# Examining the relationship between Tourism Seasonality and Tourism Carrying Capacity indexes for the Greek prefectures

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***Abstract***
*Tourism seasonality and tourism carrying capacity are major issues in the study of the tourism phenomenon. Destinations with high values in related indexes are faced with tourism saturation and sustainability. Within this context, this paper examines the relationship between tourism seasonality and tourism carrying capacity of the Greek prefectures, on data referring for the year 2018. The analysis measures tourism seasonality based on the Relative Seasonal Index (RSI), while for measurement of tourism carrying capacity (TCC) used an index consisting of fourteen sub-indices. The two variables are examined by using statistical techniques to classify the Greek prefectures by their performance. In further analysis, is applying a simple linear regression and outlier cases identified. The overall approach proposes a useful quantitative tool for tourism management and regional development because it allows considering in common the temporal and spatial dimensions of the tourism seasonality phenomenon.*

Keywords: tourism seasonality; tourism carrying capacity; regional development; spatial distribution; classification

JEL classifications: C18, O52, R10, R58, Z30.

## 1. INTRODUCTION

Tourism seasonality is a complex global tourism phenomenon, with temporal, spatial, and socio-economic dimensions, which presents differences, both between countries and within countries (Tsiotas et al., 2020a). The phenomenon refers to the unequal distribution of tourist demand, in a specific destination, during a year (Butler, 2001; Batista et al., 2019). Within this framework, an important issue of research in tourism economics is dealing with tourism seasonality (Tsiotas, 2017; Ferrante et al., 2018), since sets natural, economic, cultural, structured, and anthropogenic aspects under great pressure during peak months, in which the tourism carrying capacity of destinations is violated (Martin et al., 2019).

The World Tourism Organization defines the tourism carrying capacity as the maximum number of people who can, at the same time, visit a tourist destination, on the one hand without causing damage to the natural, economic, and socio-cultural environment and on the other hand, without reducing satisfaction of visitors (UNEP, 1997). The more in-depth analysis of these issues is more significant nowadays given that in recent years the number of people traveling around the world is increasing. In destinations such as Barcelona (Doods and Butler, 2019), Venice (Seraphin et al., 2018), and Reykjavik (Saepordottir et al., 2020), are observed problems of over-tourism (OECD, 2018). In such situations, the levels of tourism development exceed the maximum limits of the destination (Wang et al., 2020) and consequently cause significant problems in various sectors such as the environment, society, and the economy (Kyriakou et al., 2011; Jurado et al.,2012; Attallah, 2015; Koens, 2018; Menegaki, 2018), leading to loss of uniqueness and authenticity of a destination (OECD, 2018). In such a context, in recent decades, the concept of tourism carrying capacity (TCC) has been developed as a means of controlling tourism development and avoiding the negative impacts (Polyzos, 2019).

Tourism seasonality and tourism carrying capacity related as according to the intensity and concentration of tourism demand can induce consequent uneven pressures in the natural, economic, cultural, and structured environment (Jurado et al., 2012; Ahmad et al., 2020). For quantifying tourism seasonality, common indicators are the seasonality range and ratio, the coefficient of seasonal variation, the seasonality span, the seasonality underutilization factor, the share of seasonality (Duro, 2016), the Gini coefficient, and the Theil index (Fernandez-Morales et al., 2016; Porhallsdottir and Olafsson, 2017), the Relative Seasonal Index - RSI (Lo Magno et al., 2017; Ferrante et al., 2018; Tsiotas et al., 2020a), and the synthetic index $DP_2$ (Martin et al., 2019). Although the RSI is more demanding in computations (Tsiotas et al., 2020a), is also more reliable than the most widely-used Gini (Lo Magno et al., 2017; Ferrante et al., 2018; Tsiotas et al., 2020a) and will be used on analysis.

On the other hand, the tourism carrying capacity, having physical-ecological dimensions, socio-demographic dimensions, political-economic dimensions (Coccossis and Mexa, 2004; Nghi et al., 2007), biophysical and psychology dimensions (Attallah, 2015), is difficult to be determined by a number (Jurado et al., 2012, Lagos et al., 2015; OECD, 2018) and proposed the use of a set of sustainable tourism indexes (Kyriakou et al., 2011; Jurado et al., 2012). The tourism carrying capacity is complex and is the result of the carrying capacity of all the dimensions (Marzetti and Mosetti, 2005). In literature, tourism carrying capacity is dealing with different perspectives and various methodologies. Descriptive approaches are based on the DPSIR model to describe the situation in Costa del Sol, Malaga of Spain (Jurado et al., 2012), in Mantova of Italy (Castellani et al., 2007), Mediterranean cruise destinations (Stefanidaki and Lekakou, 2014), or the concept of carrying capacity applied in Greek islands of Rhodes and Kos (Lagos et al., 2015). More complex approaches have used the method of least squares in regression analysis (Urtasun et al., 2006), Dynamic systems models (Wang et al., 2020), Linear programming (Feliziani and Miarelli, 2012), and Fuzzy Logit Models (Canestrelli and Costa, 1991; Bertocchi et al., 2020).

Tourism is related to regional development, and thus seasonality can induce economic and social imbalance in regional economies (Polyzos, 2019). In this framework, recent studies approach the phenomenon of tourism seasonality as an aspect of the regional problem (Batista et al., 2019; Martin et al., 2019; Tsiotas et al., 2020a), which can further relate to tourism carrying capacity (Coccosis and Mexa, 2004; Jurado et al., 2012) and tourism saturation (Tsiotas et al., 2020b). However, the relation between tourism seasonality and tourism carrying capacity indexes has not yet been studied in a comprehensive context. This paper aims to fill this gap by focusing on the prefectures of Greece, which is a coastal country with a mixed mountainous, land, coastal, and insular morphology, consisting of more than 55km2 mountainous areas, more than 16,000 km of coastline, and more than 1,350 islands, islets, and rocky islands, of which over 230 are inhabited (Tsiotas, 2017). The overall contribution of the tourism sector to GDP reached 20,8%, with total foreign arrivals (without arrivals from cruises) at 31,3 million visitors (Ikkos and Koutsos, 2020), although there are significant inequalities among the Greek prefectures (Polyzos, 2019; Krabokoukis and Polyzos, 2020a) as a number of mainland prefectures considered as less attractive (Krabokoukis and Polyzos, 2020b) fact that lead significant touristic destinations to saturation (Tsiotas et al., 2020b).

The remainder of this paper organized as follows: Section 2 describes the methodological framework of the study, the available data, and the variables participating in the analysis. Section 3 presents the results and discusses them within the context of regional science and tourism development. Finally, in Section 4, the conclusions are given.

## 2. METHODOLOGY AND DATA

The methodological framework of the study builds on correlation analysis applied to the variables of tourism seasonality and tourism carrying capacity. The variable of tourism seasonality is configured by computing the Relative Seasonality Index (RSI) proposed by Lo Magno et al. (2017). Previous studies have shown that the RSI index is considered a more effective measure for seasonality than the Gini coefficient (Lo Magno et al., 2017; Ferrante et al., 2018; Tsiotas et al., 2020a). The mathematical expression is described by the mathematical formula:

$$S_R(\mu, C) = \frac{\sum_{i\in A}\sum_{j\in B} c_{ij}x_{ij}}{\mu * max_{i\in M}\{\sum_{j\in M} c_{ij}\}} \quad (1)$$

where $x_i$ is the i-th observation of a time-series x (expressing a tourism-variable), μ is the average value of the available observations, C is the total cost for eliminating seasonality, A is the set of high-season time periods, B is the set of low-season time periods, and M is the set of all possible observed time-patterns.

The variable of tourism carrying capacity (TCC) is configured by computing 14 variables (codes and names of the variables are shown in the Appendix). The mathematical expression of TCC is described by the mathematical formula:

$$TCC_i = \sum B_i M_i \quad (2)$$

where i is the observation, B is the weight of each of the 14 variables, M is each of the 14 variables. It was considered that all variables are equal and thus, their total weights are equal to one.

Both variables RSI={Si | i=1,...,51} and TCC={r(t)i | i=1,...,51} are computed for the year 2018. After computing the available variables RSI and TCC, further analysis is applied. At the first level, the scatterplots RST*TCC of these variables constructed, and the available 51 prefectures grouped into quadrants (Low Saturation-Low Seasonality, Low-High, High-Low, and High- High) defined by the average lines per axis to show the relationship between the two variables (Boslaugh and Watters, 2008). At the second level, using Pearson's correlation analysis (Norusis, 2011) between the two variables to determine the strength and direction of the relationship (Boslaugh and Watters, 2008). The mathematical expression of the Pearson correlation is described by the mathematical formula:

$$r_{XY} = \frac{cov(X,Y)}{\sqrt{var(X) * \sqrt{var(Y)}}} \quad (3)$$

where cov(X,Y) is the covariance of variables X,Y and $\sqrt{var(.)}$ is the sample standard deviations. Pearson's coefficient of correlation ranges in value from −1 to 1 (Boslaugh and Watters, 2008). Values close to zero represents weak relationships among the variables, while values close to one represents strong relationships (either negative or positive).

At the final level of analysis, the regression coefficient is estimated under the Ordinary Least Square algorithm. The outlier cases and the leverage statistic, are identified. As outliers considered the cases exceeding the zone defined by the 95% contінence intervals (CI). On the other hand, the leverage statistic is applied to identify influential cases in the model (Norusis, 2011). The leverage score is described as $h_i$ which is the i-th diagonal element of the projection matrix $H = X(X^T X)^{-1} X^T$. This approach aims to detect the cases (prefectures) that interrupt the consideration r (RSI, TCC).

## 3. RESULTS AND DISCUSSION

The results of the first part of the analysis, which builds on correlation scatterplots RSI*TCC, are shown in Fig.1 (codes and names of the variables are shown see in the Appendix). In this figure, the relevant map shows the spatial distribution of the Greek regions according to the quadrant grouping defined by the RSI and TCC average reference lines. As it can be observed, an arc of LL (Low Tourism Carrying Capacity - Low Tourism Seasonality) cases is configured in mainland Greece, which is composed of twenty-five of a total of fifty-one prefectures. These prefectures are Rodopi (1), Drama (2), Evros (3), Xanthi (5), Imathia (7), Kilkis (8), Pella (9), Serres (11), Kozani (13), Grevena (14), Kastoria (15), Florina (16), Ioannina (17), Arta (18), Larisa (21), Karditsa (22), Trikala (24), Fthiotida (25), Viotia (26), Evritania (28), Fokida (29), Achaia (34), Aitoloakarnania (35), Arkadia (37), Korinthia (39). According to this map, the LL behavior seems to be attributed to geographical centrality and mainland formation.

On the other hand, the pattern of the spatial distribution of the HH (High Saturation-High Seasonality) cases appears more as a matter of insularity and coastal morphology of the Greek regions. In particular, the HH prefectures are the Halkidiki (12) in northern Greece, the Argolida (38) in southern mainland Greece, the island prefectures in the Ionian Sea (east Greece), Kerkyra (30), Zakinthos (31), Kefallonia (32), Lefkada (33), the island prefectures in Aegean Sea Cyclades (46), Dodecanese (47), Samos (44), and the four prefectures of Crete, Heraklion (48), Lasithi (49), Rethymno (50), and Hania (51). This spatial imbalance of the HH cases complies with other literature findings (Tsiotas et al., 2020b) describing the sea-driven (3S) configuration of the tourism product in Greece.

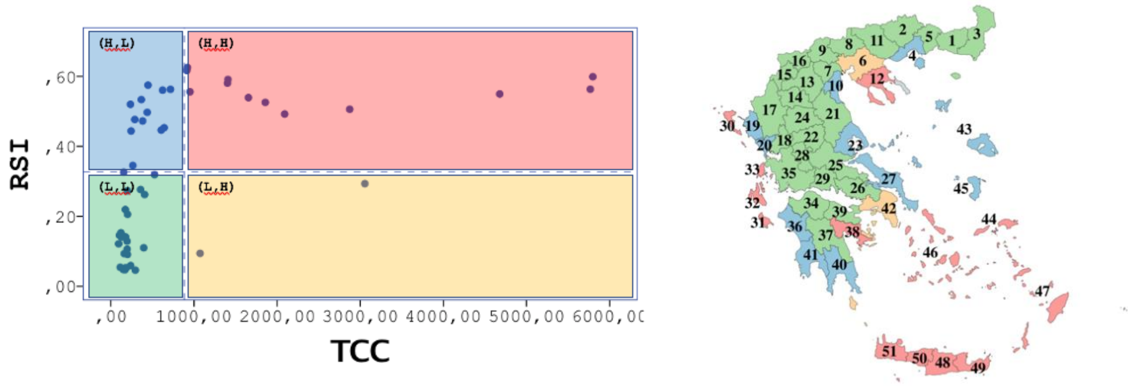


**Figure 1: The spatial Greek prefectures according to their seasonality (RSI) and tourism carrying capacity (TCC).**

Next, the prefectures of Attiki (42) and Thessaloniki (6), which includes the most populous cities of Greece, are the only LH cases described by low seasonality but high tourism carrying capacity. This result is confirmed by previous studies, which have shown that these prefectures have also high levels of tourism saturation (Tsiotas et al., 2020b). Finally, the coastal prefectures of Kavala (4), Pieria (10), Thesprotia (19), Preveza (20), Magnesia (23), Ilia (36), Lakonia (40), Messenia (41), and the island of Evia (27), Lesvos (43), Chios (45), are HL cases described by high seasonality but low tourism carrying capacity.

At the next step, a parametric bivariate correlation analysis is applied to the variables RSI and TCC, the results of which are shown in Table 1. As it can be observed, the correlation between tourism carrying capacity and seasonality is highly significant (implying that is less than 1% possibility to be a matter of chance) but the value of coefficient is not very high (ranging between 0.418-0.601), implying not a strong linear relation between the variables, as shown from Fig.1.

**Table 1: Results of the correlation analysis between tourism seasonality (RSI) and tourism carrying capacity (TCC).**

| | | TCC |
|---|---|---|
| RSI | Pearson correlation | 0.492** |
| | Sig. (2-tailed) | 0.000 |
| | N | 51 |

**. Correlation is significant 0.01 level (2-tailed)

Within this context, the third part of the analysis attempts to examine which prefectures are considered as outliers in the linear relation between tourism saturation and seasonality. The analysis builds on a linear regression model. Given that the relation between the two variables is not linear (Adjusted R Square is 0.227), the logarithm of TCC is chosen for further analysis. After the transformation, the Adjusted R square is 0.484. To ensure that the assumptions of the linear regression method were met, we tested for normality, homoscedastic, and linearity and found neither to be a problem. The Kolmogorov-Smirnov and Shapiro-Wilk tests have p-values of 0.200 and 0.489 (>0.05) respectively, while Durbin-Watson has a value of 2.087 (close to 2) (Norusis, 2011). The p-value of ANOVA is low (0.000<0.05), and thus model adapted well in data. The coefficient values of a constant term and independent variable from the OLS regression are shown in column Table 2.

**Table 2: Results of the linear regression analysis between tourism seasonality (RSI) and logarithm of tourism carrying capacity (ln_TCC).**

| | Adjusted R Square | Sig. |
|---|---|---|
| Model | 0.484 | 0.000[a] |
| | Unstandardized Coefficients | |
| Constant | -0.470 | 0.000 |
| ln_TCC | 0.131 | 0.000 |

a. Dependent variable: RSI

The analysis builds on confidence intervals constructed for the linear regression slope between RSI and ln_TCC, to identify outliers, as shown in Fig.2a. As it can be observed in Fig.2a, the case that is omitted to the point of 95%CI is the prefecture of Thessaloniki (6).

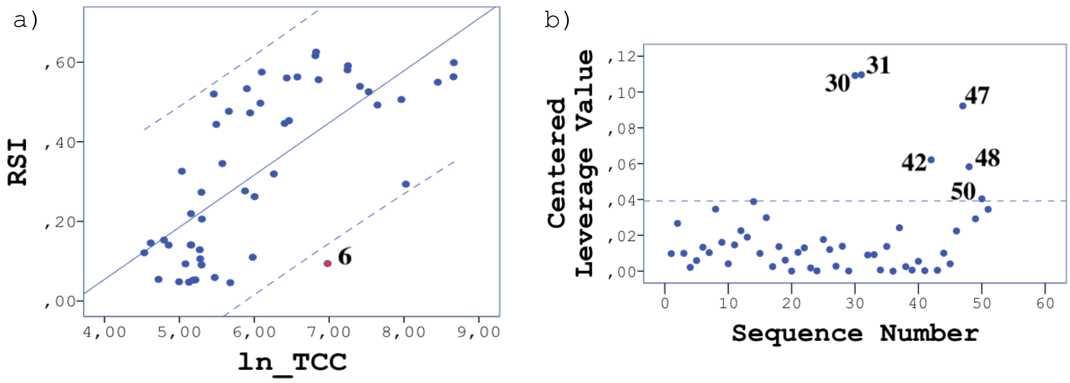


**Figure 2: a) Prediction interval for confidence level of 95%, for seasonality (RSI) and logarithm of tourism carrying capacity (ln_TCC), and b) Leverage points in linear regression model.**

Further, in Fig.3, the leverage statistic is applied to identify the influential cases in the model. Applying the empirical formula 2p/N, where p is the number of independent variables (here is 1) and N the number of cases (here is 51) (Norusis, 2011), some cases are characterized by high leverage, as shown in Fig.2b. These high leverage cases represent the prefectures of Zakynthos (31), Kerkyra (30), Dodecanese (47), Attiki (42), Heraklion (48), and Rethymno (50). The prefectures can be classified into two categories: the first includes the metropolitan areas of Attiki (6) and Thessaloniki (42), which are megacities in terms of population size, for the scale of Greece. As previously shown, these prefectures belong to the HL class described by low seasonality but high tourism carrying capacity. In a previous similar study by Tsiotas et al. (2020b) these prefectures had also characterized by high saturation. The second group includes the islands of Zakynthos (31), Kerkyra (30), Dodecanese (47), and two prefectures of the island of Crete, Heraklion (48), and Rethymno (50). These prefectures belong to the HH class described by high seasonality, high tourism carrying capacity, and as shown in a previous study, high saturation (Tsiotas et al., 2020b).

## 4. CONCLUSIONS

This paper examined the relationship between tourism seasonality and tourism carrying capacity. The proposed analysis was built on correlation analysis to classify (into quadrants defined by the average lines per axis) the pair of regional variables of the Greek prefectures, for the year 2018. The resulting four groups (Low Seasonality-Low tourism carrying capacity, Low-High, High-Low, and High- High), were examined in terms of geographical characteristics. The LL (Low Seasonality-Low tourism carrying capacity) group is configured in mainland Greece, while the HH (High Seasonality-High tourism carrying capacity) cases appear more as a matter of insularity and coastal morphology of the Greek regions. The HL category (High Seasonality-Low tourism carrying capacity) includes coastal prefectures and two island prefectures in North Aegean. The other group includes only two prefectures, Attiki (6) and Thessaloniki (42. These prefectures include the most populated cities in Greece. According to the Pearson correlation analysis that was applied, the correlation between tourism seasonality and tourism carrying capacity was found highly significant, but in linear regression model analysis, the value of Adjusted R Square was not very high. By transforming the variable of tourism carrying capacity to the logarithm, the linear regression increased and identified the outlier cases of the model. The outliers were the pair of metropolitan prefectures (Attiki (6), Thessaloniki (46)), and the five prefectures of Zakynthos (31), Kerkyra (30), Dodecanese (47), Heraklion (48), Rethymno (50). The overall analysis showed that seasonality is a factor driving tourism carrying capacity in the majority of the Greek prefectures.

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## Appendix

**Table A1**. The seasonal variables participating in the analysis correspond to the 51 Greek prefectures

| Variable Code | Prefecture | Var. Code | Prefecture | Var. Code | Prefecture | Var. Code | Prefecture |
|---|---|---|---|---|---|---|---|
| 1 | RODOPI | 14 | GREVENA | 27 | EVIA | 40 | LAKONIA |
| 2 | DRAMA | 15 | KASTORIA | 28 | EVRYTANIA | 41 | MESEENIA |
| 3 | EVROS | 16 | FLORINA | 29 | FOKIDA | 42 | ATTIKI |
| 4 | KAVALA | 17 | IOANNINA | 30 | KERKYRA | 43 | LESVOS |
| 5 | XANTHI | 18 | ARTA | 31 | ZAKEENTHOS | 44 | SAMOS |
| 6 | THESSALONIKI | 19 | THESPOTIA | 32 | KEFALONIA | 45 | CHIOS |
| 7 | HMATHIA | 20 | PREVEZA | 33 | LEFKADA | 46 | CYCLADES |
| 8 | KILKIS | 21 | LARISSA | 34 | ACHAIA | 47 | DODECANESE |
| 9 | PELLA | 22 | KARDITSA | 35 | AITOLOAKARNANIA | 48 | HERAKLION |
| 10 | PIERIA | 23 | MAGNESIA | 36 | HELEIA | 49 | LASITHI |
| 11 | SERRES | 24 | TRIKALA | 37 | ARKADIA | 50 | RETHYMNO |
| 12 | CHALKIDIKI | 25 | FTHIOTIDA | 38 | ARGOLIDA | 51 | CHANIA |
| 13 | KOZANI | 26 | VIOTIA | 39 | KORINTHIA | | |

**Table A2. The tourism carrying capacity indicators participating in the analysis**

| Code | Variable's Symbol | Description (year) |
|---|---|---|
| SE1 | STAYS | The number of to overnight stays to the number of residents (2018) |
| SE2 | VISITORS PER RESIDENT | The number of total visitors to the number of residents (2018) |
| SE3 | VISITORS PER SQ.KM. HIGH | The number of total visitors of high season to the prefecture's extend (2018) |
| SE4 | VISITORS PER SQ.KM. LOW | The number of total visitors of low season to the prefecture's extend (2018) |
| SE5 | MONTHLY AVERAGE OF VISITORS PER SQ.KM | The number of total visitors to the prefecture's extend (2018) |
| SE6 | BEDS PER RESIDENT | The number of beds to the number of residents (2018) |
| SE7 | BEDS PER SQ.KM. | The number of beds to the prefecture's extend (2018) |
| SE8 | TDI | The number of total overnight stays multiplied by 100 to the prefecture's extend multiplied by 365 (2018) |
| SE9 | FTPI | The total foreign overnight stays multiplied by 100 to the prefecture's extend multiplied by 360 (2018) |
| SE10 | DTPI | The total domestic overnight stays multiplied by 100 to the prefecture's extend multiplied by 360 (2018) |
| SE11 | ATTRACTIVENESS | The number of foreign visitors to the number of domestic visitors (2018) |
| SE12 | ECONOMICALLY ACTIVE POPULATION PER BED | The number of economically active population to beds (2018) |
| SE13 | AVERAGE ANNUAL EMPLOYMENT TO TOTAL EMPLOYMENT | Average annual employment in tourism to the average annual total employment (2011) |
| SE14 | OR | The occupancy rate (2018) |

*. All variables have length 51