo p-value for the test statistic is

$$p(R|H_0) = \frac{1+E}{1+J}. \tag{11}$$

For a given significance level, α (e.g., 0.05), we can check whether the timing of fluctuations has changed significantly by comparing $p(R|H_0)$ with α. A pseudo p-value equal to or lower than α indicates that seasonality is unstable over time.

M_j being the magnitude component calculated for the j-th random permutation (with $j = 1, \cdots, J$), the dummy representing the result of the comparison between M_j and the observed M is

$$f_j = \begin{cases} 1 & if\ |M_j| \geq |M| \\ 0 & if\ |M_j| < |M| \end{cases}. \tag{12}$$

Let $F = \sum_{j=1}^{J} f_j$ stand for the number of times the magnitude components obtained by J random permutations equal or exceed, in absolute figures, the observed M. The pseudo p-value for the test statistic is

$$p(M|H_0) = \frac{1+F}{1+J}. \tag{13}$$

Comparing $p(M|H_0)$ with a certain significance level, α, we can check whether seasonal magnitude has changed significantly between t and $t+k$. H_0 is rejected when $p(M|H_0) \leq \alpha$.

Table 2: random permutations within the pairs of observations from the $t+k$ and $t+k^{\lambda}$ distributions

t	$t+k$	$t+k^{\lambda}$	$t+k^{*}$
$y_{1,t}$	$y_{1,t+k}$	$y_{1,t+k^{\lambda}}$	$y_{1,t+k}$
$y_{2,t}$	$y_{2,t+k}$	$y_{2,t+k^{\lambda}}$	$y_{2,t+k^{\lambda}}$
$\vdots$	$\vdots$	$\vdots$	$\vdots$
$y_{i,t}$	$y_{i,t+k}$	$y_{i,t+k^{\lambda}}$	$y_{i,t+k}$
$\vdots$	$\vdots$	$\vdots$	$\vdots$
$y_{n,t}$	$y_{n,t+k}$	$y_{n,t+k^{\lambda}}$	$y_{n,t+k^{\lambda}}$

Hypotheses regarding ΔG can be tested by using the same approach applied for testing hypotheses about R and M. However, it is worth mentioning that testing the significance of ΔG means checking whether the level of concentration has changed significantly but, in general, does not provide information on the significance of the changes in the seasonal pattern and magnitude since they are measured by R and M respectively. Indeed, a small or null ΔG may be the result of the offsetting interaction of R and M, concealing significant changes in seasonal pattern and magnitude.

Let ΔG_j be the change in the Gini index obtained by comparing G_t with $G_{j,t+k^*}$, the Gini index calculated for the j-th permuted distribution $t + k^*$ (with $j = 1, \cdots, J$). The dummy representing the result of the comparison between ΔG_j and the observed ΔG is

$$h_j = \begin{cases} 1 & if\ |\Delta G_j| \geq |\Delta G| \\ 0 & if\ |\Delta G_j| < |\Delta G| \end{cases}. \tag{14}$$

Let $H = \sum_{j=1}^{J} h_j$ stand for the number of times the change in the Gini index obtained by J random permutations equal or exceed, in absolute figures, the observed ΔG. The pseudo p-value for the test statistic is

$$p(\Delta G|H_0) = \frac{1+H}{1+J}. \tag{15}$$

To distinguish the above permutation test from the Rey and Sastré-Gutiérrez permutation test in section 3.1, the test in equations 14 and 15 is named scaled permutation test as it is based on the $t + k^\lambda$ distribution obtained by rescaling the actual distribution in t. The same applies for the tests concerning R and M.

5 Changes in seasonality in the local tourism systems of Veneto

5.1 Data

Tourism demand is measured in terms of the number of tourist arrivals. Data are from the database of the Veneto Region, which publishes the monthly series of tourist arrivals in the Local Tourism Systems of the Veneto Region. The Local Tourism System (henceforth, LTS) is a place having a natural vocation to be a tourism destination, with a specialization in the production of tourist services (Lazzaretti and Capone, 2008). The definition of LTS is not based on administrative boundaries but on the identification of a homogeneous socio-economic area, which can supply integrated tourist services through the creation of tourism-related job opportunities and interconnections between the tourism sector and other sectors (e.g., the cultural sector).

Since the LTSs of the Veneto Region have different tourism specializations (seaside, mountains, spas, lakeside or cultural tourism) and each of them has its distinctive features, the best-known LTSs have been selected and grouped into five categories by tourism specialization. The seaside destination is

Jesolo-Eraclea, a town on the Adriatic Sea. Sun and beach recreation is the main attraction in Jesolo-Eraclea and this is reflected in the form of seasonality, which is characterized by one peak period during the summer. The second category includes the Dolomites, a mountain range in the north-eastern Italian Alps which is considered one of the most attractive mountain landscapes in the world. The Dolomites were declared a World Heritage Site by UNESCO in 2009. Since the Dolomites offer a tourist product including some sports and leisure activities for the winter season and others for the summer season, they are a tourist destination for both summer and winter holidays. The lakeside tourism destination is the eastern shore of Lake Garda, the largest Italian lake. Lake Garda is prevalently a sun and beach tourism destination during the summer, especially for tourists from northern European countries. In the spring and autumn seasons, the mild and pleasant climate of Lake Garda offers opportunities for sports and recreational activities,[6] and to attend cultural, food and wine events (e.g. the wine routes). Opportunities for spa tourism in Veneto are provided by the Euganean Spas, such as Abano and Montegrotto, two of the most famous spa towns in Europe. The Euganean Spas offer a tourism product including not only therapy and well-being but also a large archaeological area (at Montegrotto) from the Roman period, cultural events and several leisure activities. The last category comprises two famous art cities, Venice and Verona. These destinations face the problems of overcrowding in some periods of the year. The negative consequences of overcrowding (e.g. overloaded infrastructure, risks of damage to the cultural heritage) threaten the sustainable development of tourism in these cities, especially for Venice due to its setting in a lagoon environment.

The monthly series of tourist arrivals in the LTSs of the Veneto Region are obtained by gathering information from the survey titled "Occupancy of tourist accommodation establishments", a monthly census survey collecting information on arrivals and nights spent (by residents and non-residents) at tourist accommodation establishments at the municipality level in Italy. Data cover the time span from January 1997 to December 2016. Presuming that a decade is a reasonable timescale to observe changes in seasonality, we examined the change in the seasonal concentration over the last decade, setting 2006 and 2016 as the initial and final reference years respectively.

Table 3: seasonal indices in 2006 and 2016 distributions of tourist arrivals of six tourist destinations in Veneto.

LTS	G_{2016}	G_{2006}	SR_{2016}	SR_{2006}	TI_{2016}	TI_{2006}	CV_{2016}	CV_{2006}
Jesolo-Eraclea	0.475891	0.437106	2.5443	2.1649	0.383267	0.338451	90.51	81.61
Dolomites	0.405874	0.396726	2.5557	2.2861	0.287013	0.266740	77.64	73.10

[6] Several amusement parks are located in the eastern shore of Lake Garda, the most famous of which is "Gardaland" in Peschiera del Garda, a lakeside town in the Province of Verona.

Lake Garda	0.412814	0.441781	2.0606	2.1707	0.309952	0.361839	76.66	82.93
Euganean Spas	0.088917	0.156583	1.2937	1.4899	0.012691	0.040037	16.53	28.93
Venice	0.155326	0.156951	1.4090	1.3477	0.038745	0.042288	28.50	29.37
Verona	0.148758	0.169637	1.4352	1.4891	0.034792	0.045405	27.51	31.50

G is the Gini index of equation (1); $SR_t = \max_i(y_{i,t}) / \bar{y}_t$ is the Seasonality Ratio at time *t*; $TI_t = \sum_{i=1}^{n} \left[\left(\frac{y_{i,t}}{\bar{y}_t} \right) \cdot ln \left(\frac{y_{i,t}}{\bar{y}_t} \right) \right] / n$ is the Theil Index at time *t*; $CV_t = (\sigma_t / \bar{y}_t) \cdot 100$ is the Coefficient of Seasonal Variation; $\bar{y}_t = \sum_{i=1}^{n} y_{i,t} / n$ and $\sigma_t = \sqrt{\sum_{i=1}^{n} (y_{i,t} - \bar{y}_t)^2 / n}$.

Before moving to the decomposition analysis based on the Gini index, some of the most common seasonality indices (Lundtorp, 2001) have been computed for the initial and final year of the considered time interval 2006-2016. Results are shown in table 3. For the interpretation of results, two basic points should be considered:

1) SR_t is based on the comparison between two indices (maximum and average value), while all remaining measures are computed using all values of the distribution.
2) All indices displayed in table 3 can be used to compare the levels of seasonal concentration in different years, but changes in the seasonal pattern cannot be tracked.

It is interesting to note that changes in seasonality concentration from 2006 to 2016 measured by the Gini index (ΔG_t) are consistent with changes in the Theil index (ΔTI_t) and the Coefficient of Seasonal Variation (ΔCV_t): the intensity of seasonal variation has increased in Lake Garda, Euganean Spas, Venice and Verona, while has dropped in Jesolo-Eraclea and Dolomites. The direction of changes is always confirmed by the variation of Seasonality Ratio (ΔSR_t) with exception of Venice.

Unusual events (e.g., heavy rainfall, well below- or above-average temperatures) or variable holidays (e.g., Easter, the date for which changes from year to year) may cause irregular variations confounding the (regular) seasonal pattern in a single year. Based on that premise, the results of the comparison between the monthly distributions of 2006 and 2016 may be affected by this irregular component. Therefore, for robustness purposes, the number of tourist arrivals in a certain month of the initial distribution was obtained as the simple mean of the arrivals observed in that month over the three-year period 2004-2006. The final distribution was obtained in the same way by using the monthly observations of the three-year period 2014-2016. For the sake of simplicity, the initial and final distributions are respectively labelled as the 2006 and 2016 average distributions in the rest of the analysis.

Table 4: seasonal indices in 2006 and 2016 average distributions of tourist arrivals of six tourist destinations in Veneto.

LTS	G_{2016}	G_{2006}	SR_{2016}	SR_{2006}	TI_{2016}	TI_{2006}	CV_{2016}	CV_{2006}
Jesolo-Eraclea	0.478274	0.441279	2.5621	2.2112	0.39107	0.340394	90.71	82.31
Dolomites	0.401988	0.408603	2.5707	2.4419	0.280561	0.282337	76.86	75.83

Lake Garda	0.421640	0.437656	2.1624	2.2272	0.323129	0.346257	78.49	81.55
Euganean Spas	0.100375	0.163519	1.2446	1.4076	0.016752	0.044831	18.8	30.19
Venice	0.163323	0.154036	1.4133	1.3314	0.044075	0.039959	30.29	28.63
Verona	0.150191	0.163264	1.4123	1.4740	0.035784	0.041554	27.88	30.23

G is the Gini index of equation (1); $SR_t = \max_i(y_{i,t})/\bar{y}_t$ is the Seasonality Ratio at time *t*; $TI_t = \sum_{i=1}^{n}\left[\left(\frac{y_{i,t}}{\bar{y}_t}\right)\cdot ln\left(\frac{y_{i,t}}{\bar{y}_t}\right)\right]/n$ is the Theil Index at time *t*; $CV_t = (\sigma_t/\bar{y}_t)\cdot 100$ is the Coefficient of Seasonal Variation; $\bar{y}_t = \sum_{i=1}^{n} y_{i,t}/n$ and $\sigma_t = \sqrt{\sum_{i=1}^{n}(y_{i,t}-\bar{y}_t)^2/n}$.

Seasonality indices computed on the new average distributions are shown in table 4. Some changes can be observed comparing table 4 with table 3 which confirm the smoothing effect obtained when average distributions are considered. When seasonal concentration is measured by the Gini and the Theil index, the change of seasonality in the Dolomites becomes negative, while the positive change is confirmed by the Coefficient of Variation. The sign of the change in table 4 is also opposite to the sign shown in table 3 for Venice (negative in table 3 and positive in table 4). For reasons related to tourist flows in art cities (Cuccia and Rizzo, 2011), the seasonal concentration in Verona and Venice is quite small, as is the change in the seasonal concentration over time. Consequently, a statistical testing procedure could indicate the significance of such a change in seasonal concentration.

All results displayed in table 3 and 4, as discussed so far, suggest that a decomposition of seasonal concentration indices along with a testing procedure could lead to more robust and consistent conclusions.

5.2 Results

In this section we focus on the decomposition of ΔG_t and on the corresponding testing procedure, introduced in section 3 and 4, respectively. Table 5 shows the concentration levels, using the average distributions in 2006 (averaging years 2004-2006) and 2016 (averaging years 2014-2016), measured by the Gini index, the change in seasonal concentration, the components of the change in seasonal concentration and their pseudo p-values for each of the LTSs considered[7]. The number of random permutations was set equal to 999. The column labelled "permutation test" shows the pseudo p-values for ΔG obtained by using the Rey and Sastré-Gutiérrez test. The columns labelled "scaled-permutation test" show the pseudo p-values for ΔG, R and M calculated by applying the tests introduced in section 3.2. The pseudo p-values lower than the standard significance threshold (0.05) are shown in bold in table 5.

[77] The first two columns of table 5 repeat the first two columns of table 4, but have been retained for the sake of clarity.

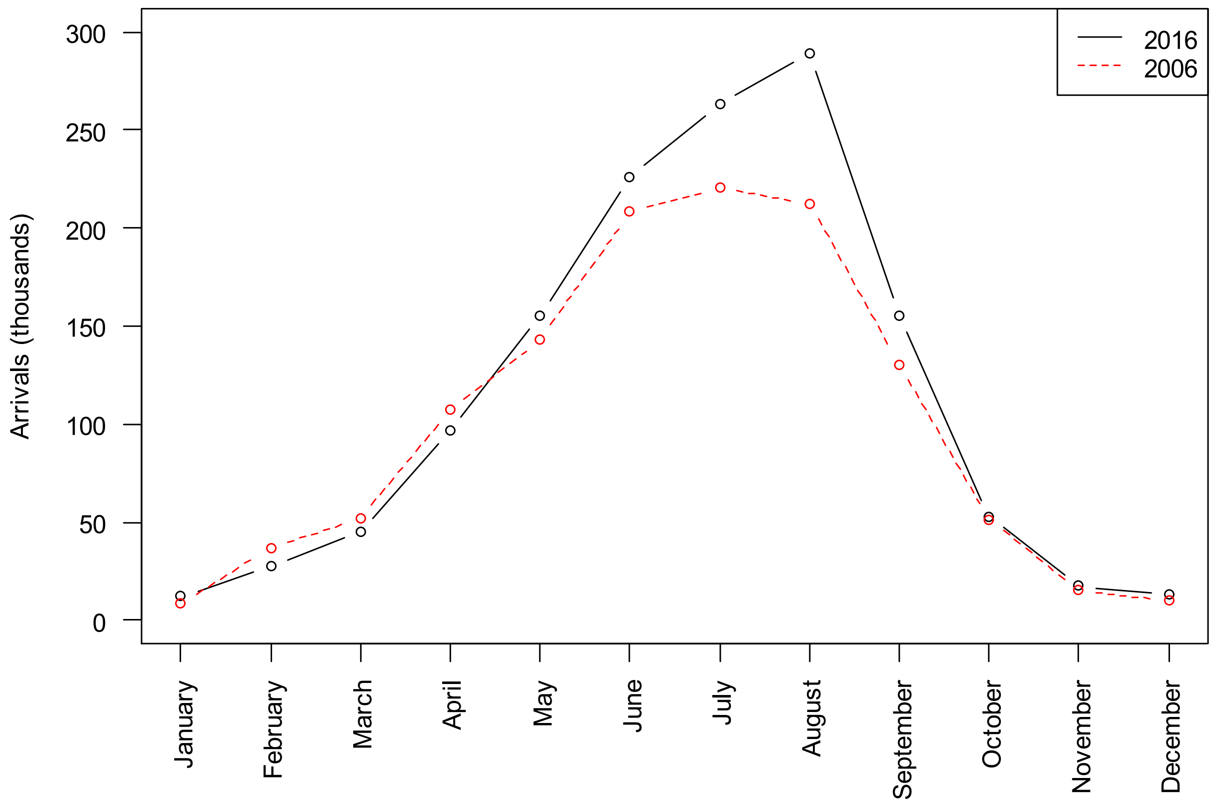
Table 5: decomposition of the change in seasonal concentration between the 2006 and 2016 average distributions of tourist arrivals.

	Indexes		Variation	Components		Permutation test	Scaled-permutation test		
LTS	G_{2016}	G_{2006}	ΔG	R	M	p(ΔG|H_0)	p(ΔG|H_0)	p(R|H_0)	p(M|H_0)
Jesolo-Eraclea	0.478274	0.441279	0.036995	0.004111	0.032884	0.201	**0.036**	0.354	**0.023**
Dolomites	0.401988	0.408603	-0.006616	0.000821	-0.007437	0.744	0.400	0.364	0.360
Lake Garda	0.421640	0.437656	-0.016016	0	-0.016016	0.682	**0.031**	1	**0.031**
Euganean Spas	0.100375	0.163519	-0.063144	0.014954	-0.078097	0.223	**0.022**	0.060	**0.003**
Venice	0.163323	0.154036	0.009287	0.002967	0.006320	0.833	0.085	**0.022**	0.192
Verona	0.150191	0.163264	-0.013073	0.001943	-0.015015	0.836	0.152	0.246	0.155

Note: Bold indicates a pseudo p-value lower than 0.05.

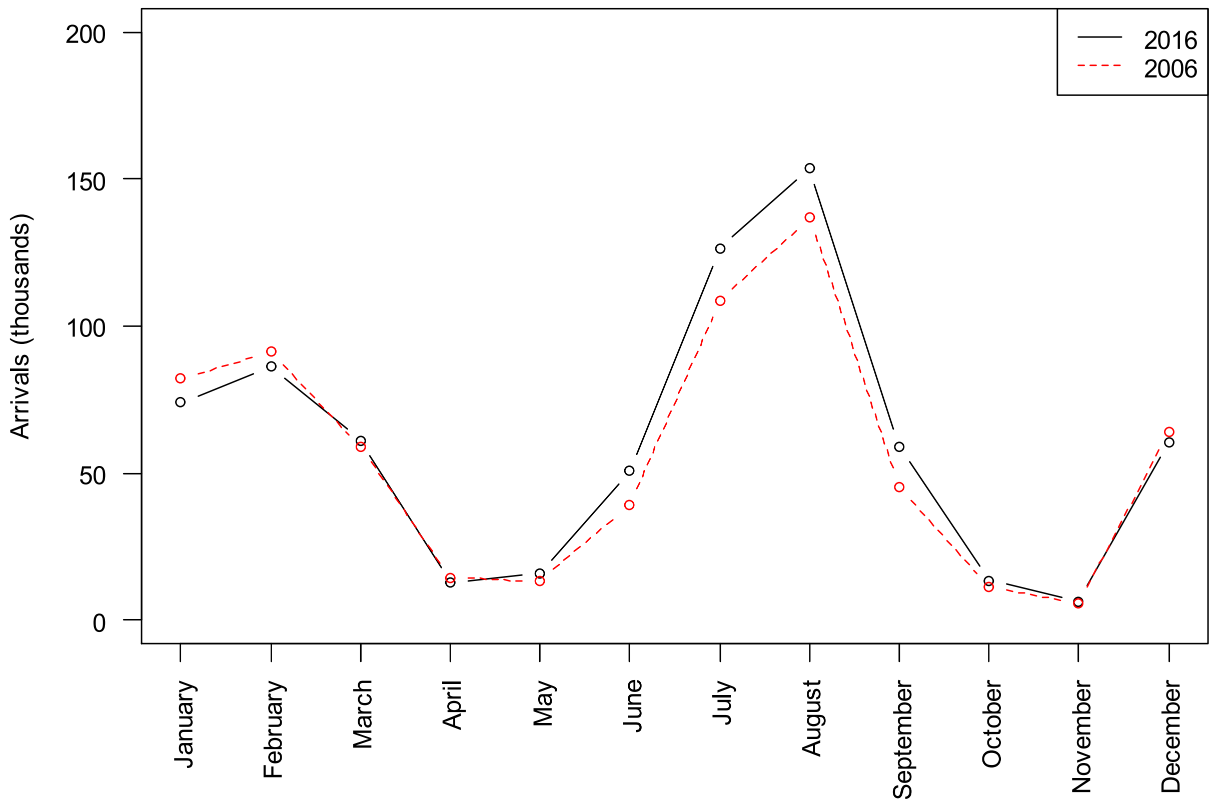
The seasonal concentration is higher in the seaside destination. Seasonality was not perfectly stable over time in Jesolo-Eraclea, since the stability component, R, is greater than 0. However, the pseudo p-value for R suggests that the seasonal pattern was not significantly altered by the changes in the monthly distribution of tourist arrivals. The magnitude of seasonality significantly increased in Jesolo-Eraclea. This increase in seasonal magnitude (0.032884) plays a major role in the significant increase in seasonal concentration (0.036995) from 2006 to 2016. These findings are confirmed by observing the average distributions of tourist arrivals in Jesolo-Eraclea, shown in figure 3. The seasonal pattern has slightly changed since 2006, because the highest point was reached in August in 2016, however the change in the seasonal pattern is not statistically significant. On the other hand, the summer peaks became more marked in July and especially in August 2016, implying an increase in seasonal concentration which is statistically significant in magnitude.

Figure 3: monthly arrivals in Jesolo-Eraclea, 2006-2016 (three-year averages, 2004-2006 and 2014-2016)



There were no changes in the seasonal pattern of tourist arrivals in the Dolomites. The re-ranking component is very small (0.000821), indicating that the seasonal scheme in this destination was stable over the period considered. The seasonal magnitude was almost unchanged on 2006, since the decrease in seasonal magnitude (-0.007437) is not significant. These findings are confirmed by the plots of monthly arrivals in 2006 and 2016, as shown in figure 4, since the two plots have approximately the same shape.

Figure 4: monthly arrivals in the Dolomites, 2006-2016 (three-year averages, 2004-2006 and 2014-2016).



The component measuring seasonal stability, R, is equal to zero for Lake Garda, indicating perfect stability in seasonality. There was a significant reduction in seasonal magnitude (-0.016016), implying that the seasonal concentration decreased to the same extent as no re-ranking of months occurred in the period considered. The plots of monthly arrivals in Lake Garda in 2006 and 2016 are shown in figure 5, where tourist arrivals increased every month over the last ten years. However, the increases for the 2006 peak months (July and August) were slightly smaller in relative terms than those in other months.

The seasonal concentration significantly decreased in the Euganean spas between 2006 and 2016. The magnitude component is significant. Seasonal magnitude decreased as the relative disparities in arrivals between months became less unequal over time. However, the decrease in seasonal concentration (-0.063144) is less than the reduction in seasonal magnitude (-0.078097) because the latter was partially offset by the effect of re-ranking (0.014954). The pseudo p-value of the stability component is small (0.06), but still above the significance threshold (0.05). Notwithstanding, if p-value is seen as a measure of the strength of evidence against the hypothesis that seasonality is stable (the null hypothesis), the pseudo p-value of the test on seasonal stability indicates that seasonality has not remained fully stable since 2006. Figure 6 shows the monthly distributions of tourist arrivals in this destination in 2006 and 2016. The two-peak form of seasonality in 2006 weakened in 2016, as tourist arrivals grew relatively faster in the 2016 off-season months, especially November and December. This disproportionate growth in arrivals reduced the relative disparities, so the ranking of months by number of arrivals changed from 2006 to 2016. For example, November was an off-season month in 2006, with the fourth lowest number of arrivals. In 2016, November had the fourth highest number of arrivals.

Figure 5: monthly arrivals in Lake Garda, 2006-2016.

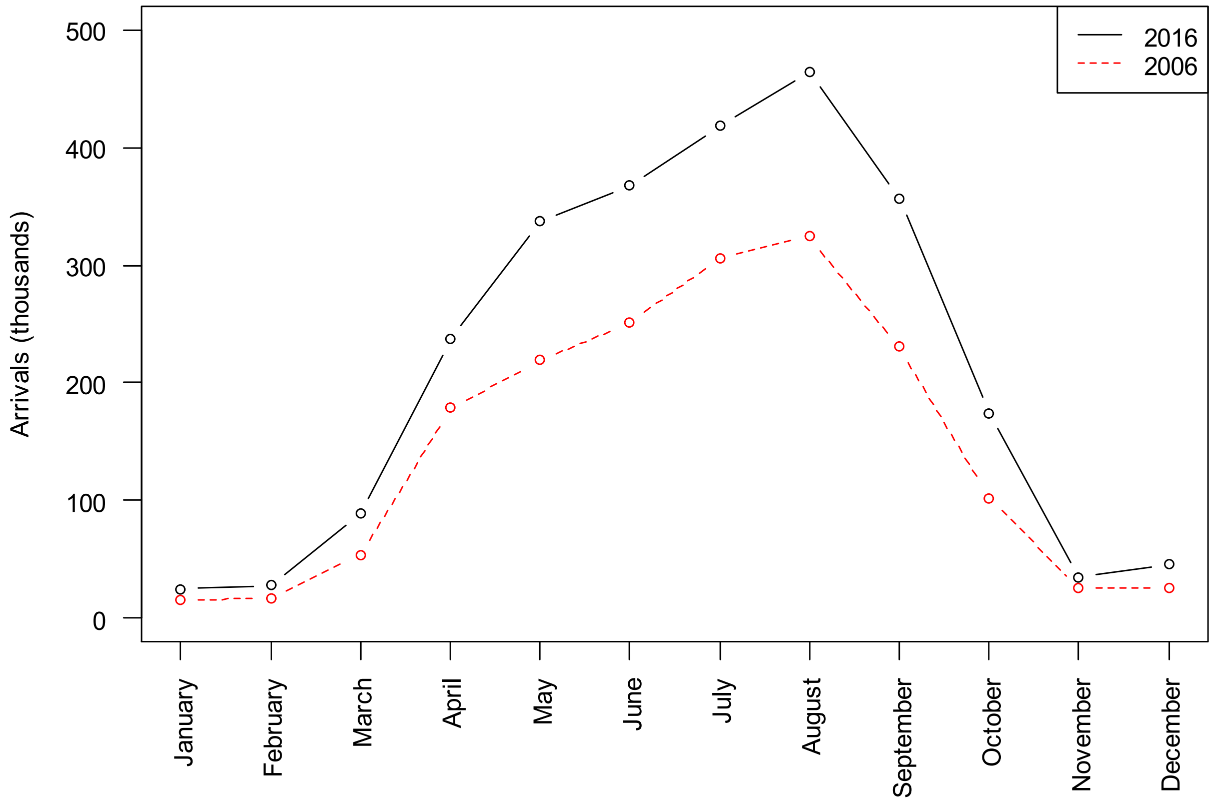
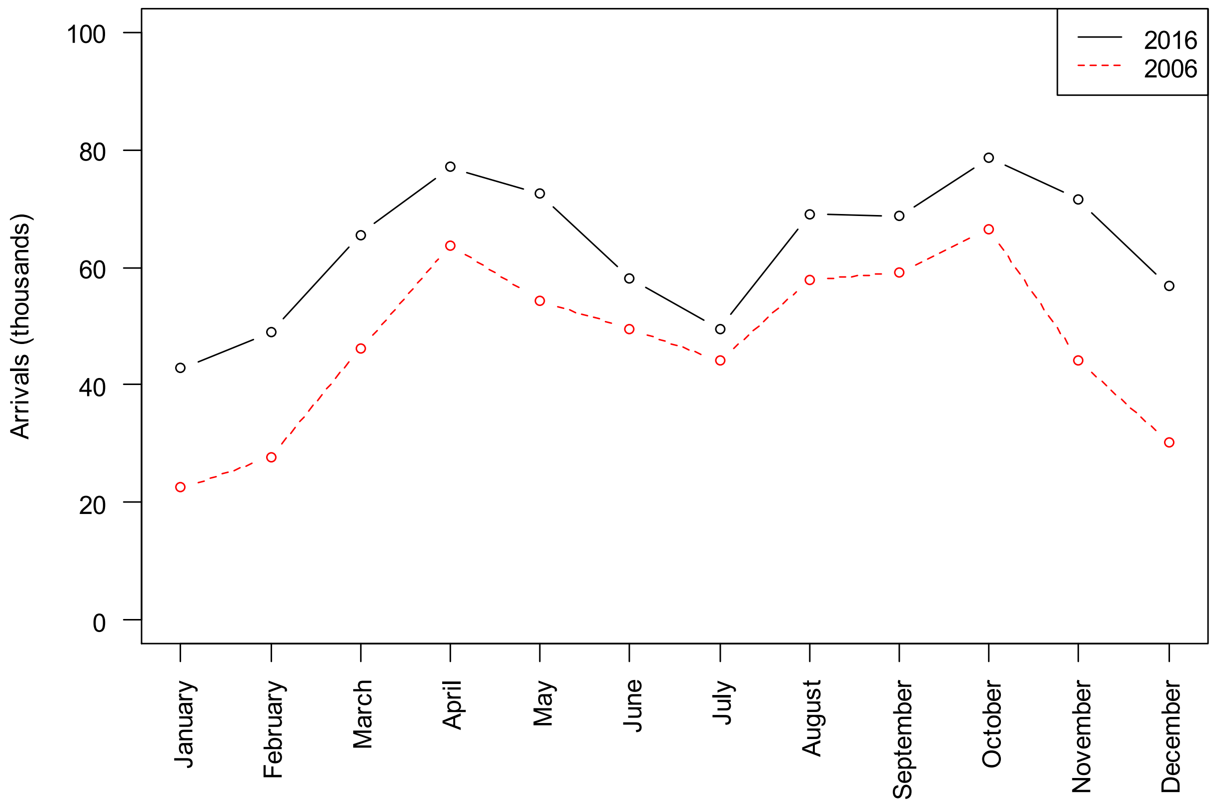
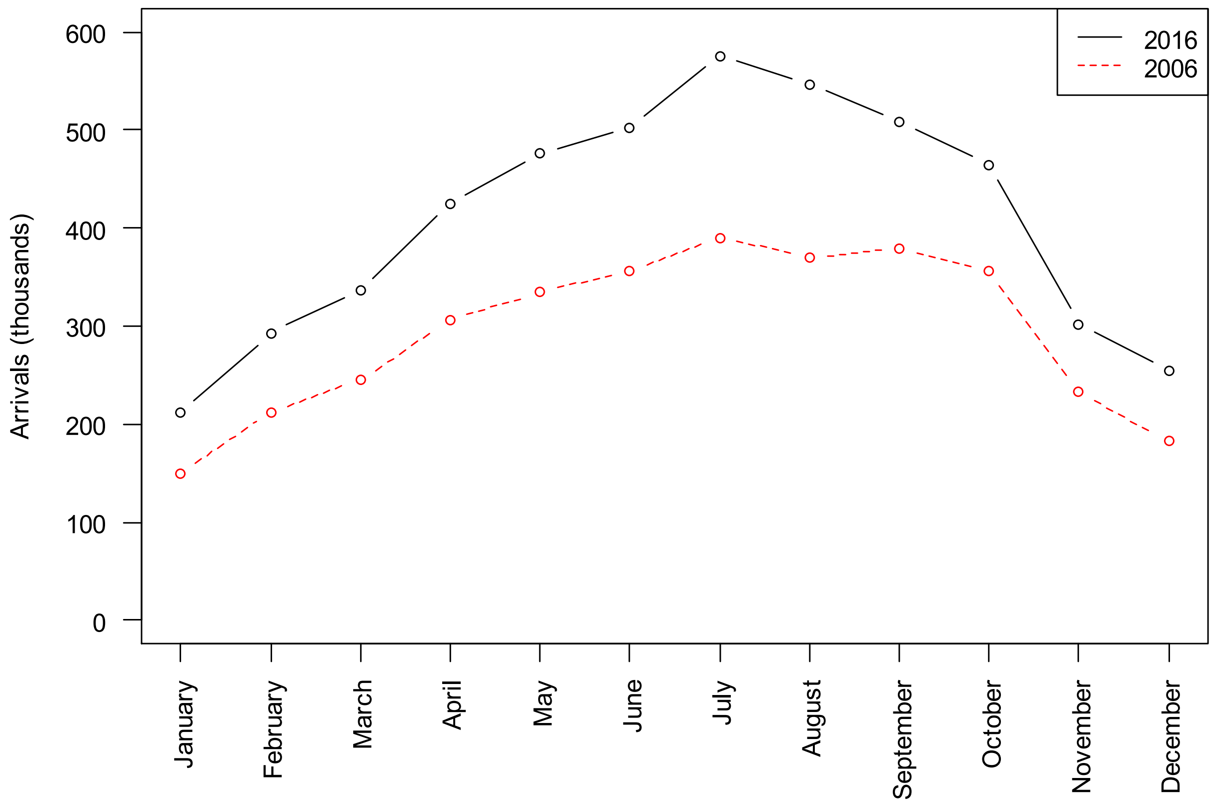


Figure 6: monthly arrivals in the Euganean Spas, 2006-2016.



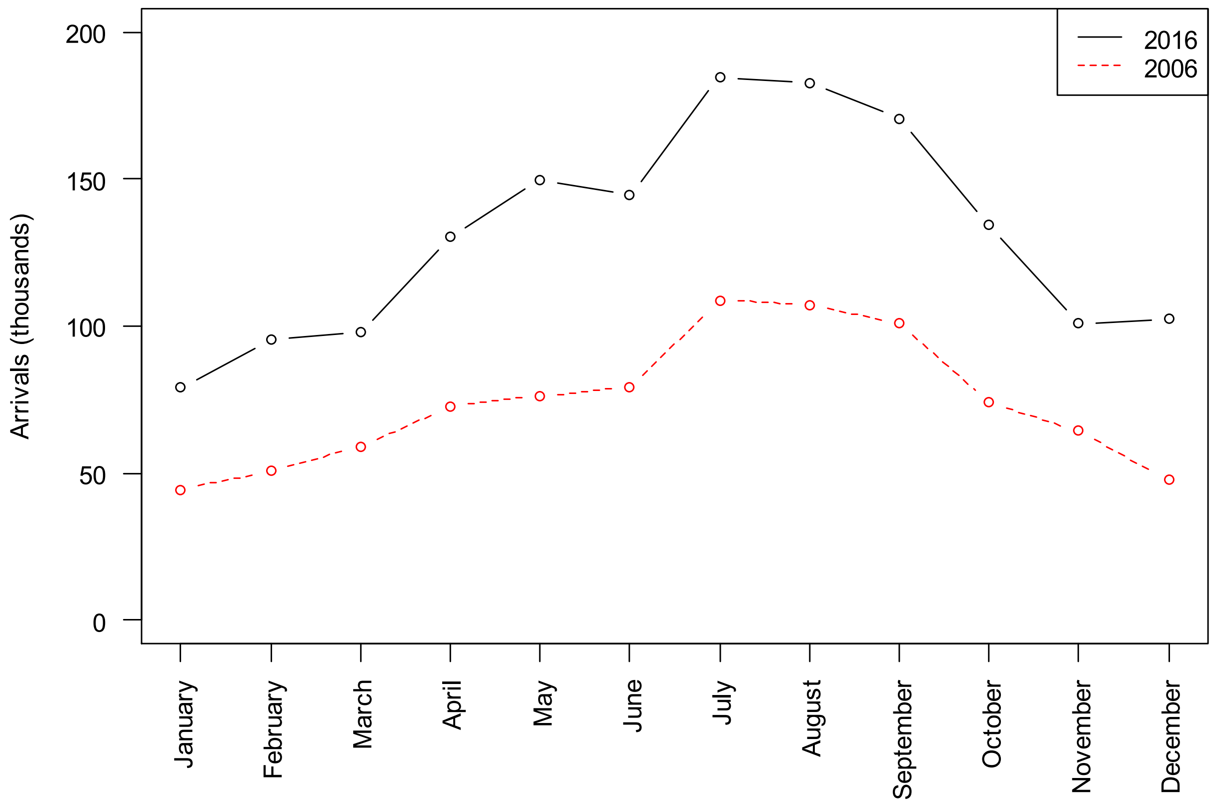
The seasonal concentration slightly increased in Venice (0.009287) over the period considered. Seasonality grew in magnitude and was unstable to some extent. The combination of these changes led to an increase in seasonal concentration in 2016 compared to its level in 2006, as the contribution of the increase in seasonal magnitude was reinforced by the re-ranking of months. While the increase in seasonal magnitude is not statistically significant, the changes in the ranking of months are non-negligible. Figure 7 shows that there was a shift in arrivals from early autumn to late spring and summer. For example, tourist arrivals in May and June overtook those in October in 2016, while August and September exchanged their positions in the ranking of months by tourist arrivals. The impact of such changes on the stability of seasonality are relevant to a destination where the seasonal concentration is low at the start of the period considered, as in Venice in 2006. When seasonality is weak, even small changes in the monthly distribution of tourist arrivals can modify the seasonal pattern, suggesting seasonal instability.

Figure 7: monthly arrivals in Venice, 2006-2016.



The seasonal concentration slightly decreased in Verona (-0.013073). The re-ranking contribution offset the reduction in seasonal magnitude only to a limited extent (-0.015015), and, in any case, is statistically insignificant. Thus, seasonal stability and magnitude in tourist arrivals in Verona have been substantially the same since 2006. Figure 8 shows that seasonal fluctuations in 2016 was similar to 2006. The number of tourist arrivals is greater in a three-month period, from July to September, and decreases in October to around the level from April to June; in the remainder of the year, the number of tourist arrivals is even smaller.

Figure 8: monthly arrivals in Verona, 2006-2016.



5.3 Discussion and policy implications

The Veneto region provides a diversified tourism product, including seaside, lakeside, mountain, cultural and spas tourism. In 2016, almost 18 million tourists came to the Veneto (ISTAT, 2017, p.613), making it the top region in Italy for tourism and fourth in Europe (after Île de France, Catalunya and Andalusia). In addition, arrivals have been increasing over the years, with an average annual growth of 3.2% during the last twenty years. Tourism is the most important sector of economic activity for the Veneto region, accounting for an important share of the regional gross domestic product (8.9% in 2016; Ufficio Statistica Regione Veneto, 2018).

A remarkable trend in the most recent years is the choice of the holiday period: of course, the high season is always the most popular option, but the possibility of travelling at other times of the year is becoming increasingly available to tourists. As shown in our analysis, the seasonal concentration in four tourist destinations (out of six) decreased over the last decade. One of the main reasons for this trend may be the appeal of saving money, which has become crucial in a period of economic crisis. Apart from this general consideration, we analyse the change in seasonality in each of the six Venetian areas and seek to identify policy implications. One general consideration concerns the different types of intervention that could be planned by local policy makers. On the one hand, local authorities could focus on the reduction of seasonality by increasing arrivals in off-season periods. On the other hand, actions could be taken in order to reduce the overall pressure of tourists on the site trying to re-distribute a constant yearly flow of tourists from peak months to the others (Cuccia and Rizzo, 2011). In the following discussion, we argue the first line of action can be applied to all Venetian destinations, with the exception of Venice and Dolomites, where the issue of sustainable tourism should be urgently tackled.

As can be seen from table 4, the seasonal indices of Jesolo-Eraclea are constantly among the highest. Looking at the decomposition of the Gini index (table 6), the increase in seasonal concentration in the observed period is significant and almost totally due to a growth in seasonal magnitude. Like all Italian seaside resorts, Jesolo-Eraclea suffers from the absence of tourists in the winter season, particularly between December and February, the coldest time of the year. This dramatic reduction in tourist influxes in the cold season has significant repercussions in terms of employment and investments in human capital (Krakover, 2000). Considering the high seasonality, the increase in seasonal magnitude and the stability of the seasonal pattern in the last decade, there is room for improvement in the Jesolo-Eraclea area. To attract arrivals out of the traditional summer season, Jesolo-Eraclea could rely on other kinds of resources not directly linked to the weather. Museums and cultural tourism in general might be a good tool to boost arrivals during the low season. An archaeological exhibition and a Natural History Museum are open throughout the year. However, they are the only attractions which remain open in the winter season: the ancient wall can be visited only in September and October, theme and amusement parks are open only from May to September, or in some cases, the off-season months but only at weekends. Water sports are restricted to a few months in the year because of adverse weather conditions, while golf courses are open all year round. Finally, cultural and sport events could be used to reduce the effects of seasonality. Unfortunately, although there is a very intense schedule of events, they are usually scheduled for the weekend. Clearly, constraints related to working activities must be considered, but the closure of most stores and hotels during the winter season does not help. In the winter season, the current situation stimulates very short visits of no more than two days. Keeping stores and hotels open, combined with strong pricing strategies and social media campaigns, could attract more tourists outside the summer season. The mountain destination studied is in the Dolomites, where the seasonal magnitude and pattern did not change significantly over the decade investigated (see table 6), with peaks in the summer and winter seasons. Although seasonality is almost constant, it could be reduced by enhancing the less popular tourist attractions in the area. For instance, strategies to attract more tourists could be implemented in autumn with its wonderful variety of coloured foliage and the potential for trekking in the woodlands and sampling the traditional local cuisine. In this region seasonality is one of the the most significant issues in tourism sustainability and there are concerns about the inefficient use of both public and private resources (Rosellò et al., 2004). Local authorities in the area are very mindful of maintaining the fragile balance between a unique natural environment and tourist flows. Following the European strategy 2020, the governance of the Dolomites National Park could stimulate the competitiveness of the tourist industry, with firms able to adapt to the evolution of the market and new technologies seeking to reduce seasonality and diversify tourist products. Sustainable, responsible and seasonally adjusted tourism could be achieved by raising awareness among tourists and operators and by developing a brand for high-quality tourism with a charter on sustainable and responsible tourism (Mathew and Sreejesh, 2017).

The lakeside destination we studied is the eastern coast of Lake Garda, the largest and best-known Italian lake. The Lake Garda tourism product is more diversified than a seaside resort like Jesolo-Eraclea since it is based not only on the sun and beaches but also on sport, leisure and cultural activities. As can be seen from table 6, the magnitude of seasonality has significantly decreased whereas the seasonal pattern has remained the same. Tourists in the Lake Garda area are mostly from German-speaking countries and from the Netherlands. As in the seaside destination, tourist flows on the lake are characterized by an unequal distribution during the year with a peak in the summer season. Despite the presence of foreign tourists, who have quite long holidays throughout the year, the tourist season on the lake usually starts in April and ends in September-October: most arrivals (73%) are in these months. Another element increasing seasonality is the preference of many foreign tourists for open-air accommodation, i.e. for the warmest months of the year. Local authorities are trying to reduce seasonality by promoting congress and business tourism and by organizing events to attract arrivals in winter months, particularly during the Christmas holidays, taking advantage of the mild weather on the lake. Some efforts should be made in the immediate future to reduce seasonality by supporting open-air sports such as trekking, climbing and cycling, not restricted to the summer season. The latter could be boosted by creating new cycle-paths, well developed on the western shore of the lake. Another attraction is local food and wine which should be better advertised. A special segment of tourists, which should not be underestimated, is the elderly (Huber et al., 2018), who love the mild weather of the lake in the off-season period and considers the lake an ideal base for excursions to the nearby art cities. Generally, they seek relaxation and a passive way of life which can be provided in seasons other than summer, reducing the level of seasonality.

The fourth destination analysed is the Euganean spa area, a very attractive destination for health and wellness tourism, with origins dating back to Roman times. The reduction in seasonality of this destination is the largest in absolute and relative terms: the Gini index drops from 0.163519 to 0.100375. The reduction is highly significant in magnitude, with a p-value less than 0.01, while the seasonal pattern is not fully stable (the p-value for the seasonal stability component is 0.06, near to the standard significance threshold of 0.05). Spa destinations generally can be seen as locations that, at lower prices, complement, , the tourist industry of nearby art cities such as, in our case, Venice and Verona. This is particularly true for non-Italian tourists who like to spend the night at spa resorts, to visit art cities and to enjoy the relaxation and wellness provided. Moreover, Euganean spas are perfect locations for congresses and cultural events. This link to art cities has contributed to the reduction in seasonality in recent years. Another factor which could reduce seasonality is the development of green tourism, recently strengthened for example by the improvement in some infrastructure, such as the ring of Euganean hills with long bike routes following the banks of the canals surrounding an isolated group of hills, the path of Monte Venda for long walks and the ancient Battaglia Canal which curves south towards the Euganean Hills. However, Euganean spa tourism is a mature product, strongly related to wellness and relaxation and requires long-term residence in order to be effective, contrary to the most recent tourist trends of short-term residence (Page et al., 2017). This has maintained a good level of arrivals, but reduced profitability. Hence the need for product innovation with a younger target combining wellness, relaxation and leisure.

Finally, we examined the changes in the concentration of tourist arrivals in two famous art cities, Venice and Verona, providing a wealth of opportunities for cultural tourism in the Veneto region. Although tourist flows in art cities are usually less affected by seasonality than seaside destinations, tourist arrivals in the two cities are so numerous that their concentration in a few months or weeks creates a problem for tourism sustainability (Manning and Powers, 1984), especially in the case of Venice. More than 50% of total arrivals in the Veneto are to the principal art cities. Although seasonality in these cities is quite small, compared to seaside, mountain and lakeside destinations, relatively small changes in the magnitude of seasonal fluctuations could create a certain instability in the seasonal pattern, as observed in Venice (see table 6 and figure 7). At the same time, seasonal concentration has not changed significantly in Verona, although the local authorities are aware of a potential problem. The local administration of Venice has implemented major actions, since summer 2017, to address the critical situation linked to the sustainability and seasonality of the tourist flow (Higgins-Desbiolles, 2018). It has been estimated that the sustainable number of daily visitors in Venice is around 22 thousand (Città di Venezia, 2017). This critical threshold is frequently exceeded during the year since overnight visitors are not the sole tourists; there is a huge influx of day-trippers,[8] especially in the summer, with spikes of over 115 thousand people on several days in 2016. These

[8] The daily average of people visiting Venice was higher than 60 thousand in 2016.

dramatic figures raise several issues which must be addressed in an area such as the Venice lagoon to avoid permanent damage to the environment (Mihalic, 2016) and the continuing depopulation of the ciy (Seraphin et al, 2018).

The number of visitors usually increases from Friday to Sunday and is significantly lower during weekdays. Although the weather considerably influences the trend, from mid-July to mid-August the sum of overnight visitors and day-trippers is constantly over 100 thousand per day (Città di Venezia, 2017). According to the plan written by the municipality of Venice in 2017 (Città di Venezia, 2017), at least three actions are required to achieve the goal of sustainable tourism in the Venice area:

- the creation of a well-trained group of police officers and tourist operators. The main objective of this action is to regulate and supervise the historical area by guiding visitor flows, distributing brochures with rules of behaviour, checking for misconduct and reporting inappropriate behaviour.
- An intense and extensive behavioural and educational campaign through web, social and traditional communication channels to inform tourists about the fragility and uniqueness of the environment they are visiting.
- A communication campaign to regulate tourist flows and reduce the weekly and monthly seasonality of arrivals. The information should include data about the days and the seasons with the highest tourist pressure according to previous years. Historical data could be combined with real time data collected through “intelligent” cameras able to record the number of people present in a particular zone.

After Venice, Verona is the second most visited art city in the Veneto. The pressure of tourism flows is particularly felt during the summer months of July-September, when the Opera season at the Arena attracts additional flows of tourists added to ordinary arrivals. The issues of sustainability and seasonality are not as strong as in Venice, but are present.. One possibility would be to target a tourist group recently in the spotlight: senior citizens or over-sixties travellers who, due to new demographics and life-style changes, now represent a new market segment. The high quality of food and wine in Verona added to its elderly-friendly tradition are attractive factors for this segment of tourists. This group of tourists fits well with the idea of quality tourism because they have higher levels of disposable income than young people and could contribute to the reduction in seasonality through their willingness to travel off-season (Pegg et al, 2012).

6. Conclusions

The concentration of tourists in short periods of the year, known as seasonality, is one of the main issues to address in the management of tourist flows in tourism destinations. The negative effects of this phenomenon are well-known and widely discussed by practitioners and in the academic literature (see, for instance, Baum, 1999; Butler, 2001; Koc and Altinay, 2007; Figini and Vici, 2012). Monitoring the evolution of seasonal concentration in tourist flows is a priority for both public and private actors in the tourism industry. The application of statistical tools is needed to measure the changes in seasonal concentration.

In this paper, we have shown that the use of conventional concentration indices to monitor the change over time in seasonal concentration can lead to misleading conclusions, as such indices do not respond to changes in the seasonal pattern, which is an essential feature of seasonality. We suggest overcoming this issue by decomposing the change in the Gini index, a widely used measure of seasonal concentration, into two components, one tracking the changes in the seasonal pattern, namely a seasonal stability component and the second measuring the changes in seasonal magnitude, obtained by excluding the effect of changes in the seasonal pattern. The decomposition provides analysts and local policy makers with additional information on changes in seasonal concentration, as a small or even no change in the concentration index may be the outcome of the offsetting contributions of changes in the seasonal pattern and magnitude. Furthermore, to assess whether the changes in the seasonal pattern and magnitude are significant, we suggest a statistical procedure for testing hypotheses about seasonal stability and magnitude components. Such a procedure builds on the Rey and Sastré-Gutiérrez (2010) technique to test the statistical significance of a change in a concentration index. We have developed the Rey and Sastré-Gutiérrez (2010) technique in order to test hypotheses concerning the two components obtained by breaking down the change in the concentration index.

The decomposition and the testing technique comprise a statistical tool that can be used by local authorities and private actors in the tourism sector to monitor the evolution of seasonality and the impact of counter-seasonal initiatives on seasonality components. For instance, local policy makers can assess whether a counter-seasonal initiative has been successful in mitigating seasonality by looking at the seasonal magnitude component, while the seasonal stability component tells them whether a shift in the timing of fluctuations in tourist flows has occurred.

The decomposition and tests were applied to study the changes of seasonality in six main tourist destinations of the Veneto region in Northern Italy from 2006 to 2016. To the best of our knowledge, this is the first study that measures and decomposes the changes in seasonal concentrations in the most popular Venetian tourism destinations. The analysis of the evolution of seasonal concentration is in accordance with one of the main goals of the "Strategic Plan for Tourism 2017-2022" drawn up by the Italian Ministry of Cultural Heritage and Activities; i.e. to expand and diversify tourist products in order to mitigate seasonality and its negative effects. The plan suggests focusing on new market segments and products with high potential in the medium and long term and on the most suitable ways to reduce seasonality and territorial concentration (Italian Ministry of Cultural Heritage and Activities, 2017).

Our results show that the magnitude of seasonality significantly increased in Jesolo-Eraclea, where the tourism product is based on the sun and beaches; whereas seasonal magnitude significantly decreased for the eastern shore of Lake Garda, which provides a more diversified tourism product compared to Jesolo-Eraclea. The largest and most significant decrease in seasonal magnitude occurred in the Euganean Spas. The seasonal pattern of tourist arrivals in Venice was unstable to some extent, whereas the seasonal magnitude did not change significantly. There were no significant changes in the seasonal pattern and magnitude in the other two destinations we analysed, i.e. Verona and the Dolomites.

To recap, two main points emerge from our analysis of the changes in the seasonal concentration in six famous Venetian tourism destinations from 2006 to 2016. First, although the destinations have different features and seasonal concentration levels, the seasonal pattern remained substantially stable in all except Venice. Second, the magnitude of seasonality significantly decreased in some destinations with a diversified tourism product, such as the Euganean Spas and Lake Garda, whereas it increased in Jesolo-Eraclea, which has the least diversified tourism product.

Natural directions for future research include the application of the decomposition and tests to tourism time series with a different frequency (weekly, daily), provided such data on tourist flows are available, and the study of the exact distributions of the test statistics concerning the components of the change in seasonal concentration. It is worth mentioning that the test is based on Monte Carlo simulations carried out every time a new time series is analysed. Although the computational burden of the Monte Carlo procedure is very low, less than one second for 10000 replications, further research may investigate the exact distribution of each test statistic.

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Appendix A

Monthly arrivals in the LTSs of Veneto region. Years 2006 and 2016 are compared.

Table A1: decomposition of the change in seasonal concentration between the 2006 and 2016 distributions of tourist arrivals.

	Indexes		Variation	Components		Permutation test	Scaled-permutation test		
LTS	G_{2016}	G_{2006}	ΔG	R	M	$p(\Delta G \mid H_0)$	$p(\Delta G \mid H_0)$	$p(R \mid H_0)$	$p(M \mid H_0)$
Jesolo-Eraclea	0.475891	0.437106	0.038785	0.018484	0.020301	0.300	0.092	**0.046**	0.258
Dolomites	0.405874	0.396726	0.009148	0.006216	0.002932	0.814	0.440	0.061	0.796
Lake Garda	0.412814	0.441781	-0.028967	0.011028	-0.039995	0.592	0.181	**0.020**	0.057
Euganean Spas	0.088917	0.156583	-0.067666	0.011890	-0.079556	0.192	**0.024**	**0.019**	**0.004**
Venice	0.155326	0.156951	-0.001625	0.000203	-0.001827	0.971	0.737	0.155	0.706
Verona	0.148758	0.169637	-0.020879	0.000748	-0.021627	0.749	**0.032**	0.581	**0.034**

Note: Bold indicates a pseudo p-value lower than 0.05.

Figure A1. Monthly arrivals in Jesolo-Eraclea, 2006-2016

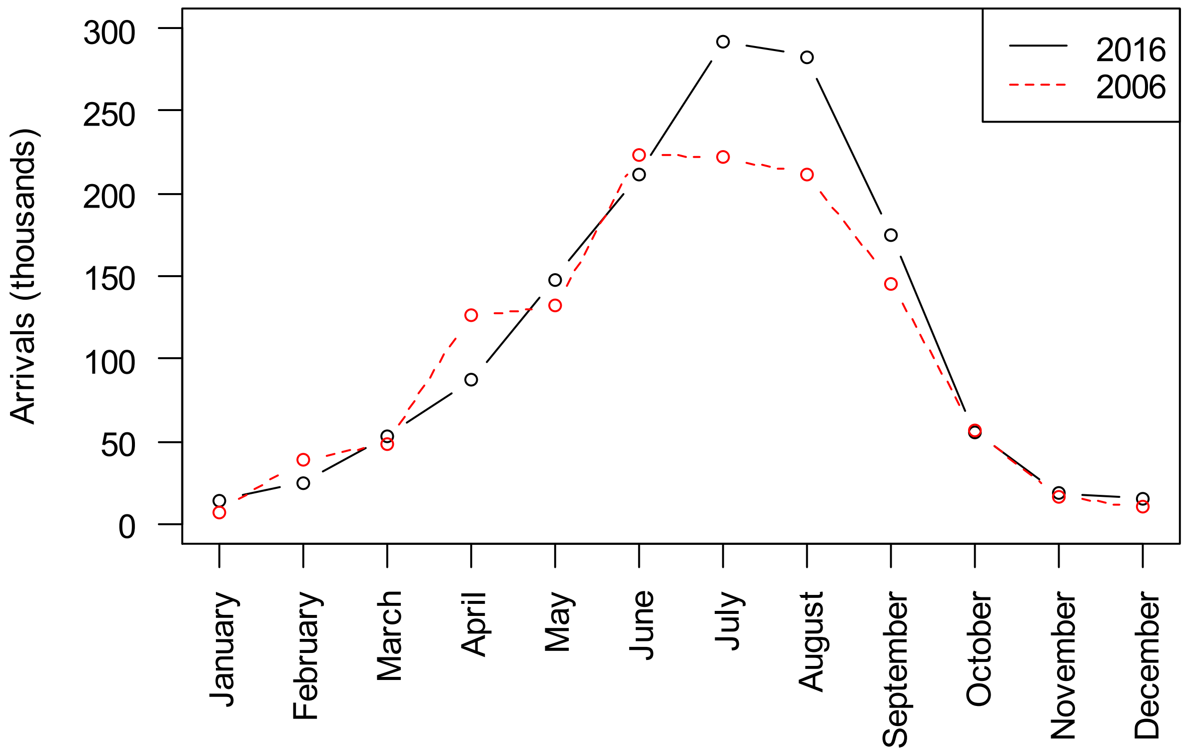


Figure A2. Monthly arrivals at Dolomites, 2006-2016

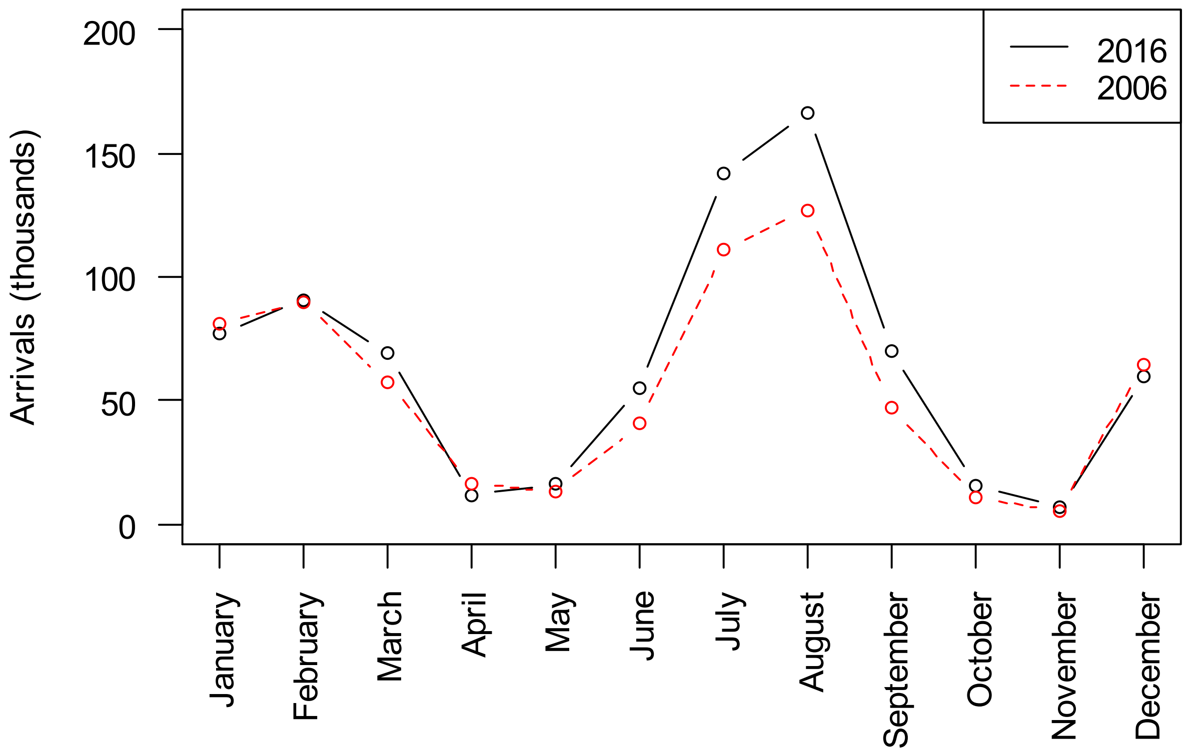


Figure A3. Monthly arrivals at Lake Garda, 2006-2016

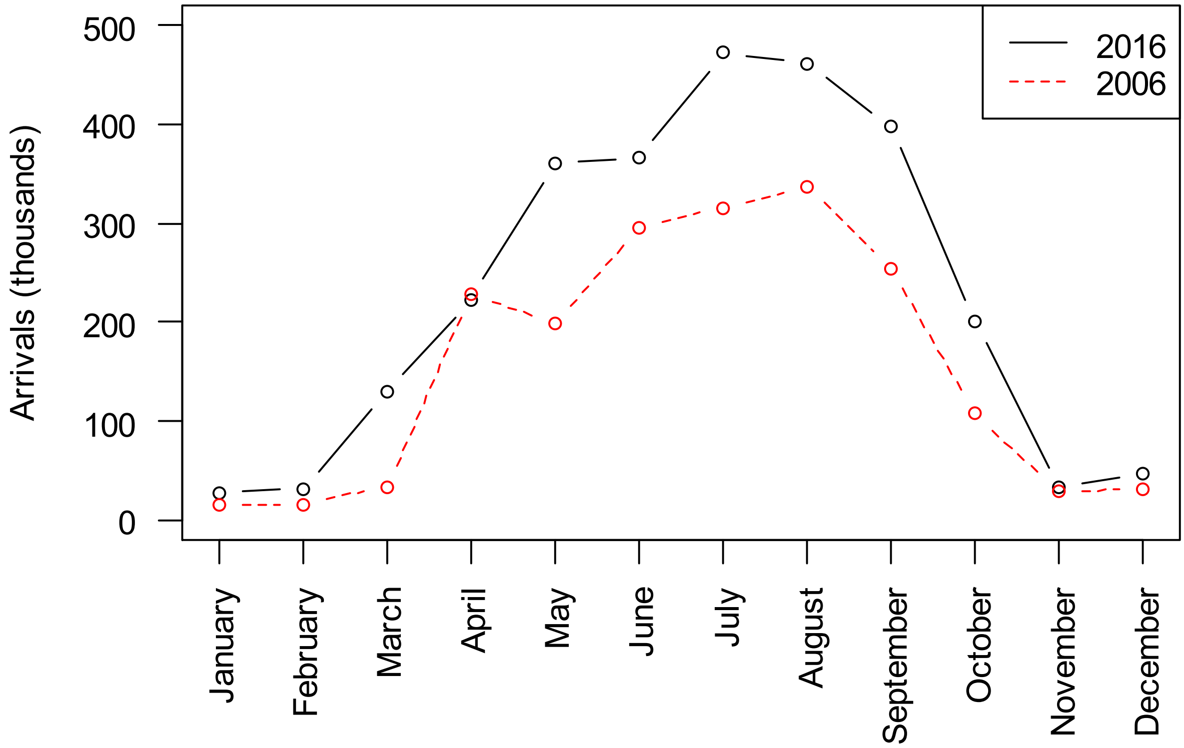


Figure A4. Monthly arrivals at Euganean Spas, 2006-2016

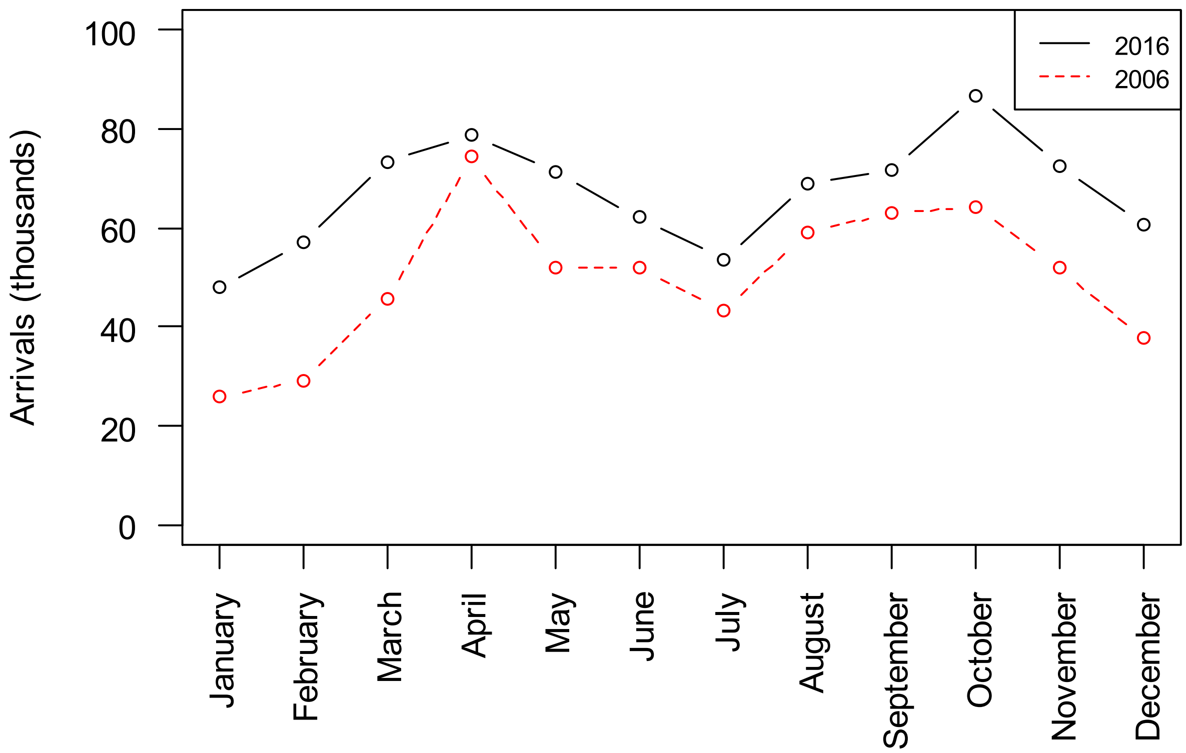


Figure A5. Monthly arrivals in Venice, 2006-2016

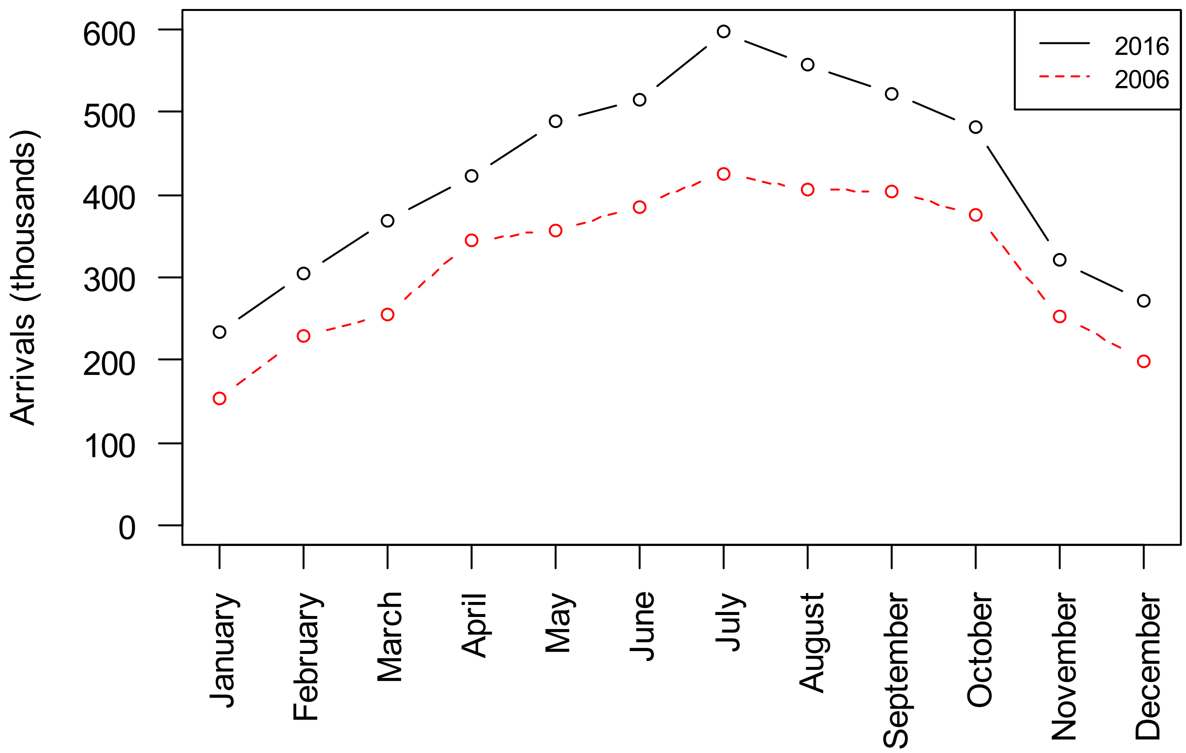
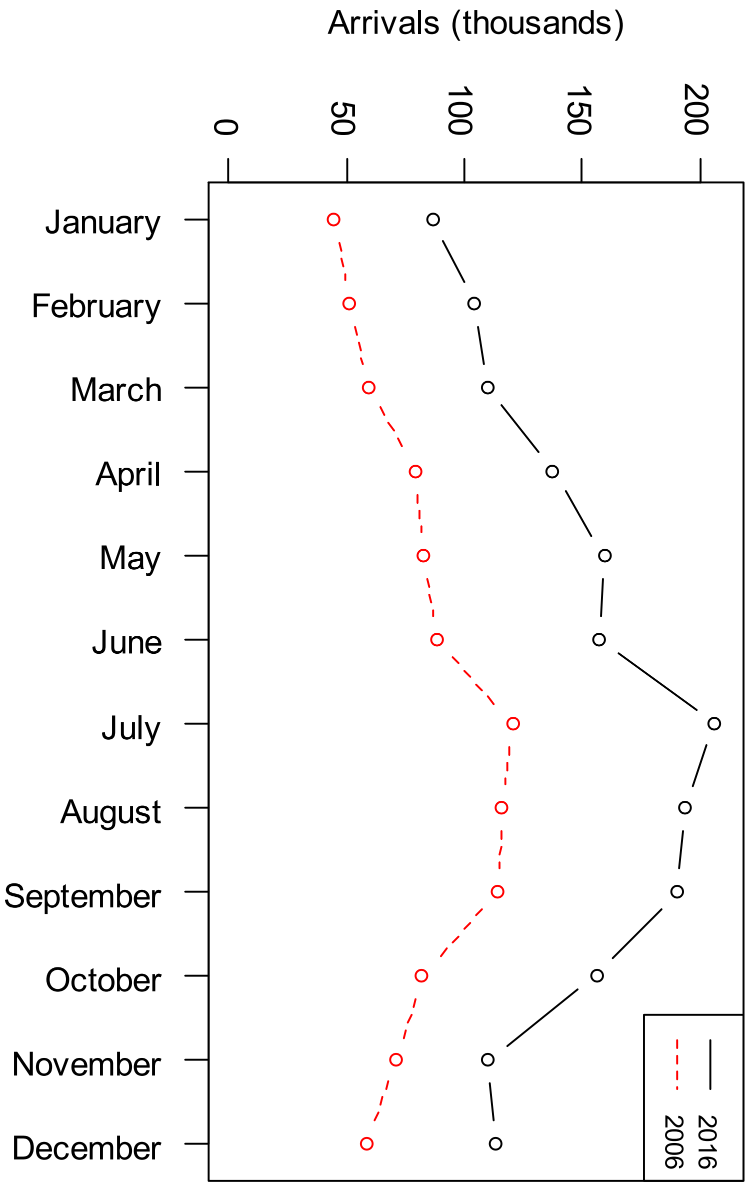


Figure A6. Monthly arrivals in Verona, 2006-2016


Arrivals (thousands)
0
50
100
150
200
January
February
March
April
May
June
July
August
September
October
November
December
2016
2006