Reg Environ Change (2015) 15:291–300
DOI 10.1007/s10113-014-0645-5

ORIGINAL ARTICLE

The impact of climate change on domestic tourism: a gravity model for Spain

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Received: 4 December 2013 / Accepted: 7 June 2014 / Published online: 25 June 2014

Abstract Climate conditions are recognised as an important determinant of tourism demand and consequently different pioneering studies have started to estimate the impact of climate change on tourism flows. However, the lack of data concerning domestic tourism demand has motivated that the majority of studies focuses on international tourism flows or considers domestic trips as the alternative to the international ones. This paper investigates the impact of temperature on destination choice decisions in the context of domestic tourism in Spain. Using a data set that comprises Spanish domestic trips from 2005 to 2007 and applying a gravity model for regional data, results confirm climate as an important factor in determining domestic tourism flows. Moreover, a simulation exercise concerning an increase in the mean temperatures of the Spanish provinces is undertaken. Findings show that while colder provinces in the north of Spain would benefit from rising temperatures, warmer provinces in the south would experience a decrease in the frequency of trips there.

Keywords Climate change · Gravity model · Domestic tourism · Spain

Editor: Marc J. Metzger.

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Introduction

Tourism has become one of the world's major cultural and economic activities, accounting for 9.2 % of the world GDP (WTTC 2012). Tourists travel to a wide variety of environments, including urban areas and isolated regions. However, warm coastal zones remain the most popular destinations, being climate one of the main determinants of tourists' destination choice. Consequently, it is not surprising that the different economic agents involved in the tourist industry have increasing interest in pinpointing the possible effects that a gradual rise in temperature and a general change in climatic conditions might have on the tourist sector.

The relatively limited attention that the literature on climate change paid to tourism during the nineties has been gradually compensated. Over the last decade, two main approaches to projecting future trends in tourism in a scenario of global warming have been developed (Rosselló 2014). The first one focuses on measuring a destination's attractiveness to tourists from a physical point of view. To that end, tourism climate indexes based on countries' climate conditions are constructed, and future climate conditions are projected in order to show the loss or gain in a destination's competitive edge. Clear examples are studies that relate winter tourism to snow coverage (Scott et al. 2003, 2007); sun and sand tourism (Moreno and Amelung 2009) or to general physical conditions for tourism (Amelung et al. 2007).

A second approach is to construct statistical models of tourist behaviour as a function of climate variables. Within this perspective, although it is possible to show the relationship between climate conditions and tourist movements from a time series viewpoint (Taylor and Arigoni 2009; Rosselló et al. 2011), the most popular strategy has been to quantify the relationship between temperature and the geographical distribution of tourist flows (Maddison 2001; Lise and Tol 2002). From a global perspective, Hamilton et al. (2005a, b) used aggregate models to estimate total international tourist arrivals and departures for a single year, including temperature as an explanatory factor. By calibrating the model, an evaluation of the consequences of simulated population and economic growth as well as variations in temperature on the distribution of international tourism worldwide can be obtained.

Recently, Tol and Walsh (2012) and Rosselló and Santana-Gallego (2014) extended previous studies by introducing a wider array of countries, together with the time dimension. By doing that, these authors show that bilateral variables (i.e. distance) are key factors in determining international tourism flows and that temperature-related parameters provide different results for different years. Results from these studies show a loss of competitiveness for traditional warm international destinations and evaluate how climate change would imply a greater loss of attractiveness for these traditional warm destinations around the world. They introduce a new framework for modelling international tourism flows which takes into account the bilateral nature of these flows that make the emphasis on the spatial nature of the tourism demand.

Because of limitations on tourist data availability, these studies have been merely centred on international tourism flows. However, in terms of figures, international tourist arrivals worldwide exceeded the 1 billion mark in 2012, while domestic tourist trips are around 5–6 billion worldwide (UN-WTO 2012). Additionally, from a regional point of view, it should be noted that in countries such as China, India, Japan, Mexico, the Netherlands, the Philippines and the USA, over 80 % of all internal tourism consumption is domestic, as opposed to international (UN-WTO 2010). In spite of these figures, there are relatively few studies that apply demand models to domestic tourism. Bigano et al. (2006) analyse tourists from 45 countries travelling to 200 destinations, including their own country of origin, showing that all tourists share the same preference for a holiday climate regardless of their home climate. The results of Bigano et al. (2006) are used in Hamilton and Tol (2007) to investigate the impact of different climate change scenarios at a regional level for Germany, Ireland and the UK, considering the national magnitudes for domestic and international tourism. The downscaling method distributes the national numbers of domestic and international tourists over 84 regions through a climate component.

Using microdata from a European household survey with information on the region of residence, Eugenio-Martin and Campos-Soria (2010) analyse the relationship between the regional climate in the home area and the choice of a holiday in a tourist's own region or abroad. They show that residents of regions with better climate conditions have a higher probability of making a domestic trip and a lower probability of travelling abroad. At this point, it should be noted that all these studies analyse domestic tourism as an alternative to international tourism, and works analysing the consequences of climate change on domestic tourist in a specific region are scarce. Moreover, it could be argued that domestic tourists could be characterised by specific determinants, different from the ones that affect international tourism such as higher travel costs, longer travel time, possible visa requirements or psychological barriers like cultural or language differences. Focusing solely on domestic trips, Bujosa and Rosselló (2013) analyse the impact of a rise in temperatures in the context of domestic coastal beach tourism in Spain, using a discrete choice model based on random utility theory. Their findings show that Spain's colder northern provinces would benefit from rising temperatures since it would increase their attractiveness for domestic tourism to the detriment of southern provinces. However, due to the purpose of their study and limitations in the methodology, only trips undertaken during June, July, August and September to 15 coastal provinces were considered.

The present study aims to expand the knowledge on the effects of climate change on domestic tourism from a regional point of view by considering the role of temperature in domestic trips by Spanish residents. Data from the Spanish Statistics and Tourism Satellite Accounts show that domestic tourism in Spain accounts for more than half of the tourism sector's total contribution to GDP. Additionally, the diversity of the Iberian Peninsula's climatic conditions provides an interesting case study that could be exemplary for other countries. We test the hypothesis that Spanish domestic tourism flows between provinces are determined by a set of explanatory variables that include the classic tourism demand determinants (i.e. price and income), plus other characteristics such as climate conditions. A gravity model, that has previously evidenced its ability to evaluate the effect of climate change on international tourism (Rosselló and Santana-Gallego 2014), is used as methodological framework.

By using the Familitur tourist data (the main survey for evaluating Spanish domestic tourism), tourist travelling within the same origin province can be considered and, consequently, substitution effects between outbound tourism from a certain province and to remain at the residence province are evaluated. This effect has been found significant in other studies, but using different methodologies (Eugenio-Martin and Campos-Soria 2010; Rosselló et al. 2011), showing how colder regions or countries tend to increase the proportion of tourists not travelling abroad when their temperatures increase. The rest of the paper is organised as follows. The second section outlines the methodology and the data used. The third section presents the results of the empirical analysis and the simulation exercise at a regional level. Finally, the fourth section summarises the main findings and some draws conclusions.

Methodology and data

Gravity model for tourism

To analyse the impact of climate on domestic tourism flows, a gravity equation to explain tourism flows is defined. This model draws on the principles of Newton's Law of Universal Gravitation, suggesting that international flows, i.e. trade, tourism, migrations or foreign direct investment, are expected to increase with a country's economic size and to decrease as the distance between country pairs grows. This framework has been extensively used for empirical exercises due to its goodness of fit, particularly to explain international trade (Deardorff 1998; Anderson and Van Wincoop 2003; Armstrong 2007; Fratianni 2007). Since tourism is considered as a special type of trade in services, gravity equations have also been used to estimate the magnitude of tourism flows in different contexts (Durbarry 2000; Eilat and Einav 2004; Santana-Gallego et al. 2010, Fourie and Santana-Gallego 2011, 2013; Kimura and Lee 2006; Vietze 2012, among others). In particular, Rosselló and Santana-Gallego (2014) justify the use of a gravity equation for analysing international tourism flows and estimate the effect of climate change on international tourism movements.

However, because of the use of the international perspective in evaluating the consequences of climate change, domestic tourism has been neglected. From a methodological point of view, this issue has entailed that the trips within the same node (origin/destination) are unknown (N_{IJ} = Non-available when $I = J$) and consequently, the no-consideration of remaining at the same region (country) as a substitution option of travelling abroad. In this paper, the regional context is considered to define a gravity equation that explains domestic tourism between Spanish regions. Applying this framework to regional data has important consequences on the characterisation of the origins and the destinations. For instance, in a worldwide context, it is necessary to take an average temperature for the whole country or to take the distance between the two capitals as the distance between two countries. These issues imply a generalisation that can limit the research, mainly when large countries (such as USA, Canada, China and Russia) are considered. Fortunately, that limitation is overcome when domestic trips are contemplated. As far as we are aware, this is the first attempt to apply a gravity model to evaluate the effect of climate change on domestic tourism by using regional data.

The reference model to be estimated can be written as:

$$\begin{aligned}\mathrm{LnTou}_{ij} = {} & \beta_0 + \beta_1\mathrm{LnGDPpc}_i + \beta_2\mathrm{LnPop}_i + \beta_3\mathrm{LnDist}_{ij} \\ & + \beta_4\mathrm{Boarder}_{ij} + \beta_5\mathrm{CCAA}_{ij} + \beta_6\mathrm{Coast}_j \\ & + \beta_7\mathrm{Island}_j + \beta_8\mathrm{WHS}_j + \beta_9\mathrm{MadBarc}_{ij} \\ & + \beta_{10}\mathrm{Mad}_i + \beta_{11}\mathrm{Barc}_j + \alpha_1\mathrm{Temp}_j + \alpha_2\mathrm{Temp}_j^2 \\ & + \alpha_3\mathrm{Temp}_i + \alpha_4\mathrm{Temp}_i^2 + u_{IJ} \qquad (1)\end{aligned}$$

where *Ln* denotes natural logs; sub-index i and j refer to the home and destination provinces, respectively; $\beta_0,\ldots,\beta_{10}$ are parameters to be estimated, $\alpha_1,\ldots,\alpha_4$ are the parameters of interest and u_{IJ} is a well-behaved disturbance term. Empirical research on tourism demand modelling and gravity equations commonly estimates this type of model using Pooled Ordinary Least Squares (POLS), where year fixed effects (to control for the year when the trip is made) are included and this is the procedure used in this paper.

Data

Domestic tourism data are obtained from the Spanish Domestic and Outbound Tourism Survey (Familitur), conducted by the Spanish Institute of Tourism Studies over a three-year period from 2005 to 2007 (see http://www.iet.tourspain.es for more information). Familitur statistics aim to quantify the flows of passengers residing in Spain between the different regions or on their way abroad and to characterise these trips in terms of their most significant aspects (purpose, the length of stay, the type of accommodation used, the means of transport). All types of trips which include at least one overnight stay are counted, regardless of their purpose.

The survey's target population includes all individuals living in first-home throughout Spain's fifty provinces. The information is collected by means of a mixed system, combining face-to-face interviews at home with telephone interviews. The households are selected by two-stage sampling of clusters with sub-sampling and stratification of the first-stage units. A monthly survey is conducted on one-third of the sample, with a quarterly reference period, so the whole sample will be surveyed by the end of the quarter. Each month, a preview of figures at the national level is released (obtained from one-third of the sample). Later on, when the whole sample has been surveyed, data are available at the regional level.

From the data set of trips, it is possible to compose a matrix with the number of families from a certain province making tourist trips to another province, and therefore dependent variable about the domestic trips from the home

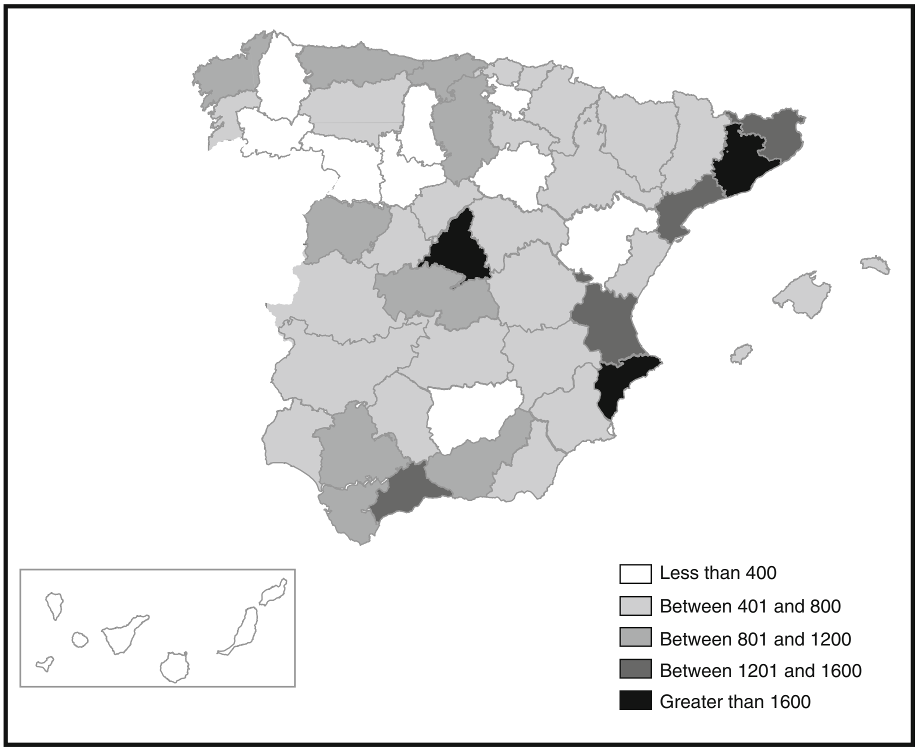


Fig. 1 Annual domestic trips to each province in thousands (annual average 2005–2007). *Source*: Own elaboration from Familitur data

province to the destination province (Tou_{ij}) is obtained. Figure 1 shows the importance of the different Spanish provinces as destinations of domestic tourist flows. It is observed how the Mediterranean and warmer Spanish provinces attract more domestic tourism and how provinces near the most densely populated areas (Madrid and Barcelona) are also important destinations, demonstrating the role of distance and the population of the home province.

Aggregated travel costs of visiting destination j from home province i have been approximated through the distance between the provinces' capital cities (Dist_{ij}) using data from the National Geographical Institute and official road maps drawn up by the Spanish Ministry of Public Works (http://www.ign.es). The travel cost is complemented by including a dummy variable (Border_{ij}) that takes a value of 1 when both provinces in the pair share a common land border or zero otherwise, as well as a dummy variable that control whether both regions belong to the same autonomous community (CCAA_{ij})—as the fifty Spanish provinces belong to one of the seventeen autonomous communities. These variables are relevant since transport networks are predominantly organised on a autonomous community level, so more travel options are available when you travel to an adjacent province or to a province that belong to the same autonomous community. Moreover, a high level of personal interrelationships is expected between these provinces.

Personal income was taken into consideration by including the regional Gross Domestic Product per capita (GDPpc_i) and the population (Pop_i) in the home province. Other site qualities of the home province are temperature at the home province measured by taking the mean annual temperature in degrees Celsius (Temp_i). Additionally, since Madrid and Barcelona are the two main home provinces, accounting for 15 and 10 % of all domestic departures, respectively; two dummy variables are included to control for these two provinces as home regions (Mad_i and Barc_i). These variables also reflect the better transport connections of the capital cities with the rest of the Spanish provinces. Additionally, a dummy variable to control for movements between the two most important cities in Spain was also included ($\mathrm{MadBarc}_\mathrm{ij}$).

Finally, a vector of site qualities of the destination includes the mean annual temperature of the province's capital in degrees Celsius (Temp_j), the number of World Heritage Sites in the province (WHS_j), the length of the destination region's coastline in thousands of kilometres (Coast_j) and a dummy variable that takes the value one when the destination province is an island (Island_j). This last variable controls for the cost of insularity and the impossibility to access the islands by road.

The temperature variable was obtained from INE with data compiled by the Spanish National Meteorology Agency (AEMET). It is important to point out that other climatic variables, such as precipitation and sunshine hour, were tested as candidates for inclusions in the specification.

Table 1 Descriptive Statistics

Variable	Obs	Mean	SD	Min	Max
$\ln Tou_{ij}$	5339	1.81	1.48	0	7.23
$LnGDPpc_i$	5339	9.93	0.21	9.49	10.43
$\ln Pop_i$	5339	13.43	0.84	11.44	15.62
$\ln Dist_{ij}$	5339	6.21	0.73	3.47	7.84
$Border_{ij}$	5339	0.11	0.32	0	1
$CCAA_{ij}$	5339	0.10	0.29	0	1
$Coast_j$	5339	0.18	0.30	0	1.43
$island_j$	5339	0.07	0.26	0	1
WHS_j	5339	0.81	0.77	0	3
$MadBarc_{ij}$	5339	0.00	0.03	0	1
Mad_i	5339	0.03	0.16	0	1
$Barc_i$	5339	0.03	0.16	0	1
$Temp_{j=}$ $Temp_i$	5339	20.26	2.70	15.9	24.9

Table 2 Estimation Results. Dependent variable *$lnTou_{ij}$*

	Model 1	Model 2
cons	−7.047**	−6.767**
$LnGDPpc_i$	0.382**	0.347**
$\ln Pop_i$	0.745**	0.749**
$\ln Dist_{ij}$	−0.900**	−0.886**
$Border_{ij}$	0.777**	0.778**
$CCAA_{ij}$	0.389**	0.426**
$Coast_j$	0.952**	0.918**
$island_j$	−0.363**	−0.319**
WHS_j	0.399**	0.397**
$MadBarc_{ij}$	1.329**	1.287**
Mad_i	0.935**	0.909**
$Barc_i$	0.439**	0.397**
$Temp_j$	0.101**	0.102**
$Temp_j^2$		−0.006**
$Temp_i$	−0.040**	−0.040**
$Temp_i^2$		−0.005*
Observations	5339	5339
R-Squared	0.54	0.54

(**) Significant at 1 %, (*) Significant at 5 %

Year fixed effects are included

However, their lack of significance suggested that they should not be included in the final estimation. Then, from the monthly average of daily maximum temperatures provided by the INE, the yearly average for each province is computed. Although other possible alternatives were tested, i.e. annual mean temperature, the annual averages of daily maximum temperatures are preferred since it is expected to offer a better reflection of the tourists' response to climate in the sense that tourists tend to go out during daytime hours when maximum temperatures are recorded. Table 1 presents the descriptive statistics of the variables considered in the analysis.

It should be highlighted that, in the previous literature, a non-linear relationship has often been found between tourism and temperature, captured using squared temperatures in the specification (Maddison 2001, Hamilton et al. 2005a, b, Rosselló et al. 2011). For this reason, the following more general model including squared terms for temperature is also investigated. The inclusion of the quadratic term often results in multicollinearity problems which can entail theoretically questionable changes in the sign of the climatic variables. To overcome this problem, temperatures can be centred by subtracting the mean from every case (Aiken and West 1991; Neter et al. 1996). As Table 1 shows, the mean temperature in the home and destination provinces is 20.26. Thus, all the temperatures were centred by subtracting this mean.

Empirical analysis

Estimation results

Bearing in mind the considerations mentioned above, Equation (1) is estimated not including (Model 1) and including the square of the temperatures (Model 2). Results are presented in Table 2, and with the exception of the temperature variables, the estimated parameters remain fairly similar in both models.

The results show that both income, measured by the GDPpc, and the population of the home province display a positive effect on the number of trips. Because the variables have been included in logarithms, the parameters can be interpreted as elasticities. As shown in Table 2, the estimated income elasticities are 0.395 or 0.363, according to the model used, i.e. a 1 % increase in income in the home province leads to an expected 0.395 % or 0.363 % increase in tourism in model 1 and 2, respectively. In this case, although the expected value remains within the normal range found in the literature reviews of tourism demand (Crouch 1992), the values can be qualified as being low. This result can be explained, on the one hand, by the inclusion of the population variable, which reduces the importance of the GDPpc, and, on the other hand, by the domestic nature of the tourist trips under analysis since in most cases, it is expected that travelling domestically is not a luxury good. Whatever the case, the GDPpc and population effect seem clear and, as expected, they can be considered to be push factors, confirming the previous literature findings.

With regard to the distance between provinces, the negative sign of the parameters show that the greater the distance, the lower the number of trips. Again, the parameter can be interpreted as distance elasticity. Thus, a 1 % increase in distance can be expected to reduce the number of tourists from a certain home province by 0.901 or 0.887 %. If this elasticity is assumed to be comparable with the travel cost elasticity of tourism demand, the results are fairly similar to those found in the literature on tourism demand modelling (Crouch 1992). Additionally, through the use of natural logarithms, it is demonstrated that the distance effect is more significant initially. Thus, once the distance is big enough, a small change in distance does not significantly affect the number of trips. As for other variables related to distance, being a neighbouring province and belonging to the same autonomous community were found to have a positive effect on the number of trips, regardless of the distance between the provinces' capitals. That is, by including these two variables, the effect of trips made by people not living in the capital with more easily accessible neighbouring provinces is corrected and other effects motivated by the expected stronger social networks between neighbouring provinces are considered.

A positive relationship with the length of the coastline and number of World Heritage Sites in the province has been found, showing that summer coastal tourism is one of the main segments of Spanish domestic tourism and also that having cultural attributes is an important tourist attractor. However, being an island province has a negative impact, a result that can be related to the higher travel cost.

As home provinces, Madrid and Barcelona display a particular tourist behaviour. It seems that congestion and overcrowding in these provinces leads to a higher push force for domestic trips per capita. Additionally, tourist trips between the two provinces also involve a positive effect even after all the other determining variables (income, population, distance) have been accounted for.

Regarding the variables of interest, Model 1 highlights the importance of temperature in explaining domestic tourism flows in Spain. Temperature shows the expected positive sign for the destination province and negative sign for the home province. Thus, the warmer the destination province, the higher its expected attractiveness; and the colder the home province, the higher the expected propensity to travel abroad. However, Model 2 qualifies this view, showing that although, in general, a positive relationship can be found between temperature at the destination and tourism demand, there is a maximum turning point for temperature. Using the estimated parameters of Model 1, this maximum is estimated at 28.7 °C. At this point, it is important to note that none of the 50 provinces that were analysed reach this temperature, signifying that, as a destination and without considering the temperature in the home province, all provinces in Spain would benefit from an increase in temperature in terms of yearly domestic tourism. However, because of the significance of the estimated squared temperature parameter, it should be highlighted that provinces with a lower temperature would

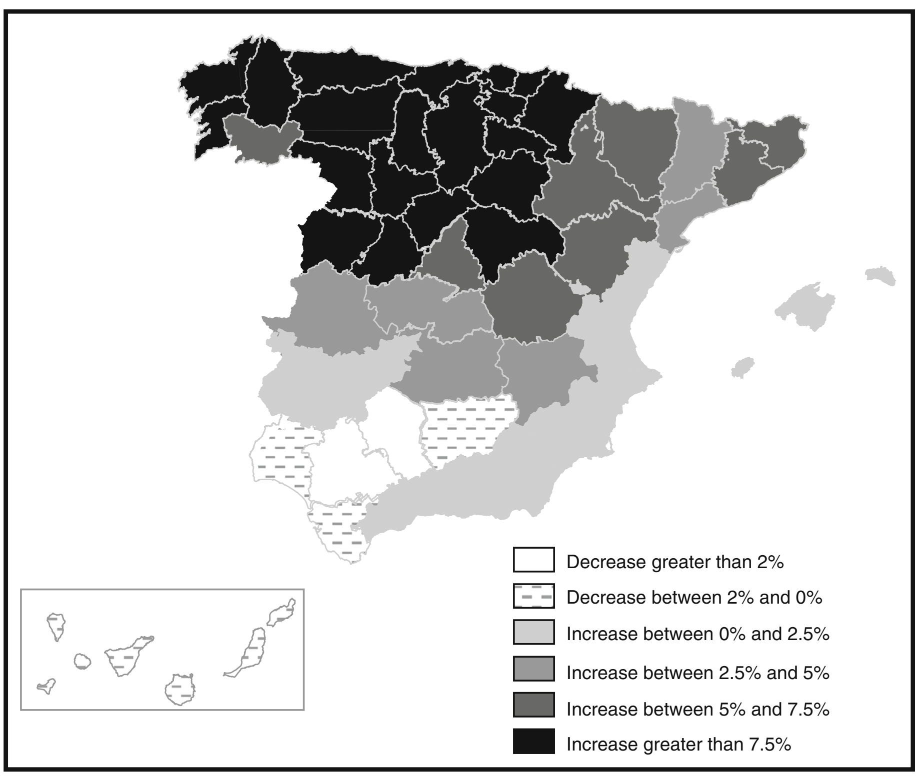


Fig. 2 Estimated percentage change of domestic tourist arrivals under a homogeneous temperature increase of 1 °C

benefit more than those with higher temperatures. Furthermore, the total tourism balance, in terms of yearly tourists to a destination, will also be affected by foreign inbound tourism which is also expected to fall. Thus, because of the complex influence of a temperature increase on tourism trips (positive at the destination, negative in the home province, but non-linear in both cases), a simulation analysis of a hypothetically increase in temperature throughout Spain was conducted in order to evaluate the consequences of a general rise in temperature on domestic tourism flows.

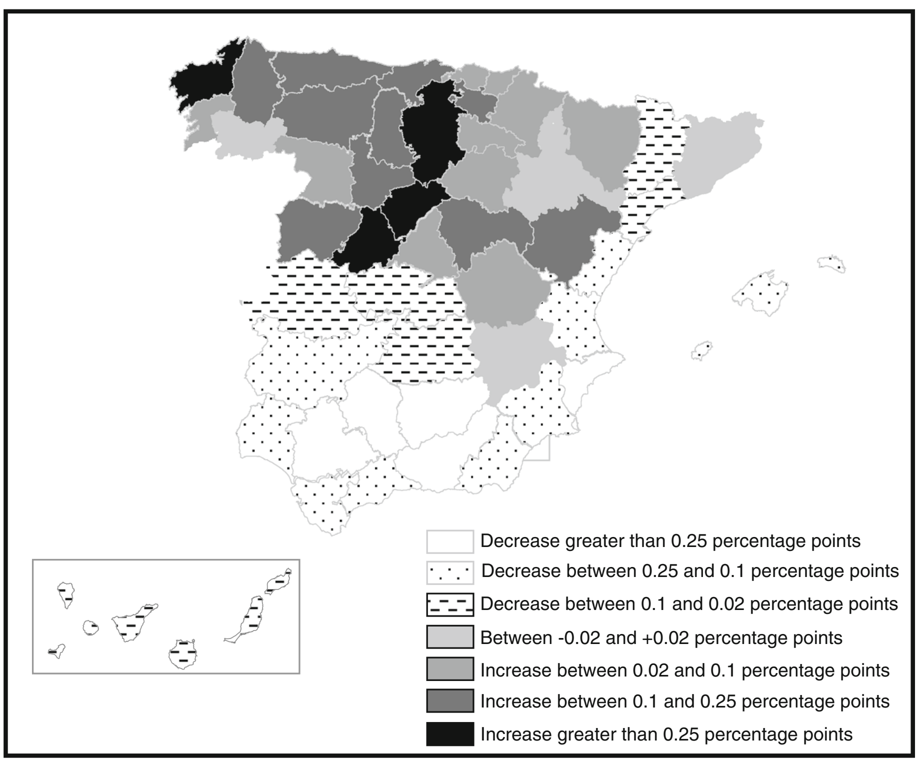
Simulation analysis

The simulation considers a uniform increase in temperature for each province of 1 and 3 °C. These scenarios are defined from the projections of temperature reported by the Spanish Ministry of Environmental Affairs. This report holds that the expected increase in temperatures in Spain for the period 2010–2040 ranges from 1 to 3 °C, with a higher impact during the summer time (De Castro et al. 2005). It is important to note that GDPpc, population or other variables that might also vary in the future were considered unchanged in the simulation. Although, these variables have been found to determine the level of tourism and they are expected to change in the near future, due to the complexity involved in projecting these variables and the specific objective of this study, only the marginal effect of a hypothetical increase in temperature was investigated.

The forecasted values from the gravity equation for each province were compared with the forecasted values when there was a change in average temperature of 1 °C (Figs. 2, 3) and 3 °C (Fig. 4 and 5), holding the remaining determinants of domestic tourist trips unchanged. Although it is feasible to evaluate non-homogeneous temperature changes throughout Spain, the latest temperature projections for Spain do not show significant differences among its regions (Jacob et al. 2014). The results of the +1 °C simulation (Fig. 2) show the expected change in tourism arrivals. In general terms, Spain's main provinces experience an annual increase in tourist numbers, with the exception of the warmest provinces in the south of Spain, along the Guadalquivir River. Seville and Cordoba are the provinces that can expect a highest drop in a scenario of +1 °C with annual drops of above 2 %. Provinces on the Mediterranean's south coast are expected to see some increase in tourists while the main gains are expected for those provinces located in the north-west.

An alternative view of the effects of the +1 °C simulation can be seen in Fig. 3, where a change in the market share is shown, suggesting that, despite the slight rise in tourist numbers observed in Fig. 2, Mediterranean southern coastal provinces show a drop in their relative share of the Spanish domestic tourist market. In both cases, the effect

Fig. 3 Change in the domestic tourism marked share under +1 °C



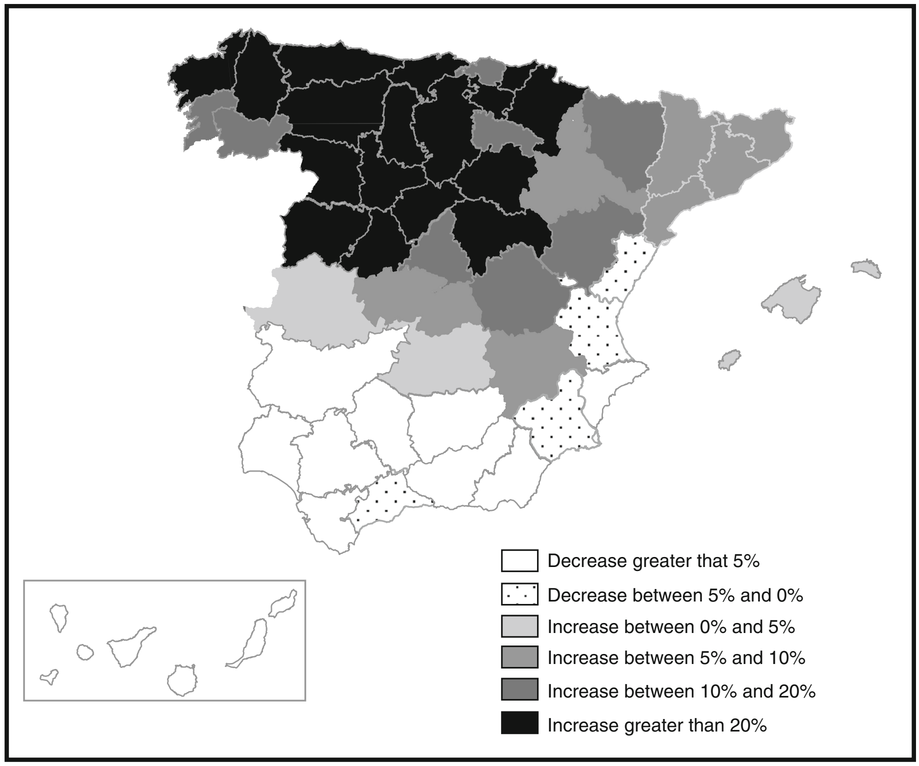


Fig. 4 Estimated percentage change of domestic tourist arrivals under a homogeneous temperature increase of 3 °C

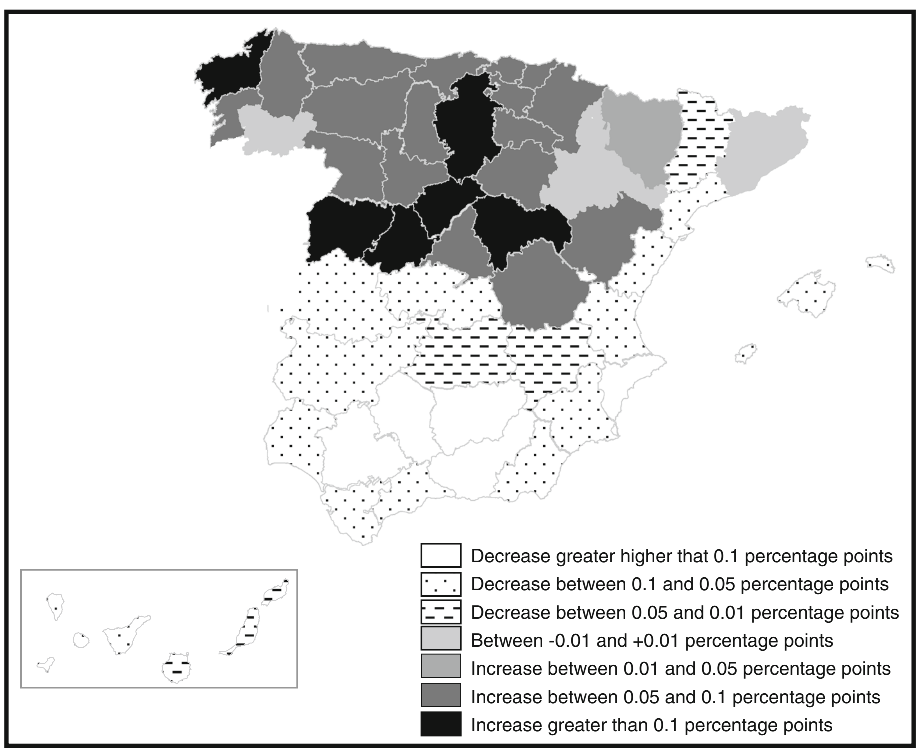


Fig. 5 Change in the domestic tourism marked share under +3 °C

caused by Madrid and Barcelona is a higher increase in tourism to provinces located to the north of both cities, as opposed to provinces to the south of them. Therefore, the results show a redistribution of domestic tourism between Spanish provinces, with a shift from southern and eastern Spain to northern Spain. These results are in line with the ones obtained by Bujosa and Rosselló (2013) in their study of summer coastal tourism in Spain.

The results of the +3 °C simulation on tourism arrivals (Fig. 4) and on market shares (Fig. 5) present a similar picture. However, it is important to highlight that some provinces will change the sign of the effect on tourism demand. Hence, the number of provinces displaying a decrease on tourism flows spreads to all provinces in the south of Spain and to southern Mediterranean ones. Again, the main gains are expected for Spanish north-west provinces.

Discussion and conclusion

The tourist industry has a serious need for data and quantitative studies that can provide new information on how climate change will modify tourism demand. To fill this gap, different approaches have been developed during the last few years to analyse the global effects of climate change on international tourism movements. However, for those countries where domestic tourism accounts for the majority of the tourism market, significant aspects are still uncertain.

Based on tourism demand models, this paper presents an application of a gravity model where domestic Spanish tourism trips are explained by distance and other origin and destination specific attributes, including climate conditions. The results show that temperature plays a central role in explaining the observed pattern of interprovincial trips. More precisely, the empirical results identify temperature as being a positive factor in determining the volume of flows to a specific destination province. However, the non-linear effect of temperature in the destinations highlights the existence of a threshold level where rising temperatures lead to a reduction in the probability of a particular destination being chosen.

The estimated model is used to evaluate the reallocation of domestic tourism in Spain in a scenario of a rise in temperatures. The results show that the expected increase in temperature will negatively affect provinces located in the south of Spain, especially in the area at the south of Madrid. Moreover, the impact of this increase on the Spanish Mediterranean provinces is also negative. In contrast, northern provinces will benefit from the general increase in temperature. Therefore, results of this paper show how domestic tourism reveals similar patterns than the international one, where an increase in the climatic attractiveness of northern regions contrasts with a decrease of southern ones. However, it is also important to note that although some studies have attributed southern regions' diminished attraction to extreme climate conditions, the results obtained in this paper only show that Spanish domestic tourism will have an increased preference for northern provinces for their domestic trips. This could be explained by both more uncomfortable climatic conditions in the south and by the emergence of northern provinces as new competitors.

Based on the projections in temperature changes by the Spanish Ministry of Environmental Affairs and findings of this paper, a number of recommendations can be formulated. On the one hand, southern and Mediterranean Spanish provinces should focus their efforts on diversifying their current tourism product, particularly those provinces whose attractiveness is solely based on good climatic conditions, summer holidays and sun and sand tourism. Actual warmer provinces should explore the possibility to expand their strong seasonal behaviour trying to attract domestic tourists during spring and autumn months. On the other hand, given the rise in their attractiveness as holiday locations, northern Spanish provinces should learn from the experience of southern ones in managing tourism development, both at private and public level. Then, business managers and hotel planners should consider the increased investments in these provinces advancing the increase in tourist numbers in these regions. At the same time, public administration should manage urban planning and land development according to sustainable development principles and avoiding the overcrowding of tourism supply that characterise some regions in the Mediterranean Spanish coastline.

It is important to point out that the presented projections are partial in the sense that they have only considered temperature variations and the all domestic market without segmentation. Consequently, they do not take into account the effects of changes in other non-climatic variables, including socioeconomic aspects or other nature-related tourism attractors that could also be affected by global warming, or different climate sensitiveness that different market segments could show. In further research, the role of these factors could be explored, extending the analysis and considering different market segments that might display different degrees of sensitivity to climate. Another interesting question would be the interaction of domestic and international tourism and the substitution effects between them. Thus, southern regions should evaluate the possibility to substitute domestic for international tourism.

Acknowledgments Financial support from CICYT Program (Spanish Government) through the grants ECO2013-44823 and ECO2011-23189 and VI Framework Program through the CIRCE project (003933-2) is gratefully acknowledged.

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