Climate and the Destination Choice of German Tourists

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Abstract

The attractiveness of a tourist destination is partly dependent on its environmental and climatic resource base. Climate change can be expected to have an effect on this attractiveness and will subsequently alter patterns of demand. An application of the pooled travel cost model using survey data on the destination choices of German tourists is presented in this study. Data on the climate, beach length and indicators of cultural, natural resource and economic attractiveness of the destination countries are used in the regression analysis. Optimal climate values were calculated and a climate index was used to examine the change in climatic attractiveness under an arbitrary scenario of climate change. It was found that, for European countries during the summer months, there would be an increase in attractiveness. However, the northern European countries become relatively more attractive closing the gap on the currently popular southern European countries.

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1. INTRODUCTION

An increase in the globally averaged surface temperature of between 1.4 and 5.8°C by 2100 is predicted by the IPCC (2001b). Based on such predictions, climate change impact studies have been produced for many different economic sectors. However, the impact on the world's largest industry, tourism, has been examined by only a few studies. Studies on the measurement of destination attractiveness (Hu and Ritchie, 1993; Shoemaker, 1984) have shown that climate is one of the most important destination attributes. Typically, when estimating tourism demand the attributes of destinations are not included. However, these attributes, according to Morley (1991), will determine the utility of a visit to a certain destination with a certain set of characteristics. This study looks further than just to the different spatial attributes of destinations but also to the temporal ones; different months have different climatic conditions. Moreover, climate change implies that these attributes will change over the long term and so utility and the resulting patterns of demand will change.

With the above in mind, the purpose of this research is to examine, by way of a case study, the demand of German tourists in terms of destination characteristics. The estimated relationships between the climate variables can then be used to examine the impact of climate change on demand. The pooled travel cost method, which is used in this study, had been developed in other case studies for the UK and the Netherlands. However, in this study, the set of destination attributes used in the regression analysis is extended and the temporal aspect is examined at the monthly scale as opposed to the quarterly scale.

This paper will be structured as follows. In the next section, the literature on the impact of climate change on tourism will be reviewed. In the third section, the pooled travel cost method is discussed. The data used in this study and the results of the regression analysis are presented in the fourth section. The implications of these are discussed in the fifth section. The sixth section concludes.

2. LITERATURE REVIEW

Despite its global economic importance and regional and, in some cases, national dependency on tourism revenues, comparatively little work has been carried out on the impacts of climate change on tourism. In the Intergovernmental Panel on Climate Change reports (IPCC 1998 and IPCC 2001a) the possible impacts on tourism and possible adaptation measures were discussed very generally with an emphasis on the ski industry and on the effects of sea level rise on recreationally important beaches.

Impact analyses have been carried out for different scales and for different sectors. For winter tourism in the Alps, Abegg (1996) analysed the impact of changes in temperature on snow depth and coverage and the consequences of these changes on ski season length and ski facilities. The influence of climate change on city tourism in North America has been analysed by Scott and McBoyle (2001) using the relationship between a tourism climate index and accommodation prices for each city.[1] Through changes in climate, the index scores change and the changes in attractiveness of different cities can be predicted. The authors argue that for Canada, climate change would result in an overall increase in the income generated through accommodation.

At a regional scale, several studies of a qualitative nature have been carried out. Nicholls and Hoozemann (1996) look at the vulnerability of Mediterranean countries to climate change.

[1] The tourism climate index used in this study is a weighted index of several climatic factors that are known to influence human comfort, and a ranking is used to signify suitability for city tourism.

They argue that tourism is an important factor to be considered when planning adaptation responses, particularly because tourism development can aggravate existing problems in the coastal zone. Perry (2000) looks at the impact on tourism in the Mediterranean region and autonomous adaptation to climate change. Caribbean coastal areas are the focus of Gable (1997) where the environmental impacts of climate change and sea-level rise are discussed, along with possible policy responses. Using scenarios and stakeholder discussion groups, Krupp (1997) examines the impact of climate change on tourism in Germany's most northern state Schleswig-Holstein. Similarly, Lohmann (2001) analyses the possible effects on tourist demand for the coastal resorts of northern Germany. Representative surveys of the German population as well as scenario techniques are used. In both studies, tourist industry focus groups were involved.

A few studies have looked at the impacts in terms of demand from particular countries for certain destinations. Viner and Agnew (1999) describe, for a range of destinations popular with UK tourists, the current climate and tourism market situation, the likely impacts on ecosystems under a scenario of climate change and the consequences for tourism demand. Only two studies have examined quantitatively the sensitivity of tourism demand to climate and climate change. Maddison (2001a and 2001b) examined climate as a determinant of the destination choices of British tourists and estimated a demand function that included climate variables and beach length for each country. The estimated function was then used to examine changes in the number of tourists as well as changes in welfare using projected changes in temperature and precipitation under a “business as usual” greenhouse gas emissions scenario. Lise and Tol (2002) adapted Maddison's model and applied it to data on the destination choices of Dutch tourists. They compared the results from the Dutch data with those from the British study and presented the results from a much cruder study of OECD tourists. The case study presented here uses the pooled travel cost method (PTCM) developed in these two studies. The basic concepts of which are discussed in the following section.

3. METHODOLOGY: THE POOLED TRAVEL COST METHOD

The studies by Maddison and Lise and Tol used a technique called the pooled travel cost method, which is based on microeconomic theory and includes characteristics of destinations which Morley (1992) and Papatheodorou (2001) argue to be necessary. This technique is a variant of the family of travel cost models, which have been widely used for estimating the demand for recreation sites. Two different types of these models exist: those that focus on single sites and those that examine multiple sites. In the former case, the purpose is to calculate the total economic value of the site and in the latter case, the object is to obtain a measure of the change in value when site characteristics change. It is this second set of models that is useful for examining the impact of climate change.

The basic premise of both types of model, however, lies in the fact that in order to use services provided by a certain site you have to travel there. This will involve a cost in terms of travel expenditure and the opportunity cost of time. Assuming that recreation is a normal good then sites with a higher travel cost will be visited less than those with the same characteristics but a lower travel cost. In the case of single sites, individuals who incur a lower travel cost for a certain site will visit that site more frequently than those individuals with a higher travel cost will. Using data on the number of visits and the cost of these visits, a demand function can be estimated. The total value of the site can be measured by the area under the demand curve. In the case of multiple sites, the characteristics of sites are included in the demand function.[2]

As travel is necessary for the consumption of the environmental amenities at a particular site, it is said to be a complement to them. That is, changes in the price of travel will affect the number of trips and through this, the quantity consumed of the amenities. Further, travel cost exhibits the quality of weak complementarity for the environmental amenities. Weak complementarity exists when there is a price where demand for the market good will be zero and changes in the public good, the environmental quality, will have no effect on welfare. In terms of travel to a site, this means that if the price of travel to a particular place is so high that no one wants to go there then changes in the qualities of that site do not bring any benefits to consumers. This enables the use of the demand curve for the market good to estimate the value of the non-market good, which in this case is the environmental quality of a site. When certain characteristics of a site improve, the demand curve for the market good, in this case travel cost, will shift outwards and to the right and so more of the favoured amenities are available at the same travel cost. To value this change, the difference in the area under the demand curves but above the market price for the original level of amenities and for the improved level is calculated.

Freemann (1993) describes the methods used to estimate the demand for multiple sites, with the qualification that these models have limitations through their simplification. One technique involves pooling the number of visits to recreation sites and estimating a single demand equation. The set of explanatory variables will include quality variables, which must be sufficiently varied across the sites, in order to use regression techniques to estimate the

[2] For example, the effect of improvements in water quality at recreation sites has been investigated with this method.

demand function. The coefficients on the parameters are the same across all sites. Freeman states that such models can be used to examine changes in the characteristics at one site, but argues that as they do not contain substitute site qualities or prices in the specification, it is not possible to examine the case where quality changes occur at more than one site.

Maddison (2001a and 2001b) adapted the recreation demand models described by Freemann (1993) and applied it to a case study of international tourism. Using data on British tourists' destination choices, he pools the choices of individuals for different destinations and estimates the demand function for British tourists as a group. He assumes that tourists have perfect information about the climate of countries. In addition, the demand function is used to analyse the impact of changes in environmental quality, in this case changes in climate. The model described by Maddison will be used in this study to examine the sensitivity of the demand of German tourists to climate and other destination factors.

4. CASE STUDY: THE DESTINATION CHOICE OF GERMAN TOURISTS

German tourists make up the second largest market in terms of expenditure (after the USA) and account for 10% of world spending on tourism (WTO 2001). Their market importance means that an examination of the possible impacts of climate change on the patterns of demand is of particular interest. Not only does a further application of the PTCM model allow a comparison of the British, Dutch and German tourism preferences, it is also an opportunity to extend the model to include climate and other variables that have never been used in tourism demand estimation. Whereas previous PTCM studies have used quarterly data and focussed on outbound tourism, this study uses monthly data and the origin country Germany is included as a destination option. This section describes the application of the pooled travel cost model to the case of the destination choices of German tourists.

4.1 Data and model specification

The dependent variable data were taken from a representative survey of 7780 German citizens who were asked about their holidays of more than 5 days that they took in 1997 (F.U.R. 1998). The respondents provided information on the region, country or group of countries where they took their holiday. They also specified in which month it took place. From the individual responses, visitation rates for each country (or group of countries) and month combination were calculated. The countries included in the analysis are presented in tables 1 and 2. Information was also provided on total holiday expenditure but not on travel cost. It was considered too time consuming to estimate the travel cost as many different modes of transport were used to reach the chosen destinations. For this reason, distance between the destination and origin capital city was taken as a proxy for travel cost.[3]

Country specific variables were included in the analysis. There are many groups of countries in the data set and so for each of the variables a group value was calculated using market shares for 1995 (WTO 2002). Table 2 contains the country groups. GDP per capita, population and population density are taken from the World Resources Institute (2000). Richer countries are more likely to have the basic facilities necessary for tourism, such as quality transport infrastructure and banking services. Richer countries will also have a developed network for domestic tourism and recreation and so the necessary tourist specific infrastructure will be in place. Such countries are more likely to be favoured as international tourist destinations. For population density, it is unclear what effect on tourism demand they have. Densely populated countries may be attractive as they will contain many towns and

[3] This was calculated using spherical trigonometry formulas for calculating the great circles distance between two points.

cities but on the other hand, if this implies a lack of natural areas, they may then be unattractive for tourism. The stability index compiled by Kaufmann (1999) is a proxy for the perception of citizens of the likelihood that their government will be overthrown by non-constitutional means. This has been included in the specification of the model to capture the influence of tourists' concerns about safety on the demand for a destination. Of course, the internal perception may be different from that of the tourists.

At a national scale, it is difficult to find comparable data on resource characteristics that are relevant to tourism. One of the key tourist markets is the "sun, sand and sea" holiday. For this particular type of holiday, the availability of beaches is important. To capture the effect of this on demand, the length of beach for each country, taken from Delft Hydraulics (1990), was included in the country dataset. Existing studies used population density and population as proxies for the existence of untouched natural areas and the number of cultural attractions respectively. Both population and population density are included in this analysis, as they may have an independent effect, however other variables are used as a proxy for natural and cultural attractions. In this study, the total area of all protected areas in a country is taken as a proxy for the availability of undeveloped land. The attractiveness of the landscape and the scope for outdoor recreation will depend on this. The total areas protected in each country were obtained from World Conservation Monitoring Centre (WCMC, 2002) for 1996. Only those protected areas of more than 1000 ha in any of the six International Union for Conservation of Nature and Natural Resources (IUCN) categories are included in the WCMC data set. The categories cover nature reserves, wilderness areas, management areas, national parks and monuments, and protected landscapes. Of course, larger countries are more likely to have larger protected areas, as will richer countries that will be able to afford to protect more of their territory. The number of sites on the World Heritage List (UNESCO, 2001) was used as a proxy for the historical and cultural attractiveness of a country. Sites on the world heritage list are those that are considered cultural or natural properties of outstanding natural value. Examples of such sites are Angkor in Cambodia and the Red Square in Moscow.

Climate data were taken from a data set on the recent climate in countries (Mitchell, 2002). For each country monthly averages for the period 1961-1991 are available for the following: daily temperature (mean, minimum and maximum), precipitation, number of wet days, cloud cover, vapour pressure, and the number of ground frost days. Some of the climate variables show a strong correlation with each other. Vapour pressure and temperature, ground frost days and temperature and wet days and cloud cover are highly correlated (0.87, -0.9 and 0.87 respectively.) On the one hand, this is because of the natural relationship between them and on the other hand because data on vapour pressure and the number of ground frost days was estimated using temperature[4]. For this reason two possible specifications of only three climate variables each were analysed. Both contain mean monthly temperature and average monthly precipitation, as in the two previous studies for the UK and the Netherlands.
The first specification contains the number of wet days per month and in the second wet day frequency is replaced by cloud cover. A wet day is defined as any day with rainfall greater than 0.1mm and the use of this variable in conjunction with precipitation provides more information on the spread of rainfall over the month. As an alternative to the inclusion of wet day frequency, the average cloud cover as a percentage was used in the second specification. The effects of sunlight on the psychological balance have been documented by Parker (2001) and the variable cloud cover has been included to capture the effect of sunlight at the destination country.

To examine the possibility of optimal levels of the climate variables the square of each of these variables was included. In the study by Maddison (2001b), the cubic and quartic terms

[4] See New et al (1999) for more details on the calculation of the different variables

of the temperature variable are included in the regression analysis, to examine the possibility that more than one temperature optimal exists because of winter sports tourism. This is examined in the third specification and the fourth specification is a refinement of the third.

There are certain disadvantages to using country aggregated climate data, particularly for large countries. Tourist destinations within a country may have a particular climate that is quite different from that of the national average and areas with extreme conditions, such as deserts or mountain ranges, which may be of little interest for tourists, will have an effect on the country average. Country data was preferred to capital city climate data, which is also inaccurate. As far as the author knows, a data set containing the climate of only tourist destinations in each country does not exist.

As Germany was included as a destination, a dummy was used to control for it being chosen more frequently. It is usual that domestic tourism makes up a large part of total tourism, as familiarity of culture and language or visits to friends and relatives will make the origin country a popular destination. Besides climate, other factors may influence temporal choice, such as public holidays or school holidays. To control for this, monthly dummies are included in the analysis. The variables and their definitions are contained in Table 3. The summary statistics of the variables used in the regression analysis are shown in Table 4.

The log of the number of visits was used, as this was found to fit the data better than the linear form. It also conveniently prevents the model predicting negative numbers of visits. The majority of recreation studies use this functional form, as did the aforementioned tourism and climate studies. As the error components from same country observations are likely to be correlated, panel corrected least squares regression analysis was used instead of ordinary least squares. It is expected that the following variables have a positive relationship with the dependent variable: Stability, GDP per capita, temperature, beach length and the “HOME” dummy variable. Whereas the coefficients of distance, precipitation and cloud cover are expected to be negatively signed. For the other variables, it is unclear what sign to expect.

4.2 Results

The results of the regression analysis are presented in Table 5. For specification 1, the regression explains 58.4% of the variation in the log of the number of visits. The number of heritage sites, length of beach and the level of GDP per capita are all highly significant and signed as expected. The stability variable “STAB” has a positive relationship to the dependent variable but it is not significant. The coefficient for “PROTECT” is negatively signed but is significant only at the 10% level. Although protected areas may be an attraction for tourists many of these protected areas may not in fact be accessible for tourists or tourist development has been restricted because the land has been protected. The coefficient on “DIST“ is as expected, highly significant and negatively signed. The popularity of domestic tourism is reflected in the positive and highly significant coefficient for the variable “HOME”. The coefficients on population and population density are not significant. From the monthly dummies, the months February and November are found to be negative and significant. This result is plausible considering that these two months lie either side of the Christmas and New Year holiday period, when many people take holidays and also a large portion of the household budget will be used during the festive period.

Temperature is highly significant. However, the square of temperature is not significant. Therefore, the optimal temperature cannot be calculated. Here we have a positive relationship between demand and temperature; as temperature increases so will demand. Purely from the human physiological point of view, this is rather unlikely, as at high temperatures, particularly in combination with high levels of humidity, a state of discomfort will occur. For precipitation, a minimum turning point is found at 137mm per month, which is much higher than the observed values for any month in Germany or in Northern Europe. Before this point, any increase in precipitation will have a negative effect on demand. There is an optimal number of wet days at 11.5 days per month. The Northern European countries have more wet days per month all year round and such a value is typical of a Mediterranean winter. The calculated optimal values for each specification are shown in Table 6.

For the second specification containing the variable cloud cover, the greatest changes are seen in the climate variables. Temperature and precipitation are no longer significant and therefore no turning points can be estimated. The square of cloud cover is negative and significant. For the majority of the other variables there are no changes in sign and significance. However, the monthly dummy for August is positive and significant; this is plausible as it is the time of school holidays and the traditional holiday month.

As in the study by Maddison (2001b), a third specification including the quartic terms of temperature was analysed. There are no changes in the significance or signs of the other variables. The turning points do not change significantly either. The turning points are 134mm for precipitation and for 11.6 days for wet day frequency. However, from the four temperature terms the square and the quartic of temperature are significant. A fourth regression is carried out dropping the least significant term, the linear temperature term. The results with this specification are very similar to those of the first and third specification. Again, the turning points for precipitation and wet day frequency are 133 mm and 11.6 respectively. Optimal mean temperatures of 24°C for the values above zero and for those below zero an optimal mean of –11°C.

5. DISCUSSION

5.1 Comparison with other studies

A comparison with the UK and Netherlands studies shows broadly similar results.[5] In contrast to the case study presented here, the two previous studies were carried out using quarterly visitation rates and climate data. The significant variables from all three studies are shown in Table 7. In all studies, distance is negatively signed but only significant when a travel cost variable is not included as well as a variable for distance. In both the German and the Dutch study, the square of temperature is not significant. Whereas, the optimal temperature in the UK study (maximum daytime temperature was used) was found to be 29°C. Precipitation was not significant in the Dutch and British studies. Maddison (2001a) also finds beach length to be an important factor in determining demand. However, in the study by Lise and Tol (2002) coast length was not found to be significant. For the variable population, the result from this study is very different from the other two. In this case study, the coefficient on population is negative but not significant. In the Dutch and British studies, population was used as a proxy for cultural resources and the coefficient was positive, as was the coefficient on the number of heritage sites in this case study. Whether this difference is caused by the additional variables or that German tourists have different preferences to the Dutch and British tourists is not clear. Not included in the German study, but in the others, was a variable to measure the price level in each country. Variables to examine the influence of age and income were also used in the Dutch study, which improved the R^2.

5.2 The climate attractiveness index and a scenario of climate change

[5] Here the comparison is made with Maddison (2001a).

According to the Third Assessment Report of the IPCC, it is projected that global surface temperature and the sea level are expected to increase during this century. Based upon the results of a set of different climate models and greenhouse gas emissions scenarios, an increase in the global mean temperature of between 0.8°C and 2.6°C is projected for the period 1990 to 2050 (IPCC 2001b). Globally the average annual precipitation is also expected to increase, however at the regional scale there may also be considerable decreases in the level of precipitation. Using the results of the case study, it is possible to examine the impact of these changes on the attractiveness of a destination. This has been done through the construction of a climate index. Taking only the climate data for each country and the coefficients for each of the climate variables resulting from the regression analysis, the contribution of climate to demand can be calculated and the countries then ranked according to their climatic attractiveness. Then using an arbitrary scenario, for the European summer months, of a 2°C temperature increase, a 15% decrease in precipitation and a 10% decrease in the number of wet days per month, new climate index values were calculated. Figure 1 shows the index values for August for certain European countries for the observed data and for the arbitrary scenario both for specification 1 and specification 1b. For specification 1, the climate scenario leads to an increase in the index value for every country; the increase is particularly so for the northern European countries. The estimated values for the specification 1b have broadly similar results. However, for Spain, Greece and Portugal there is actually a decrease in the index values under a scenario of climate change. This is because the monthly mean temperature is now higher than the calculated optimal temperature. Spain has the highest index value for August. Figure 2 shows the index values of the other countries as a fraction of Spain's value. Under a scenario of climate change, the northern European countries come much closer to Spain's attractiveness and make considerable gains on the other southern European countries. In particular, domestic tourism becomes even more attractive relative to the biggest outbound market. The popular neighbouring countries, the Netherlands, Poland, Denmark and the Czech Republic, would experience an increase in popularity.

5.3 Limitations of the method

This study has further investigated the relationship between climate and demand for particular destinations. There are, however, some limitations of this study with regard to the method. The usefulness of the pooled travel cost method is limited because of the omission of substitution effects. As the substitute site qualities and prices are not included in the demand function in the model presented here, the effect of these on the demand for a destination are not known. If for example the model predicts an increase in the number of visits to a certain destination, after a change in one or more characteristics, it is not possible to say which destinations are now avoided because they have become relatively less attractive. Moreover, the failure to account for substitution effects in the model poses a further problem when changes occur at all sites. This would be the case with climate change, which will occur globally. The decision to go on holiday or not is not included in this model, therefore increases in the total number of tourists cannot be predicted. This method is also less useful for a single country or a region to examine the importance of climate or other factors in the attractiveness for tourism. Suitable variation in the parameters used will be needed in order to carry out the statistical analysis, although with a large monthly variation in the data it would still be possible.

The implications of climate change were examined only for the summer months in Europe using an arbitrary scenario. This is of limited use, as the relative attractiveness of the climate of the different months and of other continents is also of interest. Modelled scenario changes are available for all countries of the world (Mitchell et al, 2003). In table 8, the climate values for the arbitrary scenario and the average of four scenario results of the Hadley centre climate model (HadCM3) are presented for Bulgaria, Germany, Spain and Sweden. For temperature, there is very little difference in the arbitrary and the Hadley model. However, for precipitation the arbitrary results are much lower for Sweden under the arbitrary scenario. Although the use of the arbitrary scenario is useful to illustrate the effect of climate change on a range of countries for a particular month, the work of this paper could be refined by using the detailed country climate change data. This task will be left for a subsequent paper.

6. CONCLUSIONS

A limited amount of research has been undertaken on the relationship between tourism demand and the natural resource, climate. The pooled travel cost method, employed here, exploits the necessity of travel to a destination and the associated costs of this travel to analyse the effect destination characteristics, such as climate, have on demand. Expanding on the work of previous studies, a tourism demand function, which included economic, climatic and other country characteristics as explanatory variables, was estimated using data from a survey on the destination choices of German tourists. Moreover, this study examined destination choice at the monthly level, extended the set of country characteristics used and examined domestic and outbound tourism. Proxy variables to measure safety and cultural attractiveness were included and two specifications with different climate variables were examined. The specification including wet day frequency was found to perform better than the specification with the variable cloud cover. The former specification was extended to include cubic and quartic terms. In addition to the optimal wet day frequency and precipitation levels, two optimal temperature values were estimated. For temperatures above zero, the optimal was found to be at 24°C. All of the specifications improve on the results of the earlier studies for the Netherlands and the United Kingdom. An index of climate attractiveness for each country and month was calculated and used to examine the changes in attractiveness under an arbitrary climate change scenario. The northern European countries increase in attractiveness with climate change; the southern European countries becoming relatively less attractive. Using a more detailed climate change scenario, for each country and month, as opposed to an arbitrary one for a particular month and a restricted set of countries, would be an improvement on the current study. Although the travel cost methodology provides us with an insight in to the relationship between tourism demand and destination characteristics, it inadequately describes the substitution process. For this reason, further research is needed to find suitable ways to model this process.

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Albania	Finland	Lebanon	Slovenia
Algeria	France	Libya	South Korea
Austria	Germany	Malta	Spain
Bulgaria	Greece	Morocco	Sweden
Canada	Hungary	Netherlands	Switzerland
China	Iceland	Norway	Syria
Croatia	Ireland	Poland	Tunisia
Cyprus	Israel	Portugal	Turkey
Czech Republic	Italy	Romania	United Kingdom
Denmark	Japan	Slovakia	USA
Egypt			

Table 1: Countries included in the analysis

Belgium and Luxembourg
Estonia, Latvia, Lithuania, Russian Federation and Ukraine
Bosnia-Herzegovinia, Macedonia and Yugoslavia
Costa Rica, El Salvador, Guatemala, Mexico, Nicaragua and Panama
Bolivia, Colombia, Ecuador, Guyana, Peru and Venezuela
Brazil and Paraguay
Argentina, Chile and Uruguay
Antigua, Bahamas, Barbados, Bermuda, Cuba, Dominican Republic, Guadeloupe, Jamaica, Martinique, Puerto Rica, St. Lucia and Trinidad and Tobago
Benin, Burkina Faso, Cameroon, Gabon, Ghana, Kenya, Madagascar, Mauritius, Nigeria, Senegal, the Seychelles, Togo, Uganda, Zambia and Zimbabwe
Botswana, Lesotho, Namibia, South Africa, Swaziland and Tanzania,
Bahrain, Jordan, Oman and Saudi Arabia
India, Maldives, Pakistan and Sri Lanka
Cambodia, Brunei, Laos, Malaysia, Myanmar, Singapore, Thailand and Vietnam
Fiji, Palau, Samoa and Vanuatu
Australia and New Zealand

Table 2: Country groupings included in the analysis

Variable	Definition
VISITS	Number of visits from Germany in 1997
GDPPC	GDP per capita, market prices (1995 US$)
POP	Population (thousands)
PDEN	Population density (number per square km)
STAB	Stability index value (range -2.5 to 2.5)
BLEN	Beach length (km)
PROTECT	Area of protected areas (ha)
HER	Number of heritage sites
DIST	The distance between the origin and destination capital (km)
TEMP	Average monthly mean temperature (°C)
PRE	Average monthly precipitation (mm)
WETD	Average number of wet days per month
CLOUD	Average monthly cloud cover in percent
HOME	Will take the value unity when Germany is the destination, otherwise 0
M1	Will take the value unity for January, otherwise 0
M2	Will take the value unity for February, otherwise 0
M3	Will take the value unity for March, otherwise 0
M4	Will take the value unity for April, otherwise 0
M5	Will take the value unity for May, otherwise 0
M6	Will take the value unity for June, otherwise 0
M7	Will take the value unity for July, otherwise 0
M8	Will take the value unity for August, otherwise 0
M9	Will take the value unity for September, otherwise 0
M10	Will take the value unity for October, otherwise 0
M11	Will take the value unity for November, otherwise 0

Sources: see text

Table 3 Definition of the variables used in the analysis

Variable	Mean	Std. Dev.	Minimum	Maximum
GDPPC	13171.11	11771.36	520	40998.0000
POP	100484.9	230597.8	271	1232456.0000
PDEN	180.37	291.8421	3	1620.0000
STAB	0.4920546	0.8071007	-2.420517	1.6905
BLEN	263.8499	480.7259	0	2970.0000
PROTECT	14700000	26800000	0	1.0400E+08
HER	9.103448	7.841899	0	33.0000
DIST	3548.708	3916.272	174	16933.0000
TEMP	13.93712	9.142842	-21	31.0000
PRE	74.92982	50.27468	0	251.4000
WETD	11.14361	4.97465	0	22.3000
CLOUD	57.24523	14.93074	8.1	86.8000
HOME	0.0243408	1.54E-01	0	1.0000
M1	0.0669371	0.2501669	0	1.0000
M2	6.90E-02	2.54E-01	0	1.0000
M3	0.0770791	0.2669878	0	1.0000
M4	0.0851927	0.2794518	0	1.0000
M5	0.0851927	0.2794518	0	1.0000
M6	0.0912779	0.2882964	0	1.0000
M7	0.0933063	0.2911566	0	1.0000
M8	0.0851927	0.2794518	0	1.0000
M9	0.0973631	0.2967527	0	1.0000
M10	0.0912779	0.2882964	0	1.0000
M11	0.0770791	0.2669878	0	1.0000

Table 4 Characteristics of the data used

Observations: 493

Dependent variable: Log VISITS

Specification	1		2		1a		1b	
R-squared	0.584		0.5543		0.5965		0.5964	
Variable	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
M1	-1.953E-01	-1.34	-1.348E-01	-0.94	-2.136E-01	-1.5	-2.175E-01	-1.52
M2	-4.259E-01	-2.58	-2.069E-01	-1.33	-3.905E-01	-2.42	-3.892E-01	-2.42
M3	-1.823E-02	-0.12	1.449E-01	0.96	1.329E-02	0.09	1.960E-02	0.15
M4	-3.182E-01	-1.84	-1.031E-01	-0.47	-2.720E-01	-1.58	-2.591E-01	-1.75
M5	4.180E-02	0.22	2.673E-01	1.1	6.146E-02	0.32	7.747E-02	0.50
M6	-1.264E-01	-0.65	1.198E-01	0.53	-1.421E-01	-0.73	-1.263E-01	-0.72
M7	1.441E-01	0.6	4.147E-01	1.65	8.259E-02	0.36	9.691E-02	0.43
M8	3.438E-01	1.54	5.723E-01	2.23	2.801E-01	1.28	2.936E-01	1.46
M9	2.734E-02	0.16	2.495E-01	1.23	9.259E-03	0.05	2.330E-02	0.15
M10	-1.302E-01	-0.73	1.147E-02	0.06	-1.182E-01	-0.72	-1.060E-01	-0.65
M11	-5.770E-01	-4.37	-5.193E-01	-3.92	-5.852E-01	-4.64	-5.795E-01	-4.50
HOME	1.850E+00	5.66	2.316E+00	7.31	1.881E+00	5.68	1.888E+00	5.81
GDPPC	3.300E-05	3.17	2.140E-05	2.08	3.370E-05	3.16	3.350E-05	3.09
POP	-4.740E-07	-1.35	-8.310E-07	-1.94	-4.250E-07	-1.21	-4.340E-07	-1.23
PD	-3.118E-04	-0.95	-1.159E-04	-0.29	-3.005E-04	-0.87	-2.975E-04	-0.86
STAB	2.752E-01	1.48	2.594E-01	1.45	2.627E-01	1.38	2.637E-01	1.39
BLEN	5.520E-04	2.81	5.968E-04	2.71	5.794E-04	2.73	5.826E-04	2.72
PROTECT	-9.500E-09	-1.88	-5.890E-09	-1.12	-9.820E-09	-1.84	-9.960E-09	-1.89
HER	5.524E-02	2.94	6.093E-02	2.97	5.444E-02	2.83	5.450E-02	2.82
DIST	-9.320E-05	-2.47	-1.185E-04	-3.08	-1.014E-04	-2.57	-1.012E-04	-2.56
TEMP	4.350E-02	3.11	1.796E-02	1.09	5.268E-03	0.18		
TEMPSQ	2.763E-04	0.5	-2.040E-04	-0.32	3.491E-03	3.43	3.626E-03	3.73
TEMP3					9.860E-05	1.38	1.102E-04	4.09
TEMP4					-6.420E-06	-2.77	-6.830E-06	-5.43
WET	3.688E-01	4.37			3.417E-01	4.02	3.384E-01	4.18
WETSQ	-1.603E-02	-5.72			-1.472E-02	-5.28	-1.464E-02	-5.22
PRE	-2.249E-02	-2.63	-3.584E-03	-0.56	-2.219E-02	-2.49	-2.175E-02	-2.75
PRESQ	8.210E-05	3.11	2.500E-05	1.13	8.300E-05	3.05	8.160E-05	3.21
CLOUD			5.265E-02	1.33				
CLOUDSQ			-6.545E-04	-1.98				
CONSTANT	-4.537E-01	-0.9	3.029E-02	0.02	-4.291E-01	-0.82	-4.097E-01	-0.83

Table 5: Results of the regression analysis

optimal	minimum/ maximum	Specification			
		1	2	1a	1b
temperature (°C)	maximum	not significant	not significant	23 and -11 *	24 and -11 *
wet day frequency (days)	maximum	11.50	not significant	11.57	11.56
precipitation (mm)	minimum	137	not significant	134	133

* The first optimal is for temperatures above zero the latter for below zero

Table 6: Comparison of the estimated climate optima for the different model specifications

	Maddison (2001a)	Lise and Tol (2002)	This study Specification 1
Origin Country	United Kingdom	The Netherlands	Germany
Year	1994	1988/1992	1997
Observations	305	187	493
R^2	0.5	0.43	0.58
Variable		Significant variables and their signs	
GDPPC	+	+	+
BLEN	+	ne	+
PDEN	-	ns	ns
POP	+	+	ns
DIST	ns	-	-
TEMP	+	+	+
$TEMP^2$	-	ns	ns
PRE	ns	ns	-

[1] "ne" denotes the variables that were not included in the particular analysis and "ns" indicates that the variables were included but were not found to be significant.

Table 7: Comparison of the case study results with those of the UK and Dutch studies

Country	August temperature - 1961-1990 mean	August temperature - from arbitrary scenario	August temperature - from average of 4 scenarios from HadCM3 (2000-2025)
Bulgaria	20.6	22.6	22.5
Germany	16.9	18.9	17.8
Spain	21.9	23.9	23.4
Sweden	12.5	14.5	13.7

Country	August precipitation - 1961-1990 mean	August precipitation - from arbitrary scenario	August precipitation - from average of 4 scenarios from HadCM3 (2000-2025)
Bulgaria	43.6	37.1	38.5
Germany	71.5	60.8	64.5
Spain	25	21.3	22.4
Sweden	72.2	61.4	72.5

Table 8: Comparison of the results of the arbitrary scenario and the scenario results of a climate model

Figure 1: Climate attractiveness index for the month of August for selected European countries

Figure 2: Climate attractiveness index values for August for selected European countries as a fraction of Spain's index value

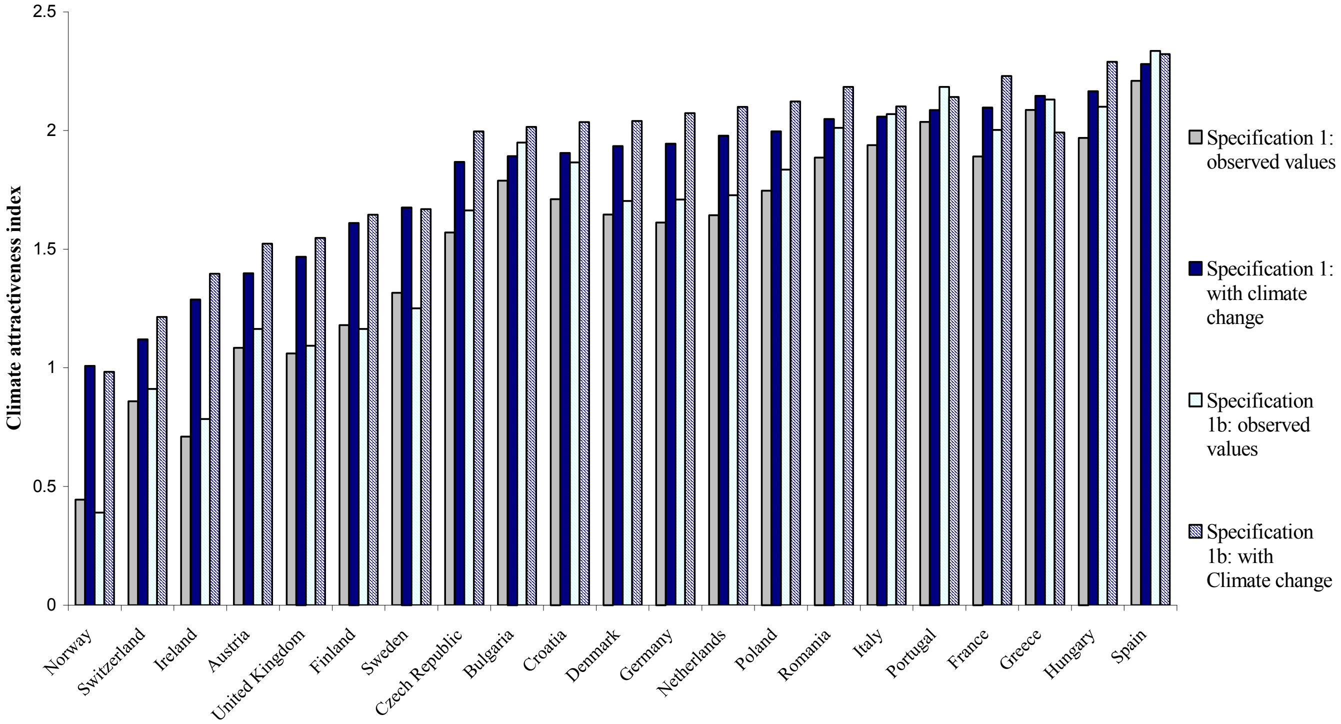
Climate attractiveness index
2.5
2
1.5
1
0.5
0
Norway
Switzerland
Ireland
Austria
United Kingdom
Finland
Sweden
Czech Republic
Bulgaria
Croatia
Denmark
Germany
Netherlands
Poland
Romania
Italy
Portugal
France
Greece
Hungary
Spain
Specification 1: observed values
Specification 1: with climate change
Specification 1b: observed values
Specification 1b: with Climate change

Figure 1

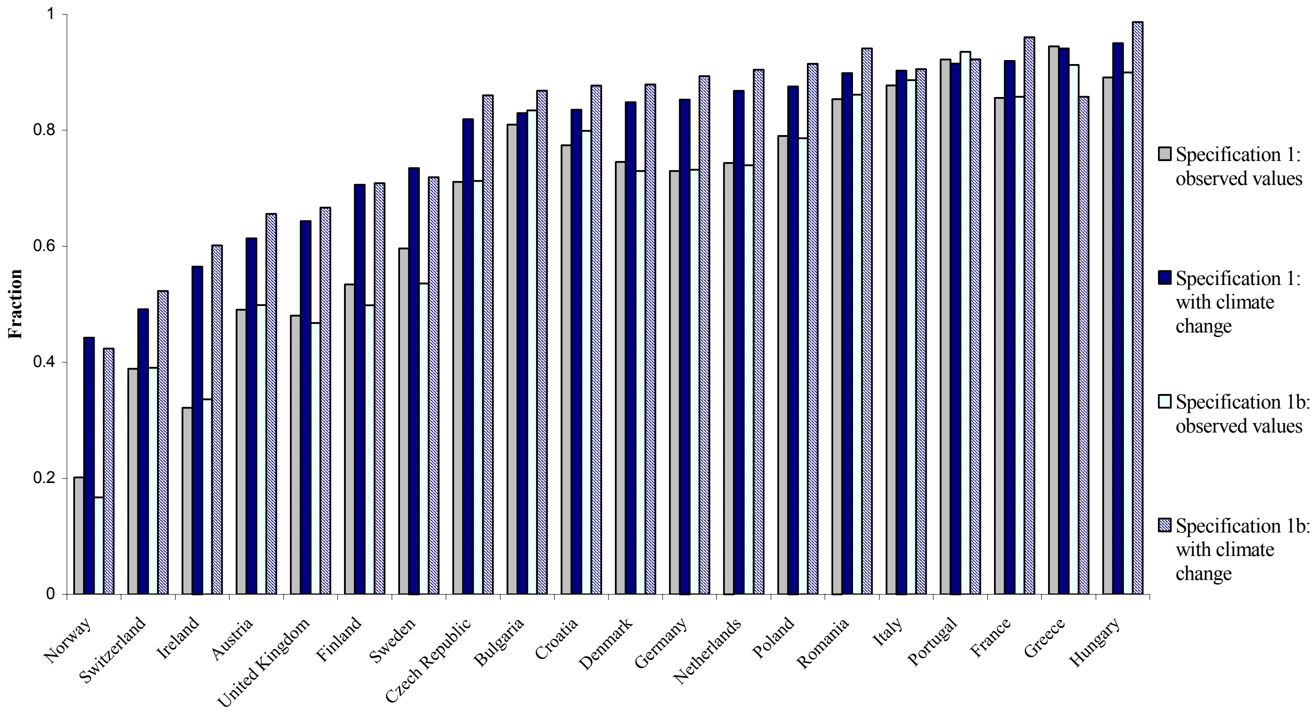
1
0.8
0.6
0.4
0.2
0
Fraction
Specification 1: observed values
Specification 1: with climate change
Specification 1b: observed values
Specification 1b: with climate change
Norway
Switzerland
Ireland
Austria
United Kingdom
Finland
Sweden
Czech Republic
Bulgaria
Croatia
Denmark
Germany
Netherlands
Poland
Romania
Italy
Portugal
France
Greece
Hungary

Figure 2

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Centre for Marine and Climate Research, Hamburg University, Hamburg

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