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Assessing weather risk in sun and sand destinations

Abstract

This paper studies the impact of climate change on the tourism demand in the *Costa de Valencia* (Spain) destination. This is a Mediterranean sun and sand destination whose main attraction is the climate. Weather data from 1937-2009 indicate a slow but steady increase in temperatures and a higher frequency of extreme weather events. The study of the effects of temperature on tourism shows that the number of both resident and non-resident tourists is positively related with the temperature. Furthermore, the number of stays of residents does not change in cold months but it increases in hot months, and the number of stays of non-residents decreases in cold months but it does not change in hot months. Finally, based on the results obtained, the authors propose some alternatives that allow sun and sand destinations to manage their weather-related risk exposure.

Keywords: tourism, weather risk, sun and sand destination, Costa de Valencia.
JEL Classification: G1, Q54.

Introduction

The tourism industry is one of the most relevant and fastest-growing economic sectors, not only in Spain but also worldwide. There are many factors which affect this industry and, among them, the climate exerts an obvious and important influence both on the different activities and elements which make up the heterogeneous tourism industry, as well as on the evolution of the tourism demand. In fact, some studies such Moreno (2005) and SNCCAP (2006) predict that climate change will affect Spanish geographical and tourism landscape, altering ecosystems in such a way that they will stop yielding the social, economic and environmental benefits they have produced to date.

Moreover, a series of possible consequences of global warming are highlighted in both reports such as: (1) viability problems in coastal destinations due to an increase in sea levels; (2) vulnerability of mountain areas, especially snow tourism; and (3) the possibility that tourists may reduce their average stay in each destination, delay their travelling decision or shift their plans towards other holiday places. Therefore, global warming will force the introduction in many tourist destinations of large changes to work towards "sustainable tourism". This will create, on the one hand, new opportunities both in traditional and new tourist destinations (Perry, 2001) and, on the other hand, the need to invest in technological elements which reduce the negative effects of adverse weather conditions (see Scott et al., 2001). Thus, climate change simultaneously presents the tourist sector with both opportunities and threats which can have far-reaching consequences not only for well-established tourist destinations, but also for those which are considering their future touristic development.

There are still many questions concerning the relationship between global warming and the Spanish tourist industry which need to be examined. Indeed, the lines of action outlined in the SNCCAP for the tourist sector are diverse, including: the development of a cartography of critical and vulnerable touristic areas taking into account different climate change scenarios, the development of systems of indicators of the climate change-tourism relationship which will allow its detection and measuring, the development of management models to optimize the main adaptation options and, lastly, the assessment of the potential impacts of climate change on the tangible and intangible cultural heritage, as well as its effect on tourism.

It is last line of action on which the present study focuses, more specifically on the impact of climate change on the *Costa de Valencia* tourist destination. This is a destination which falls within the *sun and sand* holiday category, and it is, therefore, of particular interest to the analysis of the relationship between climate and tourism in prolonged scenarios of rising temperatures, just as it is in the case of the majority of Mediterranean tourist destinations.

Climate is one of the resources exploited by the tourist industry and, as a consequence, must be considered one of its assets. Following Amelung et al. (2007), "tourism is a climate-dependent industry, and many destinations owe their popularity to their pleasant climates during traditional holiday seasons". However, according to De Freitas (2001), the problem lies in providing a precise definition of which weather conditions can be regarded as ideal, acceptable or sustainable for carrying out the tourist activity. More specifically, and also according to this author, there are three elements in a tourist destination which make up the "tourist climate". Firstly, the thermic characteristics of the destination as established by the combined action of solar radiation, the wind and the temperature and humidity of the air. Secondly, there are the aesthetic aspects such as hours of daylight, sunlight, visibility and mist. Finally, several physical elements such as rain, snow, ice, and air quality, amongst others, round out the "tourist climate" concept.

Changes in this "tourist climate" can have important impacts on tourism. For instance, Perry (2000) analyzes some of the effects that weather phenomena can have on tourism consumption. Firstly, tourists choose those holiday destinations which offer more favourable weather conditions than their places of origin. Therefore, their behavior as tourism consumers might be affected by alterations in the weather of both their places of origin and their holiday destinations. Secondly, drought periods can cause environmental degeneration and desertification, making a resort less attractive to tourists. Thirdly, heat waves have negative effects for two reasons: on the one hand, they affect people's health and hinder the enjoyment of many tourist resources, and, on the other hand, they have very negative consequences on the environment of the resorts since, for example, they increase the risk of suffering from fires in the forests and algae on the beaches. Finally, while the rise in temperature of the sea water allows the extension of the beach tourism period, it can also cause negative weather phenomena on known as "bombs", rapidly deepening depressions bringing severe gales and heavy storms which can have a negative effect on tourism.

As Scott et al. (2005) point out, although the tourism sector is regarded as a very weather-sensitive economic sector, it is surprising how few studies have been carried out on the relationship between tourism and climate. An excellent review of this scarce literature can be found in Hamilton et al. (2005). Hall (2008) and Scott and Lemieux (2010) provide interesting overviews of some of the key issues that emerge out of recent research on tourism and climate change and identify key research issues and knowledge gaps. Finally, Bigano et al. (2005) put forward a classification of such research into two groups: qualitative studies and quantitative studies. Qualitative studies highlight the vulnerability of the tourism sector to climate risk but they do not provide any information on the possible changes in tourism demand. Filling this gap would be the main role of quantitative studies, which are, in turn, classified into four big groups: (1) studies based on the fundamentals of economic theory; (2) studies aimed at predicting changes in the supply of tourist services; (3) studies which use climate change indices and demand data; and, (4) studies which establish statistical relationships between tourism and climate.

The studies by Agnew and Palutikof (2001), Maddison (2001), and Lise and Tol (2002) belong to the last group above mentioned. All of them provide empirical evidence of the importance of temperature when choosing a holiday destination. Agnew and Palutikof (2001) analyze the tourism reception of the United Kingdom, the Netherlands, Germany and Italy, and they conclude that the optimal temperature to attract tourists is 21℃. Maddison (2001), for his part, proves that quarterly climate variables are able to explain differences in flows of tourists. In particular, the study shows that British tourists are attracted to climates which hardly deviate from a maximum temperature of 30.7℃. Lise and Tol (2002) examine the tourist arrivals in different countries and come to the conclusion that, regardless of the country of origin of the tourists, the ideal temperature for tourism fluctuates around 21℃. Finally, it is also worth mentioning the works by Berritella et al. (2006) and Bigano et al. (2005). The first one studies the economic implications of climate-change-induced variation in tourism demand using a world general equilibrium model, while the second paper found a positive relationship between temperature and tourism in Italy, especially at coastal resorts as compared to those inland.

The empirical analysis carried out in the present paper follows the line of research by Bigano et al. (2005). However, instead of studying tourism at a country level, we look into the relationship between temperature and different variables which are representative of tourism demand in a specific place, the *Costa de Valencia*. This is a typical Mediterranean holiday destination of the *sun and sand* type. Furthermore, as opposed to the empirical studies carried out to date, this research will examine the relationship between tourism and climate focusing on derived weather variables such as heating degree-days, cooling degree-days and cumulative average temperatures. These variables are obtained from the observed daily average temperature and their calculation is detailed in the next section[1].

The paper is structured as follows. Section 1 describes the tourism series and the weather variables series chosen to study the impact of climate change on the *Costa de Valencia* holiday destination. Section 2 presents the empirical analysis carried out. From the results obtained, Section 3 suggests some alterna-

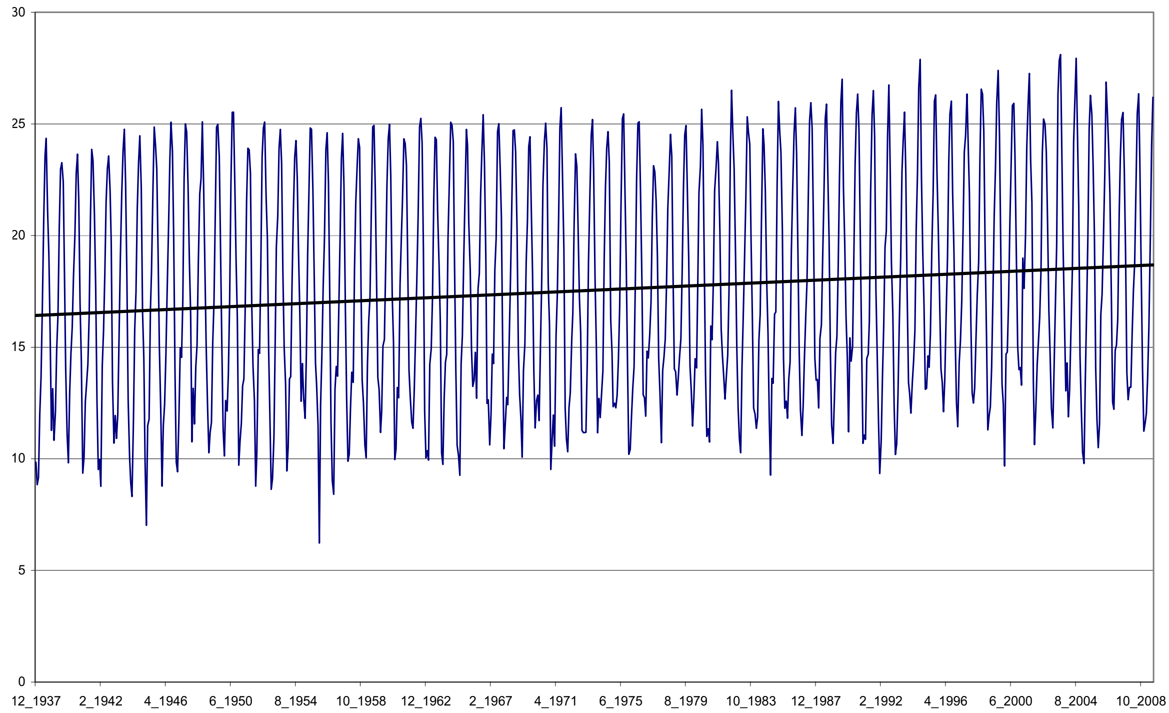
[1] Different models can be developed using two sets of weather variables: primitive variables such as temperature, precipitation, relative humidity, wind speed, atmospheric pressure and solar radiation; and derived variables including heating degree-days, cooling degree-days, and enthalpy latent days. Most models that study the impact of weather on socio-economic variables show that the key weather variable is the outdoor air temperature both in its primitive and derived forms. However, the main advantage of using derived weather variables is that they allow regression models to collect possible non-linearity influences of weather. See Moral-Carcedo and Vicéns-Otero (2005) for additional information.

tives that allow *sun and sand* destinations to manage their weather risk. The last Section summarizes the main conclusions drawn from this research.

1. Data

The country of Spain is, with France and the USA, one of the world's top tourist destinations. Of all the tourists who visited Spain in 2009, 9% came to the Valencian Community. This region has three touristic destinations: *Costa Azahar*, *Costa Blanca* and *Costa de Valencia*. All of them share similar attractions for tourism that are, among others, the high number of hours of sunlight throughout the year, the beaches, the Mediterranean cuisine and the possibility to practise open-air sports in whatever season of the year. Out of the three destinations, we have chosen for our study the *Costa de Valencia.* The reason is that the city of Valencia has recently been elected as the annual seat of three major worldwide sporting events: motor racing's Formula 1 European Grand Prix, a tennis Master Series tournament and the horse-jumping circuit known as Global Champions Tour[1].

1.1. Weather sample selection. *Costa de Valencia* is comprised of a set of municipalities (from north to south, they are Sagunto, Valencia, Cullera, Alzira, Gandía, Oliva and Xàtiva) in which the flow of tourists is located. Although *Costa de Valencia* includes mainly coastal strips, it also contains mountain zones and, as a consequence, this destination could present a wide range of extreme daily temperatures. Therefore, it is necessary to clarify the choice of the representative temperature of the *Costa de Valencia* destination. Given that the city of Valencia has the majority of the hotel establishments found in *Costa de Valencia*, we have selected the temperature of this city. However, in order to avoid the urban heat island effect, we have chosen the daily maximum and minimum temperatures, measured between 00:00 and 23:59 UTC at the weather station situated at the Valencia airport, and provided by the *Agencia Estatal de Meteorología* (AEMET, www.aemet.es). Then, we have calculated the daily average temperature as the arithmetic average of the maximum and minimum temperature.



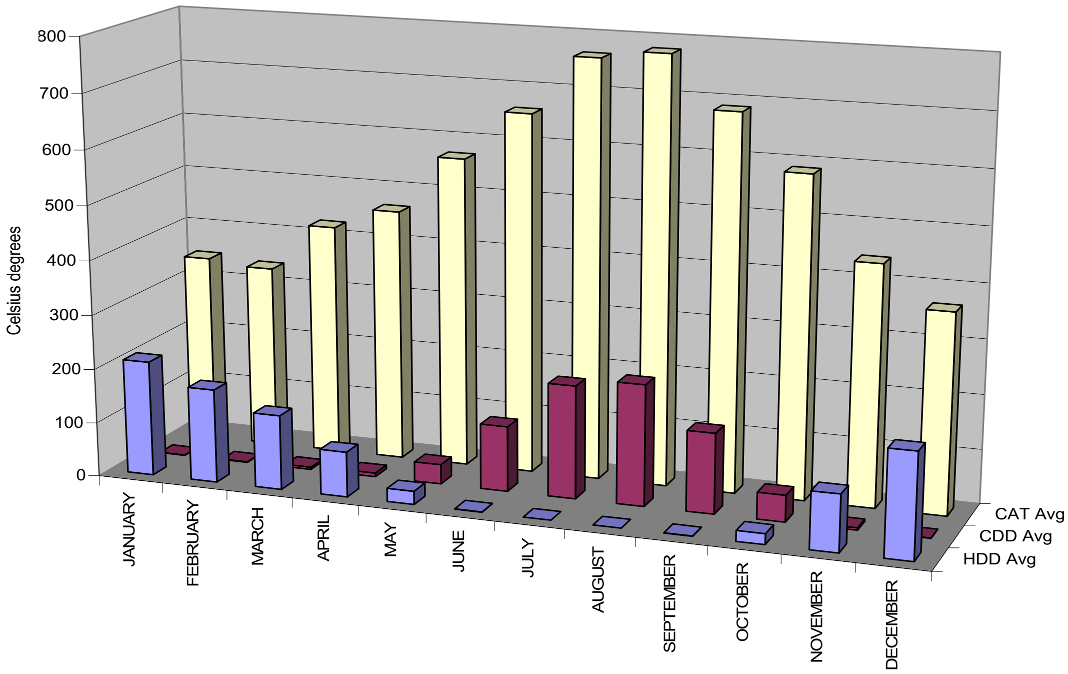
Notes: Figure 1 illustrates the evolution of the monthly average temperature from December 1, 1937 through July 31, 2009. The figure shows a seasonal variation in temperature with cyclical peaks and valleys in summer and winter months, respectively. Furthermore, the linear trend depicted on the figure indicates that the temperature has undergone a slow but steady increase over the last 70 years.

Fig. 1. Evolution of the monthly average temperature at the Valencia airport

Next, we have calculated three monthly weather indices derived from the daily average temperature: the heating degree-days (HDD) index, the cooling degree-days (CDD) index and the cumulative average temperature index (CAT). The HDD and CDD are calculated as $HDD_d = max\ (T_{ref} - T_d,\ 0)$ and $CDD_d = max\ (T_d - T_{ref},\ 0)$, where T_{ref} is a reference temperature, considered as temperature of comfort and usually fixed at 18°C and T_d is the daily average temperature measured on *d* day. The monthly HDD and CDD indices are obtained as the accumulation of HDD_d and CDD_d over a cal-

[1] See www.unwto.org/facts/menu.html for further details on international tourism worldwide, and www.exceltur.org and www.ine.es for additional information on tourism in the Valencian Community (last accessed on May 19, 2010).

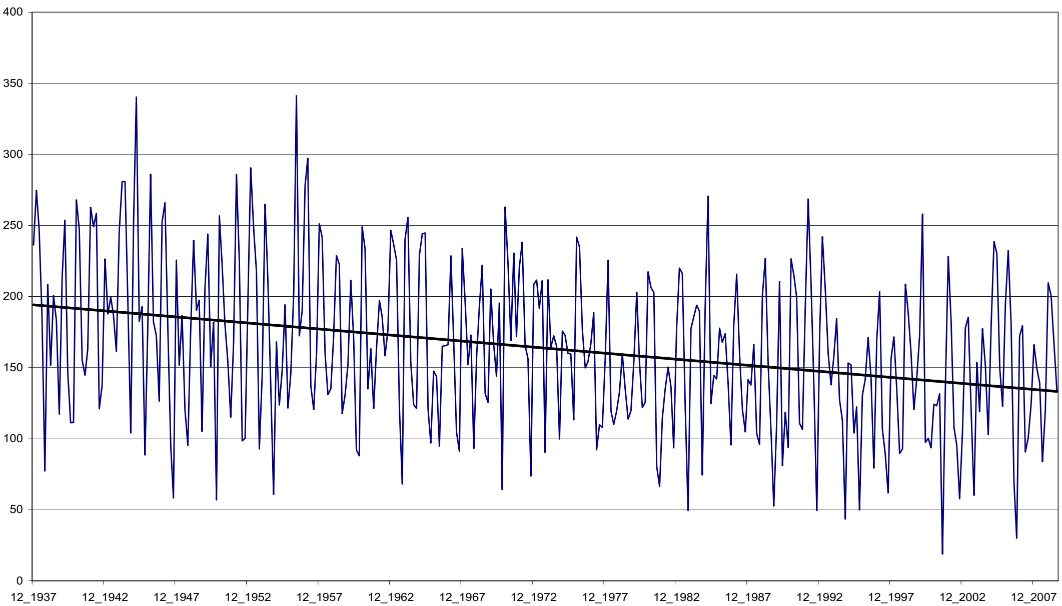
endar month, respectively. Finally, the monthly CAT index is calculated as the accumulation of the daily average temperature over a calendar month[1].



Notes: Figure 2 shows the average monthly evolution of the three indices for the whole period. The CAT index depicts the seasonal behavior of a Mediterranean destination. In this case, the HDD index indicates December, January, February and March as the coldest months, while the CDD index points to June, July, August and September as the hottest months. The first group has been selected as "winter months" while the second one has been denoted as "summer months".

Fig. 2. Average values for the HDD, CDD and CAT indices

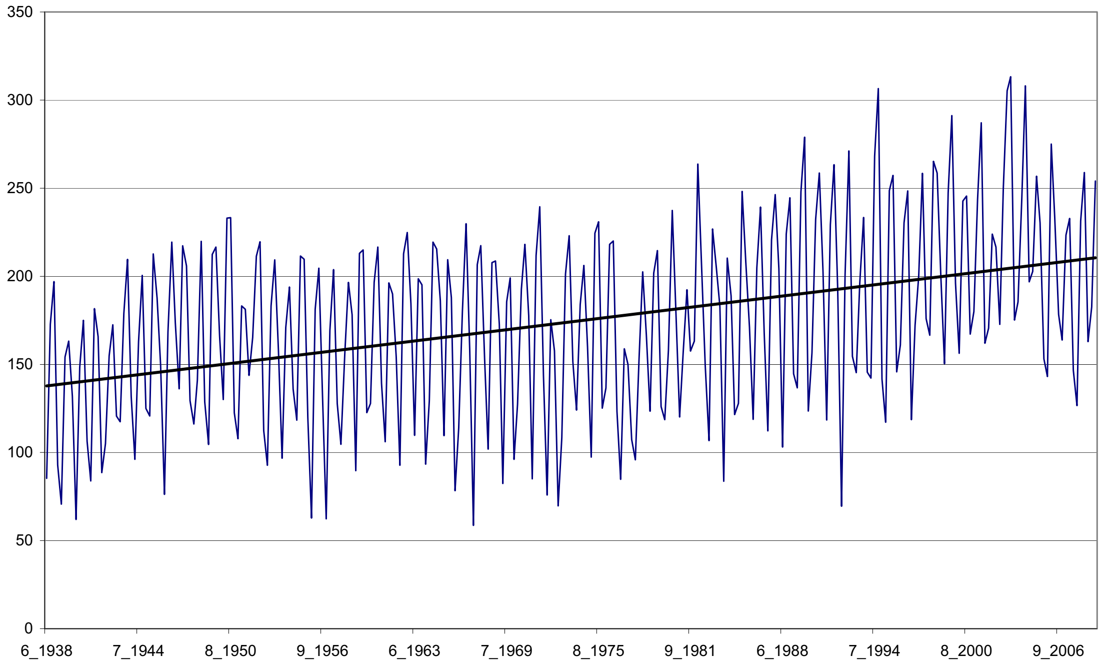
If we focus on the evolution of the indices in these two groups of months, we observe that the HDD index of winter months has decreased (Figure 3a) while the CDD index in the summer months has increased over time (Figure 3b). That is to say, colder months are less cold and hotter months are even hotter, indicating a steady warming in the Mencian weather.



Notes: The Figure 3a presents the evolution of the HDDs index in winter months (December, January, February and March) for the period of 1937-2009. We have defined winter months as those that have the four highest average monthly HDDs index values.

Fig. 3a. Evolution of CDD index in winter months

[1] Note that these functions, unlike the series of temperature in levels, have the advantage of allowing for the measurement of the intensity and duration of cold or heat in winter and summer days, respectively.



Notes: The Figure 3b presents the evolution of the CDDs index in summer months (June, July, August and September) for the period of 1937-2009. We have defined summer months as those that have the four highest average monthly CDDs index values.

Fig. 3b. Evolution of HDD index in summer months

One of the features of climate change is the significant increase in the number of extreme meteorological events. Following Beniston et al. (2007), due to global warming, European society appears to be particularly vulnerable to changes in the frequency and intensity of extreme events such as heat waves, heavy precipitation, droughts and wind storms. To test for regional extreme temperature events, we have calculated the evolution of the number of extreme cold and hot days. We have defined extreme weather days as days that are located in the tails of the historical distribution. Specifically, extreme cold days are those days whose daily average temperature is below the 5% percentile ($T_d < 9.1^o$) and extreme hot days are those with average temperatures above the 95% percentile ($T_d > 26^o$).

Figures 4a and 4b depict the evolution of the number of both extreme types of days over 70 years. We observe an upward trend in the annual number of extreme hot days from the beginning of the sample (Figures 4b), while the number of extreme cold days (Figure 4a) shows a polynomial downward trend. However, it is important to highlight that the number of abnormally high cold days began to increase halfway through the nineties.

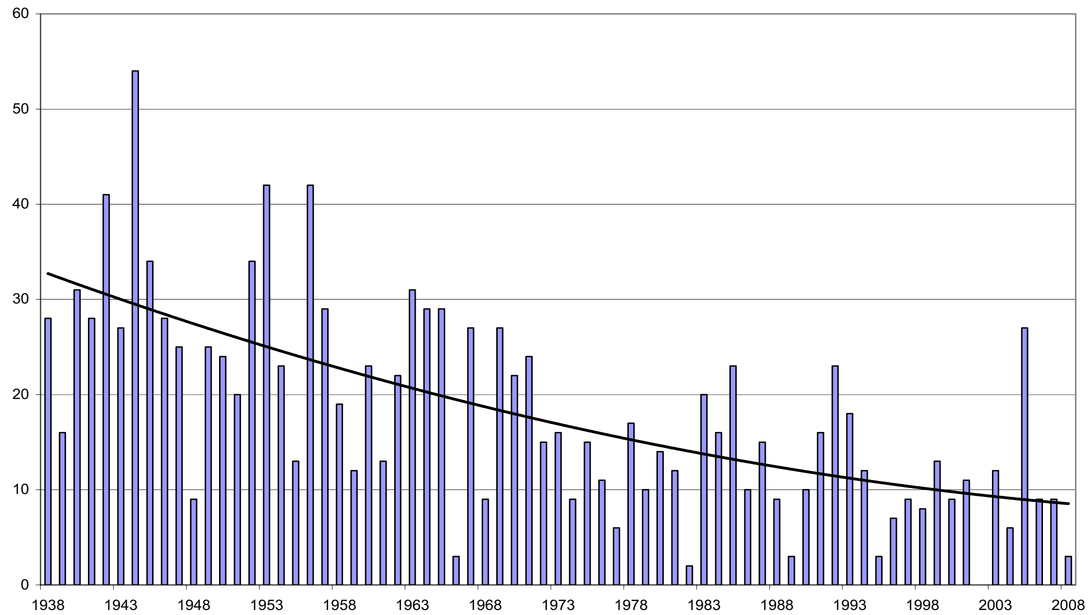
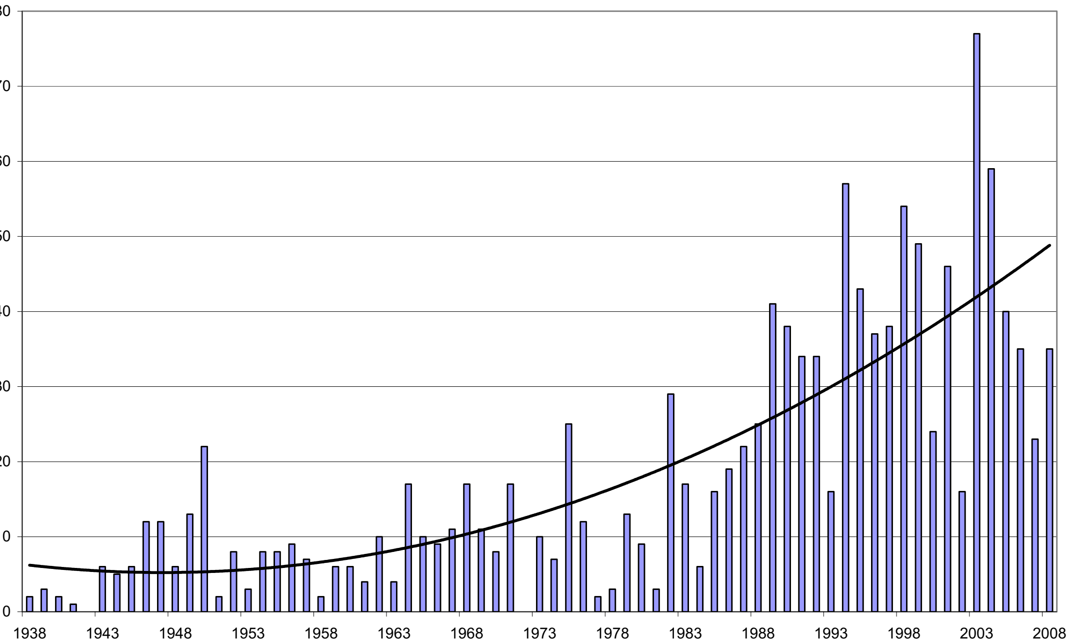


Fig. 4a. Annual evolution of extreme cold days



Notes: Figures 4a and 4b present the number of days with abnormal temperatures per year for the period of 1938-2008. An extreme cold day is a day whose average temperature is below the 5% percentile ($T_d < 9.1°$) and an extreme hot day is a day whose average temperature is above the 95% percentile ($T_d > 26°$) of the historical distribution of the daily average temperature. We have calculated the daily average temperature as the arithmetic average of the maximum and minimum temperatures measured between 0000 and 2359 UTC at the weather station situated at the Valencia airport.

Fig. 4b. Annual evolution of extreme hot days

1.2. Tourism in the *Costa de Valencia* destination. As representative of the tourism demand enjoyed by the *Costa de Valencia*, we have selected the data provided by the *Hotel Occupancy Survey* carried out monthly by the Spanish National Statistics Institute (www.ine.es). Specifically, we have considered two aspects of tourist trends with regard to demand: the information on tourists and their overnight stays. Following the survey, tourists are all persons who stay for one or more consecutive nights in the same accommodation, while an overnight stay or occupied vacancy is understood to be each night that a tourist stays in the establishment. Both of these variables have been divided into two groups depending on whether the tourist is resident in Spain or not. Following Eugenio-Martin and Campos-Soria (2010), the climate in the region of residence is a strong determinant of holiday destination choice. Furthermore, the consideration of this division is pertinent because, as we will see, the behavior of these two kinds of tourists differ substantially. Therefore, we have considered six variables: number of resident tourists (RT_t), the number of non-resident tourists (NRT_t), the total number of tourists (T_t), the number of overnight stays made by resident tourists (RS_t), the number of overnight stays made by non-resident tourists (NRS_t) and the total number of overnight stays (TS_t). In all the cases, the period of analysis runs from January 1999 to July 2009.

Figures 5a and 5b show the monthly evolution of the number of tourists and overnight stays. An upward trend is observed in all series as well as a strong seasonality in the series of the number of resident tourists (RT_t) and in the series of the number of overnight stays of resident tourists (RS_t). Both of them present peaks in the months of March through April and in July through August. The series of totals shows a similar behavior to the resident series given that residents make up 86.45% of tourists and 89.07% of overnight stays. Finally, an analysis of monthly seasonality, not reported in the paper, shows a strong peak in the series in the month of August.

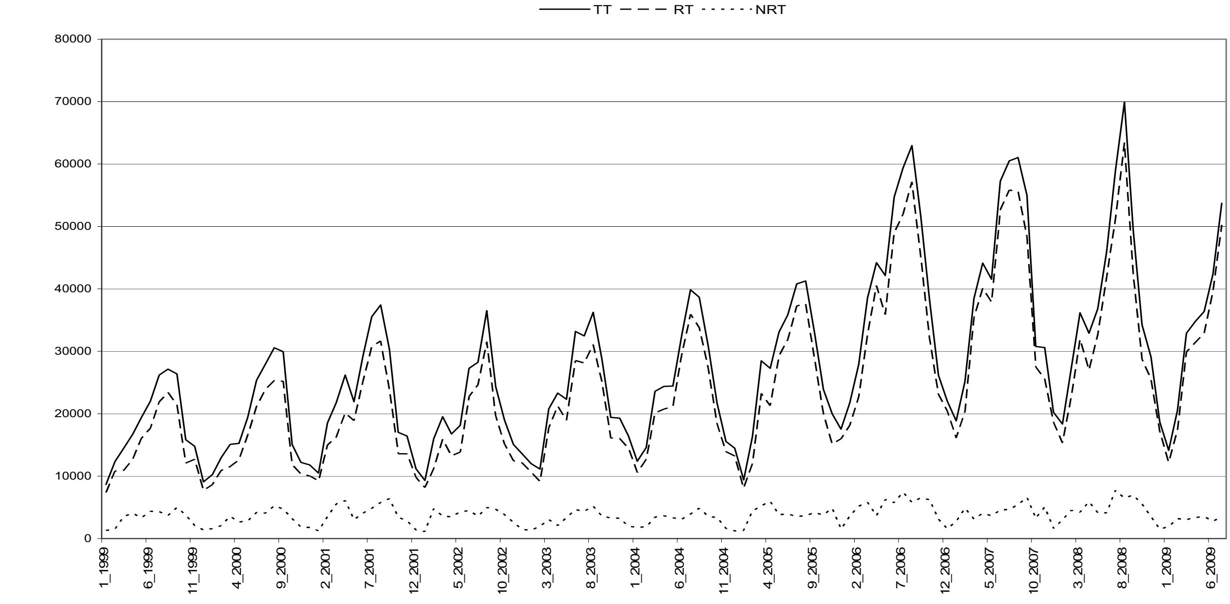
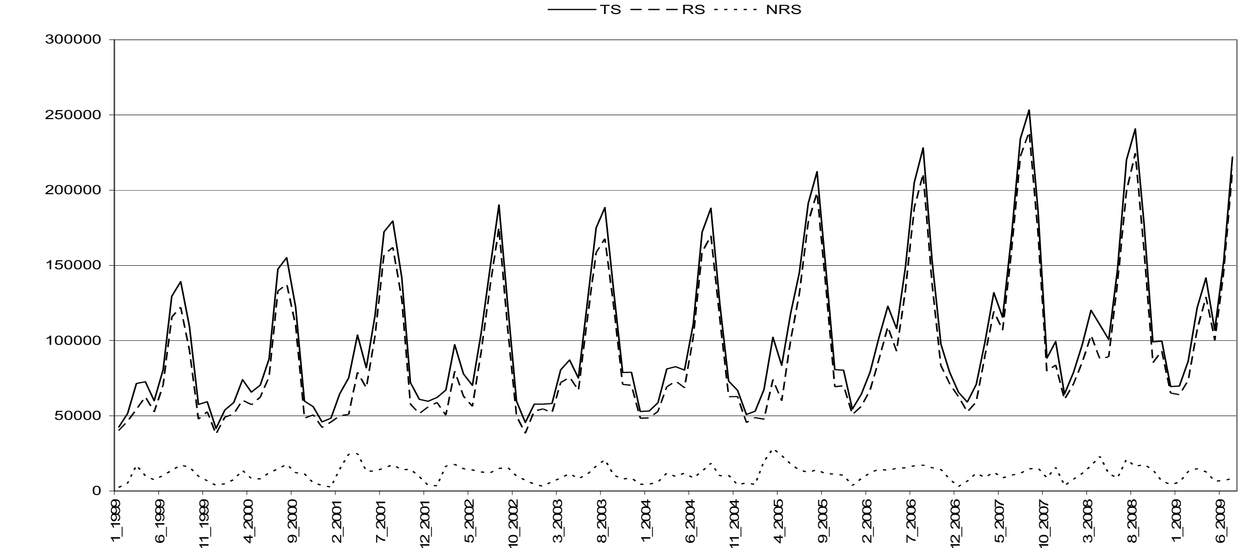


Fig. 5a. Tourists



Notes: Figures 5a and 5b show the monthly evolution of the number of resident tourists (RT_t), the number of non-resident tourists (NRT_t), the total number of tourists (T_t), the number of overnight stays made by resident tourists (RS_t), the number of overnight stays made by non-resident tourists (NRS_t) and the total number of overnight stays (TS_t) for the period from January 1999 to July 2009.

Fig. 5b. Overnight stays

Table 1 presents the cross correlations between the series of tourism in the *Costa de Valencia*. All the coefficients are significant and positive at the 1% level. A high correlation between the number of tourists and the number of overnight stays (89.6%) is observed. Another interesting result is the high correlation detected between the series that distinguished the origin of the tourist. Although Figures 5a and 5b show apparently different patterns, the correlation between the number of resident tourists (overnight stays) and the number of non-residents tourists (overnight stays) is 64.9% (42.5%)[1].

Table 1. Cross correlation coefficients between tourist variables

	T_t	RT_t	NRT_t	S_t	RS_t	NRS_t
T_t	1					
RT_t	0.996**	1				
NRT_t	0.711**	0.649**	1			
S_t	0.896**	0.893**	0.643**	1		
RS_t	0.891**	0.893**	0.587**	0.996**	1	
NRS_t	0.472**	0.413**	0.812**	0.509**	0.425**	1

Notes: This table presents Spearman's cross correlation coefficient between the variables selected asrepresentative of the tourism demand in the *Costa de Valencia* destination: the number of resident tourists (RT_t), the number of non-resident tourists (NRT_t), the total number of tourists (T_t), the number ofovernight stays made by resident tourists (RS_t), the number of overnight stays made by non-residenttourists (NRS_t) and the total number of overnight stays (S_t). **indicates significance at the 1% level.

[1] Due to abnormal temperatures in the series of indices, we have also conducted a similar analysis by applying the Spearman's non-parametric correlations coefficients. The results obtained are qualitatively similar and are available upon request from the authors.

2. Empirical analysis

This section studies the relationship between weather and tourism at the *Costa de Valencia* destination. Firstly, we have estimated the association between the six series of tourism demand and the three weather indices calculated in Section 1. The sampling period has been adjusted to the length of both series. Therefore, the time frame goes from January 1999 to July 2009 (127 monthly observations).

Table 2 shows the correlations between the variables. We observed a significant and positive Pearson's cross correlation between the CAT index and all the tourist series indicating a strong and positive association between the number of tourists, or overnights stays, and the accumulated index of temperatures. Furthermore, the correlation of tourists series with the HDD_t index is negative while the correlation with the CDD_t index is positive suggesting that the number of tourists that come to *Costa de Valencia* is lower in colder months and higher in hotter months. These results are expected and consistent with a sun and sand destination.

Table 2. Cross correlation coefficients between tourist variables and weather indices

	RT_t	NRT_t	T_t	RS_t	NRS_t	S_t
CAT_t	0.649**	0.580**	0.664**	0.776**	0.446**	0.785**
HDD_t	-0.574**	-0.598**	-0.597**	-0.592**	-0.463**	-0.612**
CDD_t	0.629**	0.525**	0.640**	0.822**	0.402**	0.824**

Notes: This table presents Spearman's cross correlation coefficient between the six variables selected as representative of the tourism demand in the *Costa de Valencia* destination and the three weather indexes. RT_t is the number of resident tourists, NRT_t is the number of non-resident tourists, T_t is the total number of tourists, RS_t is the number of overnight stays made by resident tourists, NRS_t is the number of overnight stays made by non-resident tourists, S_t is the total number of overnight stays. CAT_t is the monthly cumulative average temperature index. HDD_t is the monthly heating degree-days index and CDD_t is the monthly cooling degree-days index. **indicates significance at the 1% level.

Before establishing the econometric models to study the relationship between tourism and weather, two issues must be addressed. Firstly, the degree of association between resident overnight stays (RS_t) and CDD_t index and between non-resident overnight stays (NRS_t) and HDD_t index is slightly higher than when CAT_t is considered. This may indicate a non-linear response of tourism to weather. Secondly, as we have seen in Figures 5a and 5b, both tourists and overnight stays data series present a trend that may respond to demographical or economic factors. Our calculations have shown that a linear estimation is statistically significant in accounting for that trend. Furthermore, it has been confirmed that higher order terms are not significant in the trend estimation.

Next, we estimate the effects of temperature on tourism. To do this, we have developed two equations. The first one includes the linear trend and the CAT_t index, and the second one incorporates the trend, the temperatures of cold months (HDD_t) and the temperatures of hot months (CDD_t):

$$I_t = c + \alpha_1 LT_t + \beta_1 CAT_t + \varepsilon_{1t}, \tag{1}$$

$$I_t = c + \alpha_2 LT + \beta_2 HDD_t + \delta_2 CDD_t + \varepsilon_{2t}, \tag{2}$$

where t is the time variable representing months, I_t stands for the tourist variable considered ($T_t, RT_t, NRT_t, S_t, RS_t$ or NRS_t) and LT_t is the monthly linear trend.

Table 3 presents the estimates of the equations (1) and (2) for the six tourist variables considered. We observe, in all the cases, four common results: (1) a high percentage of tourism variability is explained with weather variables; (2) there is a positive and significant link between tourism and the CAT index, (3) when the relationship between tourism and the HDD index is significant, it is always negative, and (4) when the link between tourism and the CDD index is significant, it is always positive. Specifically, the results for the number of resident tourists (RT_t) and the number of non-resident tourists (NRT_t) are qualitatively similar. The results of equation (1) for the six variables show a significant and positive relationship with the CAT index, indicating that when the temperatures are high the tourism demand increases.

Equation (2), in the case of the number of resident tourists (RT_t) and the number of non-resident tourists (NRT_t), detects that there are more tourists in hot months and fewer tourists in cold months, suggesting a linear relationship between the number of tourists and the CAT index. However, the picture in the case of the series of overnight stays is quite different. Although, a positive link is observed for the CAT index in equation (1), the adjusted R^2 of the estimations of equation (2) slightly improves for the number of overnight stays made by resident tourists (RS_t) and for the number of overnight stays made by non-resident tourists (NRS_t). Furthermore, when RS_t is the dependent variable, the coefficient of the HDD_t is not significantly different from zero but the coefficient of the CDD_t is positive and significant at the 1% level. This fact indicates that the number of stays made by residents does not change in cold months but it increases in hot months.

The opposite is found when NRS_t is taken as the dependent variable. The number of stays made by non-residents decreases in cold months but it does not change in hot months. These results may be justified by the features of residents and non-residents that come to *Costa de Valencia* in winter months. The domestic tourists are usually pensioners that come in scheduled and organized trips, while the great majority of foreign tourists that come in winter months to *Costa de Valencia* are citizens of the United Kingdom, Germany and France, who are looking for warmer weather than in their country. When they do not find it, they reduce the number of stays.

The different behavior observed for resident and non-resident tourists supports the hypothesis that the climate in the region of residence is a strong determinant of holiday destination choice (see Eugenio-Martin and Campos-Soria, 2010); however, our results indicate the climate in such destination is a key factor for determining the duration of the stay.

Table 3. Estimates of the equations (1) and (2)

Equation	Variable	C	LT_t	CAT_t	HDD_t	CDD_t	ARS
Panel A. Tourists							
1	RT_t	-16733.56	200.54	49.46	-	-	0.77
		(0.00)	(0.00)	(0.00)			
2	RT_t	9082.48	200.94	-	-41.32	57.93	0.78
		(0.00)	(0.00)		(0.00)	(0.00)	
1	NRT_t	125.31	10.02	5.28	-	-	0.39
		(0.76)	(0.00)	(0.00)			
2	NRT_t	3456.27	10.02	-	-9.07	3.06	0.42
		(0.00)	(0.00)		(0.00)	(0.04)	
1	T_t	-16608.25	210.56	54.74	-	-	0.77
		(0.00)	(0.00)	(0.00)			
2	T_t	12538.75	210.95	-	-50.39	61.00	0.78
		(0.00)	(0.00)		(0.00)	(0.00)	
Panel B. Overnight stays							
1	RS_t	-65621.88	502.32	224.94	-	-	0.75
		(0.00)	(0.00)	(0.00)			
2	RS_t	27690.72	506.37	-	0.98	399.88	0.82
		(0.00)	(0.00)		(0.98)	(0.00)	
1	NRS_t	2880.03	9.48	14.12	-	-	0.19
		(0.09)	(0.41)	(0.00)			
2	NRS_t	11885.92	9.46	-	-25.06	7.62	0.21
		(0.00)	(0.40)		(0.00)	(0.21)	
1	S_t	-62741.86	511.80	239.06	-	-	0.75
		(0.00)	(0.00)	(0.00)			
2	S_t	39576.64	515.83	-	-24.08	407.50	0.82
		(0.00)	(0.00)		(0.51)	(0.00)	

Notes: This table presents the estimates of the equations (1) and (2) for the six tourist variables considered: the number of resident tourists (RT_t), the number of non-resident tourists (NRT_t), the total number of tourists (T_t), the number of overnight stays made by resident tourists (RS_t), the number of overnight stays made by non-resident tourists (NRS_t) and the total number of overnight stays (TS_t). All the observations are monthly and LT_t is a variable that indicates a monthly linear trend. CAT_t is the monthly cumulative average temperature index. HDD_t is the monthly heating degree-days index and CDD_t is the monthly cooling degree-days index. ARS stand for the adjusted R-squared. P-values appear in parenthesis.

3. Managing weather risk

Just as firms in the lodging industry use financial derivatives to deal with risks from fluctuations in internal rates, exchange rates and commodity prices (see Singh and Upneja, 2008), hotel establishments and tourism operators can also use weather derivatives to manage weather uncertainty (see Table 5 in Scott and Lemieux, 2010). These products offer a new perspective on risk management in tourism and some papers have studied their usage in tourism establishments which are highly dependent on the level of snow. Bank and Wiesner (2010) examine the motivations, concerns and obstacles regarding the usage of weather derivatives in the winter tourism industry, while Beyazıt and Koc (2010) propose a pricing method for put options on snow levels for tourism establishments operating in ski resorts. As far as we know, our paper is the first analysis of opportunities of hedging in sun and sand tourist establishments. Specifically, in this section we propose several alternatives for reducing the risk of weather fluctuations observed at the *Costa de Valencia* destination. Note that these strategies may be applied to any other sun and sand destination running similar weather risks to those detected in the previous section.

The alternatives we discuss are based on weather derivatives that can be traded on both *over-the-counter* markets and/or standardized derivatives markets, such as the Chicago Mercantile Exchange

(CME)[1]. CME weather products are temperature-based index futures and options that are geared to seasonal and monthly weather in 24 U.S., 6 Canadian, 11 European, 3 Asia-Pacific cities and 3 Australian cities[2]. The weather indices are CDD and HDD for all the cities, except for the case of European ones in which the derivatives are based on CAT and HDD indices. Among the list of European cities, there are only two Mediterranean cities: Rome and Barcelona. The latter city is of special interest for our purposes due to its proximity to the *Costa de Valencia* destination. In particular, the meteorological indices of Barcelona are measured daily at the Barcelona Prat de Llobregat Airport and the cross correlation coefficients between the monthly weather indices in Barcelona airport and Valencia airport are 98.83%, 97.30% and 97.32% for CAT, CDD and HDD indices, respectively. Therefore, lodging establishments located in the *Costa de Valencia* destination could use Barcelona weather derivatives with a small tracking error.

Specifically, CME weather products quantify weather in terms of degrees above or below monthly or seasonal average temperatures in a similar way as we have described in Section 2. The size of the trading unit is 20 euros times the respective index[3]. A firm involved in the tourism sector should evaluate the economic variable of relevance for its revenues and its potential risk. If, for example, a hotel has its main business focused on domestic tourists and the economic reference is the number of stays, a cold summer can have a negative effect on its revenue. To hedge against the potential risk of a colder than normal month of August, with fewer cooling degrees days than the average (around 780°C, see Figure 2, some possibilities can be undertaken: to sell CDD futures contracts at 780°C or, alternatively, to buy CDD put options at a strike price of 780°C). Note that, in both cases, weather derivatives cover volume risk, not price risk and the payoff is based on how the weather index performs relative to a reference level. Obviously, the size of the transaction will depend on the size of the position to hedge[4].

Based on the results obtained in the previous section, Table 4 summarizes the possible strategies that firms belonging to the tourist or the lodging industry can carry out to reduce the weather risk when the relevant variable is the number of overnight stays.

Table 4. Strategies to manage weather risk

Business mainly focused on:	Strategy	
	Futures/forward contracts	Options contracts
Residents	Sell contracts based on CDD index	Buy CDD put options
Non-residents	Buy contracts based on HDD index	Buy HDD call options
Both residents and non-residents	Buy contracts based on CAT index	Buy CAT call options

Notes: This table presents some alternatives for managing the weather-related risk detected in the *Costa de Valencia* destination. These strategies have been designed taking into account that the relevant variable for the revenue of hotel establishments is the number of overnight stays.

Conclusion

Moreno (2005) makes some severe predictions regarding the future of the main Spanish economic sectors, including the tourism industry. In this paper, we have carried out an examination of the relationship between weather and tourism in *Costa de Valencia*, a Mediterranean sun and sand destination whose main attraction for tourism is the climate. Firstly, we have studied the evolution of the temperature for the period of 1937-2009 and we have observed a slow but steady increase in temperatures and a rise in the number of days with extreme temperatures, both cold and hot. Therefore, climate change is reflected by higher temperatures and higher temperature volatility in the *Costa de Valencia* destination. Secondly, we have investigated the effect of weather on tourism. After conducting a regression analysis, some interesting results have been obtained. Fluctuations of temperature significantly impact the tourist variables. The number of tourists is affected positively by the temperature. The higher the temperature, the higher the number of tourists that comes to *Costa de Valencia*. This is a result that one might expect in a sun and sand destination. However, we have also found that hot months provoke longer stays by domestic tourists, while cold months result in shorter stays in foreign tourists. Finally, several alternatives have been proposed in order to manage weather-related risks in a Mediterranean sun and sand resort. The methodology used in this study could be of interest for weather-sensitive firms such as hotels, restaurants

[1] It is important to remark that weather derivatives allow firms to hedge for low-risk high-probability events such as hot winters or cold summers. By contrast, weather insurance contracts covers high-risk low-probability events such as hurricanes or floods. A comparison of both types of contracts can be found both in Turvey (2001) and in Pollard, Oldfiled, Randalls and Thornes (2008).

[2] See Dorfleitner & Wimmer (2010) for a theoretical and empirical analysis of temperature futures contracts traded at the CME.

[3] See http://www.cmegroup.com/trading/weather/ for further details about the CME weather products (last accessed on May 10, 2010).

[4] A comprehensive review of different approaches to pricing weather derivatives can be found in Geman & Leonardi (2005).

or travel companies, in order to evaluate and manage the exposure of their revenues to the weather effect.

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