Detection of **Empirical Relationships** between the NOA and International Tourism Demand to the Balearic Islands

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Objectives | Tourism is a climate-dependent industry, as a lot of tourist activities heavily rely on specific weather conditions. Therefore, it seems also reasonable to consider meteorological factors as significant determinants of tourism demand; however, relatively little systematic research has been carried *out*. The most widely-used meteorological variable in determining tourism is temperature. Other variables are also used such as rainfall, wet days, cloud cover, humidity, sunshine and wind speed. One potential key variable to explain Tourism could be the NAO (the North Atlantic Oscillation). The NAO has a significant impact on the meteorological conditions (temperature, storms, precipitations, wind speed, among others) observed predominantly in the Atlantic zone and the Mediterranean region. The phenomenon is formally defined as an anomalous difference in the atmospheric pressure between the subtropical high-pressure belt, around the latitudes of 35º- 40º in the Northern Hemisphere and centered near the Azores, and the subpolar low-pressure belt, centered over Iceland.

The NAO is usually characterized by mean of an index defined as the mean value of the difference between the normalized sea level pressure between Lisbon (Portugal) and Stykkisholmur (Iceland) during the winter months. The analysis of this index allows distinguishing two different phases of the NAO, one negative and the other positive.

The negative phase is associated with large amount of precipitations and a higher-than-normal temperature in Europe, in the western Mediterranean and in the southeastern of North America. Conversely, the positive phase is associated with drier and colder than normal conditions in Europe, in the western Mediterranean and in the southeastern of North America.

The influence of the NAO on the tourism sector has not been studied yet. The objective here is to empirically analyze if the NAO has a statistical impact on international tourism demand of the BI (Balearic Islands). The study is centered on analyzing the impact on the number of tourist arrivals to the BI from Germany and UK (United Kingdom). The tourism industry in the BI accounts directly or indirectly for around 60% of its GDP. Visitors from Germany and UK represent almost 80% of the tourist arrivals.

Methodology | Two alternative methods of analysis are employed. The first one is based on the causality concept developed by Granger. The procedure starts constructing simple causal models

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \ldots\ldots + \alpha_p x_{t-p} + \beta_1 y_{t-1} + \ldots\ldots + \beta_p y_{t-p} + \varepsilon_t \quad (1)$$

and

$$y_t = \mu_0 + \mu_1 y_{t-1} + \ldots\ldots + \mu_p y_{t-p} + \delta_1 x_{t-1} + \ldots\ldots + \delta_p x_{t-p} + u_t \quad (2)$$

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where x_t and y_t are the two time series object of analysis and they must be stationary. The residuals of the models ε_t and u_t must be uncorrelated white-noise series. As usual in this kind of analysis, the best order p for the equations is selected by minimising an Information Criterion. The first equation means that the variable x_t can be expressed in function of its own past and of the past of y_t. In the same way, the second equation determines that the variable y_t can be determined by its own past and the past of the variable x_t. Therefore, the definition of causality in the sense of Granger implies that y_t is causing x_t if it is proved that some estimated coefficient β_i is statistically non-zero. Similarly x_t is causing y_t if it is demonstrated that some δ_i is statistically non-zero. Moreover, if both of these events occur, it is said to be a feedback relationship between x_t and y_t. The null hypothesis of the contrast with two restrictions is that y_t does not Granger-cause x_t in the first regression

$$H_0 : \beta_1 = \beta_2 = \ldots\ldots = \beta_p = 0$$

and that x_t does not Granger-cause y_t in the second regression.

$$H_0 : \delta_1 = \delta_2 = \ldots\ldots = \delta_p = 0$$

The statistical test used to contrast these hypotheses is the conventional F-test. And as usual, if the p-value of the test is smaller than 0.05, then the null hypothesis is rejected and it can be said that there is a Granger causality relationship between the variables.

The second perspective to analyse the empirical relationship is based on the cross-correlation function (CCF). The sample cross-correlation (CC) between two time series y_t and x_t is calculated using the expression

$$\rho_{X,Y} = \frac{C_{X,Y}(l)}{\sqrt{C_{X,X}(0)}\,\mathrm{g}\sqrt{C_{Y,Y}(0)}} \qquad l = 0, \pm 1, \pm 2, \ldots \tag{3}$$

where

$$C_{X,Y}(l) = \begin{cases} \sum_{t=1}^{T-l} (x_t - x)(y_{t+l} - y)/T & \text{if } l = 0,1,2,\ldots \\ \sum_{t=1}^{T+l} (y_t - y)(x_{t-l} - x)/T & \text{if } l = 0,-1,-2,\ldots \end{cases} \tag{4}$$

Nevertheless, it must be recalled that the analysis using CCFs should be handled with care. If each one of the analyzed series has a very high degree of autocorrelation, then the nonzero values of the CCF do not necessarily imply a true relationship between the two time series For that reason, in order to avoid possible fictitious CCs, it is necessary to remove all of the autocorrelation in each time series and then cross-correlate that which remains. If the identical method of removing autocorrelation is applied to each variable, the true CC between variables is preserved.

The procedure followed here starts assuming that each one of the time series under study follows an autoregressive process with additive Gaussian noise. Consequently, the method implies to fit a p-order autoregressive model (AR(p)) for x_t of the form

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \ldots\ldots + \alpha_p x_{t-p} + e_t \tag{5}$$

and a q-order autoregressive (AR(q)) for y_t

$$y_t = \mu_0 + \mu_1 y_{t-1} + \ldots\ldots + \mu_p y_{t-q} + u_t \tag{5}$$

where x_t and y_t are the original time series that show autocorrelation, $\{\alpha_i\}_{i=0}^{p}$ and $\{u_j\}_{j=0}^{q}$ are the coefficients that must be optimally estimated in order to get non-autocorrelated residuals $\{e_t\}_{t=1}^{T}$ and $\{u_t\}_{t=1}^{T}$. The order p and q of the autoregressives will be those that minimize the Akaike Information Criterion. Finally, the residuals in (5) and (6) will be the filtered series to be cross-correlated.

Main results and contributions | The NAO has a Granger causality effect on the number of arrivals to the BI from Germany and UK. The NAO index is cross-correlated with the UK and German tourist arrivals.

Conclusions | It has been demonstrated that the NAO has a statistical significant connection with the number of tourist arrivals to the BI from Germany and UK.