Climate preferences and destination choice: a segmentation approach

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Abstract:
A data set of the holiday destination choices of German tourists is segmented using phase in the life cycle; second, holiday motivation and holiday activities and third, the region of residency. For each segment demand is estimated using data on environmental and economic characteristics of countries. The optimal temperature, where demand peaks, ranges from 22°C to 24°C across the segments. More interestingly, the steepness of the temperature demand relationship is different for different segments. Even though the temperature optima are similar, changes in temperature, for example caused by climate change will have a larger effect on demand depending on the steepness of the temperature-demand relationship. A climate index is calculated for each country using climate data and the respective coefficients from the estimated demand equations. The climate index values are different across the segments: the segment containing those tourists who were swimming and sunbathing while on holiday has the highest index values of all of the segments.

Keywords: tourism demand, segmentation, climate preferences

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1 Introduction

Recent studies assessing the impact of climate change on tourism demand patterns use current behavioural patterns to estimate what demand will be under scenarios of climate change (Lise and Tol, 2002; Maddison, 2001; Hamilton *et al*. 2005). As well as environmental changes such as climate change, countries can be expected to experience changes in population, in income, in values and in policy emphasis. In order to gain an insight into the possible range of impacts in an unknown future, scenarios are used. The SRES scenarios of population change and economic development are based on storylines describing different futures according to a positioning on a globalization-regionalization scale and on an economic-environmental emphasis scale (IMAGE Team, 2001). These different storylines have different energy use and emissions patterns and therefore different estimates of climate change. Hamilton *et al*. (2005) examine future changes in global tourism flows with respect to, not only a climate change scenario, but also to the economic and population scenarios of SRES. But it is not only the amount of potential tourists that will change. In addition, the socio-economic and demographic characteristics of those who travel will change. Moreover, on a long-term scale, it is plausible that tourism trends and tourist preferences will change. On the supply side, new destinations may emerge, while some existing destinations may no longer be available for tourism.

To extend existing studies, tourism scenarios that describe possible tourism trends or that include demographic changes could be used along side the socio-economic and climate scenarios. Such scenarios would extend the storylines of the SRES scenarios to include tourism aspects. The core of these scenarios would be the relationship between demand and destination climate, and for each scenario there would be a different tourism demand and climate relationship.

Market segmentation involves defining tourist groups according to certain demographic, behavioural or psychographic traits. In the numerous segmentation studies in the literature, the segments are compared according to socio-economic characteristics, holiday characteristics or preferences for certain destination characteristics. One of the frequently used means of segmentation is nationality. Although not segmentation studies, the studies by Maddison (2001), Lise and Tol, (2002) and Hamilton (2003) have examined the tourism demand of the UK, the Netherlands and Germany respectively. These studies use the pooled travel cost method to examine the relationship between destination characteristics and demand. Moreover, climate variables, namely temperature, precipitation and in the case of the German study, wet day frequency, were included in the demand equation. Using the climate coefficients obtained from the regression analyses, the optimal values of the climate variables are estimated. The results of these studies apply to the demand of a nation as a whole. For tourism scenarios that, for example, seek to examine a new trend or a demographic change, the interest is in the climatic preferences of certain demographic or behavioural groups and not in national groups.

The objective of this study is to combine the segmentation approach and the pooled travel cost method to examine the climate preferences of different segments and so provide quantitative information for tourism scenarios. A survey of the holiday travel behaviour of German citizens during 1997 is segmented using three different means: phase in the life cycle, holiday motivation and holiday activities, and region of residence. The next section begins with a review of the literature on segmentation. Following this, the methods used to segment the survey data and to analyse the climate-demand relationships of the segments are presented. The results of the statistical analyses and, as a means of comparison, the climate index values for certain destinations are discussed in section four. The fifth section concludes.

2 Literature review

Segmentation can be carried out using various criteria; the most common, however, is the use of the life cycle. Lawson (1991) examines the expenditure and activities of eight family life cycle groups. These groups were heterogeneous in terms of spending and in the activities chosen. Unfortunately, this study does not examine the behaviour of different national groups even though five countries are represented. Oppermann (1995) argues that travel patterns are dynamic over the life cycle. What is more, childhood holiday experience, according to Oppermann, has an influence on destination choice later in the life cycle. These ideas are confirmed in a longitudinal study of German tourist behaviour: younger tourists leave Central Europe more frequently than older tourists, and for the age group 34-48 there is a decline in demand compared to the other age groups. In addition, different generations show different travel patterns at the same point in the life cycle. The bi-modal demand pattern over the life cycle, with the trough occurring in the thirties to late forties, is observed by Collins and Tisdell (2002). Psychological needs also change over the life cycle and as a consequence the type of tourist behaviour chosen. Gibson and Yiannakis (2002) note that, for a survey of citizens of the USA, getting older affects the pattern of behavioural roles taken. In their study, the tourist role "sun lover" is observed most frequently. Nevertheless, this role becomes less important over the lifetime of the individuals surveyed. Segmentation according to age has been carried out extensively for the senior market. Even within the senior market there are heterogeneous groups (Shoemaker, 1989). Reviewing the literature on the senior market, Fleischer and Pizam (2002) find that income and health are the determinants of heterogeneity between the groups in terms of number of vacation days. Moreover, the number of vacation days decreases with age.

The use of nationality as a segmentation approach has generated some debate (Dann, 1993; Mykletun *et al*. 2001). Mykletun *et al*. (2001) find that nationality is the most important factor in defining groups according to levels of expenditure or of satisfaction. Other studies confirm that there are differences in the behaviour of nationalities in terms of destination choice motivation, spatial distribution patterns and the likelihood of independent travel (Oppermann, 1992; Oppermann, 1994; Kozak, 2002). Yuan and MacDonald (1990), however, find that the motivation for travelling is the same across national groups.

In order to gain a profile of high spending groups, segmentation studies have been carried out according to levels of expenditure at a destination. Mok and Iverson (2000) note that very little work has been done on segmentation according to expenditure. Nevertheless, studies on visitors to the Canary Islands and the Balearic Islands show that different nationalities and different demographic clusters have heterogeneous expenditure patterns (Bethencourt *et al*., 2002; Perez and Sampol, 2000).

The activities undertaken by tourists are also used to segment the tourist market. This can be done generally by defining different types of tourists (Gibson and Yiannakis, 2002; Wickens, 2002) or more specifically using activity choices to build homogeneous clusters (Lise and Tol, 2002; Shoemaker, 1994).

Some of the segmentation studies analyse different preferences for destination characteristics. Hu and Ritchie (1993) find that for a survey of Americans, climate is ranked higher by recreational tourists than by educational ones. Moreover, climate is ranked second from 16 possible attributes by the former segment and ranked 12th by the latter. Shoemaker (1994) uses factor analysis to build three segments of tourists: adventurous/educational travellers, get away/family travellers and gamblers/fun travellers. The gamblers/fun travellers rank "good climate/weather" higher than the other two groups. In addition, this group ranks "opportunity to sunbathe" and "good beaches" higher than the other groups. Based on segmentation according to nationality, Kozak (2002) examines the push and pull motivations of German and British tourists visiting Mallorca and Turkey. He found that there are some differences in the importance attached to destination characteristics between the resorts visited and by the origin country of the tourists. For both origin countries "enjoying good weather" is the most important motivational factor. From the destination-based factors, "weather" is the second most attractive factor for the British visitors to Mallorca and the most important for those visiting Turkey. The German tourists rank "weather" as the most important characteristic for both destinations.

These studies demonstrate that climate is a significant factor in determining a country's attractiveness. Nevertheless, the rank position does not tell us how climate influences the demand for different countries. Using factor analysis and data on the destination choices of Dutch tourists, Lise and Tol (2002) construct nine activity clusters. For each of the activity clusters a demand function is estimated using climate other country characteristics. They find that the optimal temperature for fishing and playing tennis is 18°C. For visiting amusement parks and other attractions they find an optimal of 15°C, and for travelling with public transport, which they interpret as budget holiday makers, they find an optimal of 20°C. Surprisingly, for their beach holiday segment they do not find an optimal temperature.

3 The model and its application

The model specification and the data set of country characteristics that are used in this study are taken from Hamilton (2003), where detail on the data sources and the pooled travel cost methodology can be found.

3.1 Data

The original survey contained the responses of 7780 German citizens in 1998 to questions about the holidays that they took in 1997 (FUR, 1998). Those not taking a holiday were dropped from the data set. The data set has been constructed so that for every destination and month, the total number of trips taken by the survey group was calculated. In addition, for each country the data shown in tables 3 and 4 were collected. For each month and country, climate data on the average monthly temperature, wet day frequency, and the average monthly precipitation are included in the data set.

As well as the destination and departure month, the travel survey contains information about the type of accommodation, the transport mode and total expenditure for each holiday. Moreover, a series of questions deals with holiday motivation and the activities undertaken on holiday. For a scenario that assumes a change in holiday trends, it is useful to know if certain holiday activities or certain motivations have different climate-demand relationships. Three segments were made from the responses about motivation and three were made from responses about activities. In addition, the travel survey contains information about the socio-economic characteristics of the respondents: for example, gender, age, education, profession, origin state and phase in the life cycle. Using age and family status to segment the data allows an examination of the climate preferences of different age groups and of the differences in behaviour of households with and without dependent children. Four segments were constructed using phase in the life cycle. As geographic regions have diverse environmental conditions, it is interesting to study if these conditions affect environmental preferences for holiday destinations. Moreover, these regions may exhibit cultural dissimilarities. Segmentation was carried out according to four broad geographic groups. In addition to the segments of interest, the inverse of each segment was generated. For example, for the segment of all tourists under 40 without dependent children, the inverse segment was created containing all of the destination choices of the survey respondents who were over 40 or had dependent children.

In Hamilton (2003), the best fit was achieved with the following specification (equation 5-1), which was estimated using panel corrected least squares regression for the complete data set:

Equation 1:

$$\ln(VISITS) = a + \beta_1 M1 + \beta_2 M2 + \beta_3 M3 + \beta_4 M4 + \beta_5 M5 + \beta_6 M6 + \beta_7 M7 + \beta_8 M8 + \beta_9 M9 + \beta_{10} M10 + \beta_{11} M11 + \beta_{12} HOME + \beta_{13} GDPPC + \beta_{14} POP + \beta_{15} PDEN + \beta_{16} STAB + \beta_{17} BLEN + \beta_{18} PROTECT + \beta_{19} HERITAGE + \beta_{20} DIST + \beta_{21} TEMP + \beta_{22} TEMP^2 + \beta_{23} PRE + \beta_{24} PRE^2 + \beta_{25} WETD + \beta_{26} WETD^2 + \varepsilon$$

Where M represents the month of departure (where M1 is January, M2 February and so on), HOME is a dummy variable for holidays taken in Germany, GDPPC is the GDP per capita of the destination company in 1995 US$, Pop is the population of the country in thousands, PDEN is the number of people per km2, STAB is the stability index value of the destination country, BLEN is the length of beach of the country in kilometres, PROTECT is the area of protected area in hectares, HER is the number of UNESCO heritage sites, DIST is the distance between the origin and the destination capital, TEMP is the average monthly mean temperature (°C), PRE is the average monthly precipitation (mm) and WET is the average number of wet days per month.

This specification was used to estimate the demand function for each segment and its inverse. In order to test whether there are differences between the estimated demand equation for the segment (containing a subset of the destination choices) and the pooled model (containing all of the observed destination choices), a Chow test is used. This tests the null hypothesis that the two models are equivalent. In this case, the test is if the complete model (containing the destination choices of all of the surveyed tourists) is significantly different from the segmented models, that is, the segment of interest and its inverse. The test statistic is given by:

Equation 2: $SSR_c \cdot (n - 2p - 2) / SSR_s / (n - p - 1)$

and is distributed as F(*n*-*p*-1, *n*-2*p*-2), where SSR_c and SSR_s are the sum of squared residuals for the complete model and the segmented models respectively. The number of observations is denoted by *n*, and *p* is the number of parameters. The subscripts *c* and *s* denote the complete model and the segmented model respectively.

For each segment, it is possible to compare the estimated coefficients. Moreover, the estimated coefficients can be used to estimate the optimal value of the climate variables. In

Hamilton (2003) climate index values for the complete data set, calculated using the estimated coefficients of the climate variables, are presented for the climate of certain European countries in August. In this study, the index values of each segment are calculated and compared.

3.2 Segmentation Specification and Data

Firstly, segmentation according to the stage in the life cycle of the respondents was carried out. There were eight possible responses covering three age groups and whether there were dependent children in the household or not. These were combined to form four clusters. In addition, the inverse segment of *Children* was examined more closely. The segment definitions are presented in table 1.

Information was available on the federal state of residence of the respondent. There are 16 federal states in Germany and these were used to form four segments, which are defined in table 1. These segments capture broad regions of topographic and climatic similarity. As well as the influence of environmental factors, differences in culture may give rise to different travel patterns, which has been observed in aforementioned studies of different nations.

There were eight survey questions on motivation and nine on holiday activities. Based on the literature review, three segments were produced for both motivation and activities. These are defined in table 1. The segments *Sport* and *Outdoor* may in fact be very similar, as one would expect that those whose motivation is to take part in sporting activities will go on to carry out those activities while on holiday.

Segment name	Definition
Life cycle segments	
Young	Respondent between 14 and 39 years old
Children	Respondent from a household with children under 14
Middle	Respondent between 40 and 59 years old
Senior	Respondent older than 60 years
Regional segments	
East	Respondent resident of Berlin, Brandenburg, Saxony, Saxony-Anhalt or Thuringia
North	Respondent resident of Bremen, Hamburg, Mecklenburg-Western Pomerania, Lower Saxony or Schleswig-Holstein
South	Respondent resident of Baden-Württemberg or Bavaria
West	Respondent resident of Hessen, North Rhine-Westphalia, Rhineland-Palatinate or Saarland
Motivation and activity segments	
Sport	Motivation is to take part in sport
Health	Motivation is to do something for one's health and appearance
Family	Motivation is to spend time with partner, friends and family
Outdoor	Holiday activities include walking, hiking, cycling or other outdoor activities
Sights	Holiday activities include sightseeing and taking part in cultural events
Swimsun	Holiday activities include sunbathing and swimming

Table 1: Definition of the segments

4 Model Estimation and Empirical Results

4.1 Life cycle segments

Eight different demand equations were estimated corresponding to the life cycle segments defined in table 1 and the inverse of those segments. The regression results for the main segments and the inverse segment *Invchildren* are presented in table 2. The different segments show different R^2; the segment *Children* has the best fit. For all segments, the variable HOME has a positive relationship with demand and is statistically significant. The results for the oldest segment, *Senior*, show the largest value for the coefficient of the HOME dummy variable. This denotes that older people prefer domestic holidays. The youngest segment, YOUNG, have the lowest value for this variable. These results confirm the findings of Oppermann (1995). For the oldest segment, GDPPC is not significant; for the other groups it is. Moreover, there are no significant differences in the estimated coefficients. The results for the oldest segment, however, show a significant and negative relationship between population (POP) and demand. The other three groups show negative but non-significant relationships. As in the combined model, the coefficients of the variable stability (STAB) are not significant. PROTECT is significant and negative for the youngest and the middle aged segment. There are no significant differences in the two coefficients. For BEACH the pattern of significance is the same. The relationship with demand, however, is positive. This variable is more important for the youngest group. Moreover, for *Young* the variable HERITAGE is significant at the 1% level, for the segment *Middle* at the 5% and for the segments *Children* and *Senior* at the 10% level. DISTANCE has a negative coefficient for all of the subsets but it is not significant.

Table 3 reports the results of the Chow test for the four segments. In each case, the hypothesis that each segment and its inverse have the same demand function as the complete data set can be rejected.

	Young		Children		Middle		Senior		Invchildren	
Observations	355		240		349		252		430	
R-squared	0.57		0.61		0.58		0.56		0.59	
Variable	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
M1	-2.72E-01	-1.59	-2.81E-01	-1.13	-1.56E-01	-0.90	-6.78E-02	-0.25	-2.47E-01	-1.63
M2	-3.90E-01	-2.24	-4.48E-01	-1.78	-2.93E-01	-1.80	-8.00E-02	-0.36	-3.33E-01	-2.19
M3	-2.28E-01	-1.97	-2.86E-01	-1.33	-1.18E-01	-0.86	3.08E-02	0.18	-1.97E-03	-0.02
M4	-3.06E-01	-2.20	-3.92E-01	-1.32	-2.26E-01	-1.42	7.17E-02	0.37	-2.04E-01	-1.48
M5	-2.63E-01	-1.43	-3.25E-01	-1.19	1.46E-01	0.70	5.32E-01	2.19	1.44E-01	0.89
M6	-2.85E-01	-1.60	-4.32E-01	-1.50	2.08E-02	0.11	3.95E-01	1.36	-4.79E-02	-0.28
M7	-1.39E-01	-0.64	1.04E-01	0.31	1.98E-01	0.76	6.20E-02	0.18	7.16E-02	0.31
M8	-1.02E-01	-0.52	2.79E-01	0.83	3.07E-01	1.35	3.21E-01	1.10	1.42E-01	0.68
M9	-9.77E-02	-0.70	-3.56E-01	-1.14	-1.56E-02	-0.07	3.38E-01	1.24	7.06E-02	0.44
M10	-3.25E-01	-2.10	-1.11E-01	-0.47	-1.25E-02	-0.07	-6.06E-03	-0.02	-1.26E-01	-0.81
M11	-6.49E-01	-4.33	-5.09E-01	-1.75	-2.63E-01	-1.42	-2.21E-01	-0.96	-4.85E-01	-3.36
HOME	1.14E+00	4.31	1.58E+00	4.76	1.71E+00	5.46	2.46E+00	7.35	2.03E+00	6.35
GDPPC	3.56E-05	4.01	3.73E-05	4.02	3.19E-05	3.29	1.11E-05	0.96	2.84E-05	2.38
POP	-3.14E-07	-0.87	-2.48E-07	-0.47	-3.20E-07	-0.86	-8.92E-07	-1.99	-4.38E-07	-1.18
PD	-9.30E-05	-0.34	-9.45E-05	-0.20	-9.26E-05	-0.26	-4.10E-05	-0.15	-9.72E-05	-0.25
STAB	-4.02E-02	-0.20	-1.64E-01	-0.70	-1.75E-02	-0.07	1.16E-01	0.55	2.07E-01	0.73
BLEN	5.71E-04	4.07	1.94E-04	1.14	2.96E-04	1.95	9.01E-05	0.49	5.79E-04	2.80
PROTECT	-1.32E-08	-3.14	-8.33E-09	-1.48	-1.02E-08	-2.25	-5.89E-09	-0.97	-9.02E-09	-1.64
HER	4.17E-02	2.52	3.52E-02	1.73	4.15E-02	2.14	4.22E-02	1.72	4.88E-02	2.38
DIST	-2.63E-05	-0.86	-9.12E-05	-1.76	-4.12E-05	-1.23	-5.98E-05	-1.12	-9.65E-05	-2.36
TEMPSQ	3.31E-03	4.46	4.33E-03	3.58	-1.11E-03	-0.36	1.37E-03	1.14	3.04E-03	3.08
TEMP3	8.21E-05	3.60	7.51E-05	1.98	4.34E-04	1.94	5.42E-05	0.94	1.05E-04	4.08
TEMP4	-5.73E-06	-6.02	-6.03E-06	-3.25	-1.34E-05	-2.80	-4.89E-06	-2.22	-6.22E-06	-4.79
WET	2.69E-01	4.00	4.05E-01	4.35	3.27E-01	4.03	1.08E-01	1.05	2.74E-01	3.28
WETSQ	-1.04E-02	-3.97	-1.69E-02	-4.76	-1.35E-02	-4.86	-7.11E-03	-1.77	-1.24E-02	-4.38
PRE	-2.79E-02	-4.18	-2.60E-02	-2.74	-2.00E-02	-2.48	-7.36E-05	-0.01	-1.51E-02	-1.84
PRESQ	1.02E-04	4.31	9.04E-05	2.67	7.08E-05	2.64	2.39E-05	0.71	6.13E-05	2.40
CONSTANT	-3.82E-01	-1.23	-1.05E+00	-2.09	-8.45E-01	-1.85	-1.32E-01	-0.27	-3.18E-01	-0.72

Table 2: Results for the life cycle segments

Segment name	F-statistic
Life cycle segments	
Young	1.286 ***
Children	1.196 *
Middle	1.327 ***
Senior	1.171 *
Regional segments	
East	1.245 **
North	1.268 **
South	1.294 ***
West	1.268 **
Motivation and activity segments	
Sport	1.229 *
Health	1.335 ***
Family	1.306 ***
Outdoor	1.330 ***
Sights	1.267 **
Swimsun	1.276 ***

*** Significant at the 0.5% level
** Significant at the 1% level
* Significant at the 5% level

Table 3: Chow test F-Statistics for differences between the segments, the inverse of the segments and the full model

significant for the segment *Middle*. For the other segments, however, all of the climate variables are significant. The observed optimal climate values of the segments are shown in table 4. The optimal temperatures for the two oldest age segments are not significant. The segment *Children* has the highest optimal temperature of 24°C and the relationship between temperature and demand is much more peaked for this segment. Those with children prefer destinations that are near this optimal temperature. A change in the temperature would lead to larger changes in demand than it would for the *Young* segment, which has a similar optimal temperature but a less peaked temperature-demand relationship. For wet day frequency, the highest optimal frequency of 13 days is found for the *Young* segment (the *Invyoung* has an optimal at 11.4). Again, the segment *Children* has a more peaked wet days-demand relationship than the other segments. The precipitation minima range from 133mm (*Invchildren*) to 144mm (*Children*).

	temperature (°C)		wet day frequency (days)	precipitation (mm)
	maximum		maximum	minimum
Life cycle segments				
Young	23	-12	13.0	137
Children	24	-15	12.0	144
Middle	ns	ns	12.1	141
Senior	ns	ns	ns	ns
Regional segments				
East	ns	ns	11.5	128
North	21	-18	12.5	146
South	23	-10	11.3	127
West	23	-9	11.9	138
Motivation and activity segments				
Sport	23	-12	10.8	125
Health	23	-12	11.4	117
Family	23	-10	11.8	139
Outdoor	23	-10	10.9	120
Sights	22	-13	11.5	123
Swimsun	23	-17	11.1	134

ns - not significant

Table 4: Optimal values of the climate variables for each segment. Only those significant at the 5% level are listed

Climate index values were calculated for the month of August for certain European countries. The different values for each of the segments and the index values for the pooled model are shown in Figure 1. The highest index values are for the segment *Children*, which has even higher values than the combined data set. The lowest values are estimated for the segment *Senior*. In general, the *Middle* segment has higher climate values than the *Young* segment. There are some differences in the ranking of the different countries.

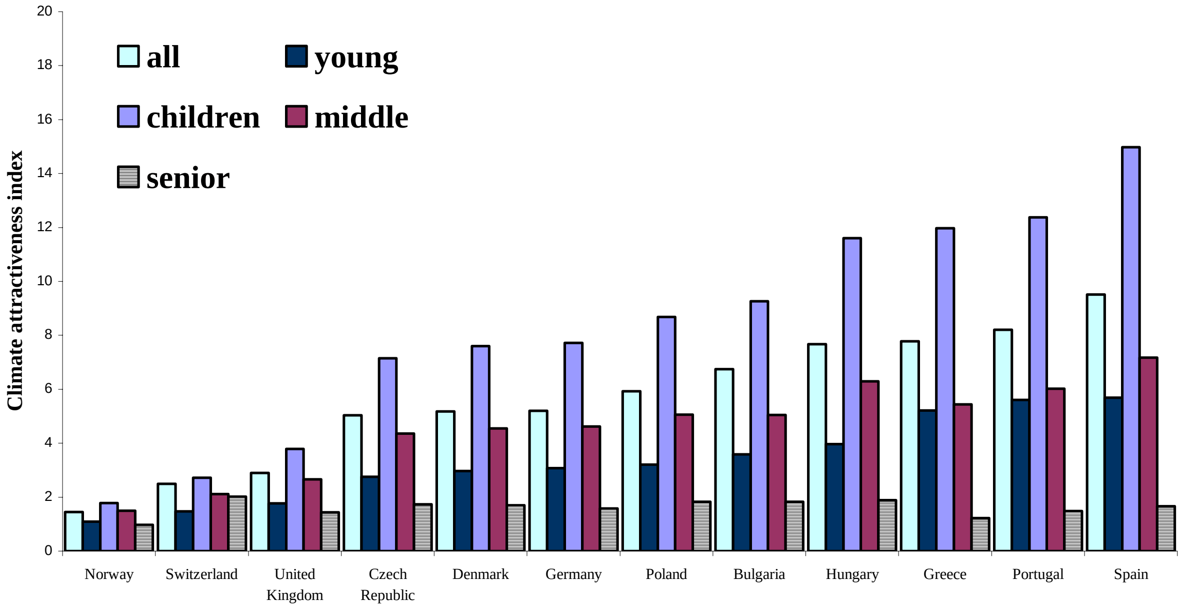

Figure 1: Climate index values for the life cycle segments

4.2 Regional Segments

The demand equations of the six regional segments as defined in table 1 and four inverse segments were estimated. The results of the main segments are shown in table 5. Again, there are different R^2 values for each of the segments; *South* has the worst fit of all. The segment *East* has the largest coefficient for the variable HOME of all of the segments. GDPPC is significant for all segments apart from *East*. The segment *West* has the largest coefficient for GDPPC. The coefficient on population is negative and significant at the 10% level for the segment *East*. This was also seen for the oldest group in the life cycle segmentation. The coefficient for BEACH is positive for each segment but significant for the segments *North* and *West*; the latter has a larger coefficient. The segment *North* has a negative and significant coefficient for PROTECT. The segments *South* and *West* have positive and significant coefficients for HERITAGE. The coefficient on DISTANCE has the correct sign for all segments but is only significant at the 10 % level for *East* and *South*.

	East		North		South		West	
Observations	274		283		329		328	
R-squared	0.56		0.62		0.53		0.59	
Variable	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
M1	-2.81E-01	-1.28	-8.43E-02	-0.57	-2.98E-02	-0.15	-3.19E-01	-1.50
M2	-3.29E-01	-1.53	4.88E-03	0.03	-4.18E-01	-1.86	-1.12E-01	-0.62
M3	-1.09E-01	-0.55	6.78E-02	0.45	-2.81E-01	-2.14	-7.37E-02	-0.56
M4	-3.20E-01	-1.55	-2.89E-02	-0.18	-3.54E-01	-2.42	-1.57E-01	-1.05
M5	-6.53E-02	-0.27	4.39E-01	2.28	1.09E-02	0.07	-1.24E-01	-0.69
M6	-1.68E-01	-0.59	1.43E-01	0.75	-1.91E-01	-1.04	-2.16E-01	-0.96
M7	3.07E-01	0.99	3.05E-01	1.56	-4.79E-01	-2.39	2.42E-01	0.94
M8	6.33E-02	0.20	2.69E-01	1.47	1.14E-01	0.57	4.54E-02	0.17
M9	-1.30E-01	-0.47	1.22E-01	0.74	8.78E-02	0.52	-1.67E-02	-0.07
M10	-1.74E-01	-0.69	7.05E-02	0.40	-2.33E-01	-1.36	-1.70E-01	-0.94
M11	-3.89E-01	-2.13	-3.39E-01	-2.06	-5.17E-01	-3.14	-5.25E-01	-2.10
HOME	2.09E+00	6.82	1.95E+00	5.14	1.28E+00	4.35	1.72E+00	4.77
GDPPC	2.04E-05	1.64	2.94E-05	3.04	2.85E-05	2.21	3.84E-05	3.49
POP	-6.55E-07	-1.84	-5.23E-07	-1.09	-5.01E-07	-1.11	-5.71E-07	-1.10
PDEN	-2.68E-04	-0.97	-6.05E-05	-0.32	1.97E-05	0.05	2.05E-04	0.53
STAB	-6.98E-02	-0.25	-1.10E-01	-0.68	1.17E-02	0.05	-1.09E-01	-0.43
BLEN	1.70E-04	0.94	3.52E-04	2.75	2.79E-04	1.42	4.16E-04	2.36
PROTECT	-7.66E-09	-1.46	-9.69E-09	-2.38	-7.67E-09	-1.52	-9.13E-09	-1.71
HER	2.75E-02	1.46	3.27E-02	1.32	4.08E-02	2.19	4.52E-02	2.10
DIST	-7.67E-05	-1.90	-1.89E-05	-0.56	-7.44E-05	-1.89	-7.99E-05	-1.53
TEMPSQ	1.96E-03	0.39	3.30E-03	4.36	3.12E-03	3.09	2.48E-03	2.16
TEMP3	1.47E-04	0.38	1.70E-05	0.74	1.18E-04	2.37	1.04E-04	2.99
TEMP4	-7.26E-06	-0.87	-4.31E-06	-3.56	-6.82E-06	-4.45	-5.68E-06	-3.87
WET	1.86E-01	2.38	2.26E-01	2.75	2.71E-01	3.17	3.27E-01	3.35
WETSQ	-8.11E-03	-3.15	-9.04E-03	-3.09	-1.20E-02	-3.64	-1.38E-02	-4.27
PRE	-1.42E-02	-1.65	-1.41E-02	-1.52	-1.78E-02	-2.30	-1.88E-02	-1.89
PRESQ	5.51E-05	2.00	4.83E-05	1.49	6.99E-05	2.78	6.81E-05	2.27
CONSTANT	5.26E-02	0.11	-8.01E-01	-2.09	-5.78E-01	-1.45	-8.45E-01	-1.70

Table 5: Results for the regional segments

From the results of the Chow test shown in table 3, it can be seen that the demand equations for the respective segments and their inverses are not equivalents.

Segments *South* and *West* have significant coefficients for all of the climate variables. The calculated climate optima can be seen in table 4. The segments *South* and *West* both have an optimal temperature of 23°C. The estimated temperature-demand relationship, however, is much steeper for the segment *South*. For precipitation, the minimum optima range from 127mm to 146mm. It is interesting that *South* and *West* have significant climate optima, as the south west of Germany is the warmest and sunniest region of Germany. It would seem that tourists with a warmer home climate are more particular about their holiday destination climate.

Figure 2 shows the index values for the regional segments. The complete model has higher index values than any of the segments. Generally, the highest index values are for the segment *West* followed by the segment *South*, although there are some differences in ranking.

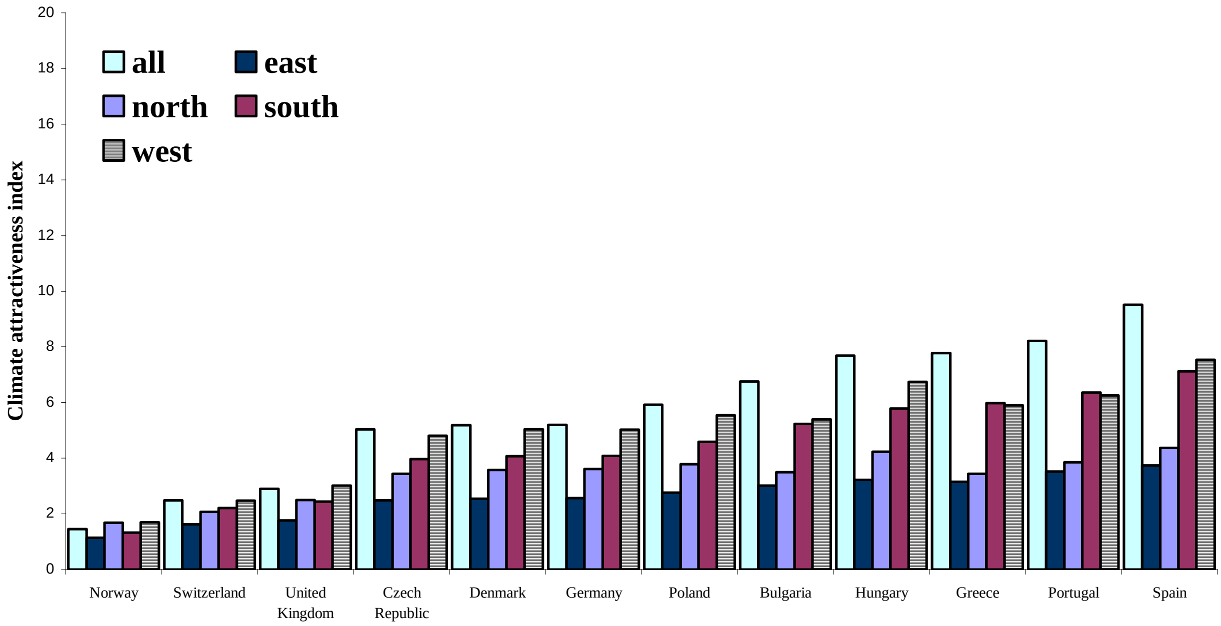

Figure 2: Climate index values for the regional segments

4.3 Activity and Motivation Segments

The statistical analysis was carried out for the six activity and motivation segments, as defined in table 1, and their inverse segments. The results of the regression analyses are presented in tables 6 and 7.

For all the motivation segments, the coefficients for HOME are positive and significant (see table 6). The motivation segment *Health*, however, has the largest coefficient for this variable and it is more than twice as large as the coefficient for the *Sport* segment. This may be caused by an aversion to longer distances when tourists are looking for a holiday that will be beneficial for their health. Avoiding stress, which may be in terms of the physical distance but also in terms of cultural or linguistic distance, could be a restriction on health holidays. Moreover, Germany has a very strong tradition of health resort holidays (Kur) at domestic destinations where the air is considered particularly beneficial. The importance of trips to family and friends within Germany is reflected in the size of coefficient of the HOME variable for the *Family* segment. Like the majority of the other segments discussed above GDPPC is positive and significant for all of the motivation segments. The variables POP, PDEN and STAB are not significant for any of the segments. As visiting the beach is often seen as a family destination it is not surprising that BEACH is significant and positive for the *Family* segment. The *Sport* and *Health* segments have positive and significant coefficients for the variable HERITAGE.

For segmentation according to motivation, the hypothesis that each segment and its inverse have the same demand function as the complete data set can be rejected (see table 3).

	Sport		**Health**		**Family**	
Observations	263		404		330	
R-squared	0.54		0.59		0.60	
Variable	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
M1	5.94E-02	0.27	-1.60E-01	-0.81	-3.54E-01	-1.59
M2	-1.79E-01	-1.24	-1.39E-01	-0.67	-5.37E-01	-2.80
M3	-2.42E-01	-1.63	-4.76E-02	-0.29	-1.50E-01	-0.88
M4	-2.09E-01	-0.96	-2.40E-01	-1.36	-4.26E-01	-2.25
M5	-6.50E-01	-2.30	6.04E-02	0.32	-2.97E-01	-1.49
M6	-4.80E-01	-1.59	-9.93E-02	-0.53	-4.35E-01	-1.74
M7	-3.66E-01	-1.17	1.72E-01	0.79	-1.51E-01	-0.57
M8	-1.25E-01	-0.38	3.74E-01	1.80	1.14E-01	0.40
M9	-2.83E-01	-0.84	7.95E-02	0.38	-3.25E-01	-1.64
M10	-5.14E-01	-2.18	-7.38E-02	-0.40	-2.83E-01	-1.51
M11	-4.30E-01	-1.43	-6.04E-01	-3.40	-4.60E-01	-2.08
HOME	1.00E+00	3.41	2.02E+00	5.50	1.90E+00	5.15
GDPPC	4.52E-05	3.63	3.47E-05	2.97	4.13E-05	3.54
POP	-3.95E-07	-1.00	-6.17E-07	-1.28	-2.92E-07	-0.62
PDEN	3.52E-05	0.12	-3.14E-04	-0.93	-1.22E-04	-0.30
STAB	1.61E-02	0.05	1.93E-01	0.68	-1.01E-02	-0.03
BLEN	9.97E-05	0.53	2.94E-04	1.66	3.74E-04	2.11
PROTECT	-9.34E-09	-1.54	-1.03E-08	-1.96	-9.60E-09	-1.81
HER	4.18E-02	2.24	4.93E-02	2.11	3.45E-02	1.52
DIST	-7.91E-05	-1.48	-8.40E-05	-2.01	-1.11E-04	-2.48
TEMPSQ	3.53E-03	3.01	3.98E-03	4.09	3.88E-03	3.15
TEMP3	9.64E-05	2.52	1.02E-04	4.35	1.58E-04	2.66
TEMP4	-6.37E-06	-4.38	-7.12E-06	-5.46	-8.66E-06	-3.88
WET	3.09E-01	3.45	2.94E-01	3.50	3.75E-01	4.53
WETSQ	-1.43E-02	-3.71	-1.29E-02	-4.56	-1.59E-02	-5.37
PRE	-2.25E-02	-2.78	-2.00E-02	-2.25	-2.32E-02	-2.66
PRESQ	9.03E-05	3.24	8.51E-05	3.06	8.34E-05	2.78
CONSTANT	-6.37E-01	-1.42	-6.82E-01	-1.50	-7.57E-01	-1.59

Table 6: Results for the motivation segments

The climate variables are significant for all of the motivation segments. There is little difference in the optima for temperature or for wet days across the motivation segments (see table 4). Nevertheless, differences in the steepness of the climate-demand relationships can be seen. The segment *Family* has the steepest and highest demand relationship for temperature and wet day frequency. Precipitation minima range from 117mm (*Health*) to 139mm (*Family*). The climate index values for the motivation segments are shown in figure 3. The values for the segments *Sport* and *Health* are lower than the index values from the pooled model, whereas the values for the segment *Family* are higher. There are slight differences in the ranking of the countries.

	Outdoor		**Sights**		**Swimsun**	
Observations	414		460		375	
R-squared	0.59		0.58		0.55	
Variable	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
M1	-3.47E-01	-2.01	-2.54E-01	-1.80	-2.36E-01	-1.09
M2	-3.97E-01	-2.11	-4.12E-01	-2.53	-4.20E-01	-1.81
M3	-2.87E-01	-2.05	1.01E-03	0.01	-1.92E-01	-0.94
M4	-3.93E-01	-2.42	-1.36E-01	-0.91	-2.30E-01	-1.13
M5	-5.45E-02	-0.30	2.64E-01	1.78	1.85E-01	0.83
M6	-2.97E-01	-1.65	1.04E-01	0.58	-1.14E-01	-0.49
M7	-6.75E-02	-0.29	2.89E-01	1.37	2.74E-01	1.02
M8	1.07E-01	0.45	4.16E-01	2.02	3.83E-01	1.40
M9	-8.74E-02	-0.45	2.05E-01	1.22	-5.99E-02	-0.27
M10	-3.77E-01	-2.09	2.57E-02	0.16	-1.23E-01	-0.56
M11	-5.36E-01	-2.65	-4.46E-01	-3.26	-4.74E-01	-2.86
HOME	2.13E+00	6.20	1.97E+00	6.46	1.33E+00	3.30
GDPPC	3.66E-05	2.90	2.12E-05	2.07	2.68E-05	2.61
POP	-6.94E-07	-1.41	-6.26E-07	-1.60	-6.33E-07	-1.25
PDEN	-2.61E-04	-0.71	-1.40E-04	-0.38	1.94E-05	0.05
STAB	1.78E-01	0.58	2.06E-01	0.70	5.73E-02	0.18
BLEN	2.69E-04	1.39	6.65E-04	3.61	6.51E-04	3.61
PROTECT	-1.04E-08	-1.77	-8.32E-09	-1.62	-1.48E-08	-2.22
HER	4.94E-02	2.22	4.80E-02	2.50	4.49E-02	1.74
DIST	-8.97E-05	-1.92	-8.93E-05	-2.35	-6.20E-05	-1.24
TEMPSQ	3.39E-03	3.34	3.74E-03	3.91	5.85E-03	5.19
TEMP3	1.17E-04	3.78	7.62E-05	3.10	5.71E-05	1.90
TEMP4	-7.16E-06	-5.01	-6.48E-06	-5.00	-7.35E-06	-4.97
WET	2.86E-01	3.64	2.39E-01	2.73	4.20E-01	3.31
WETSQ	-1.31E-02	-4.85	-1.04E-02	-3.60	-1.89E-02	-3.96
PRE	-1.65E-02	-1.98	-1.83E-02	-2.18	-2.54E-02	-2.43
PRESQ	6.87E-05	2.55	7.45E-05	2.95	9.44E-05	2.79
CONSTANT	-3.35E-01	-0.68	-1.67E-01	-0.36	-1.06E+00	-1.98

Table 7: Results for the activity segments

The results for the activity segments are shown in table 7. For the variable HOME, the activity segment *Swimsun* has a much lower coefficient than the other two activity groups *Outdoors* and *Sights*. The coefficient is significant for all of the activity segments. Population, population density and stability are not significant. As expected from the definition of the segment *Swimsun*, BEACH is positive and significant. Curiously, there is no statistically significant difference between the BEACH coefficients for the segments *Sights* and *Swimsun*. Taking into consideration the fact that 65% of the tourists stated that sightseeing was one of their holiday activities and 64% stated that swimming or sunbathing was part of their holiday it is clear that there is some overlap in these two segments. In addition, the standard package holiday there will normally be some combination of these two activities. For the variable PROTECT there is a negative and significant relationship evident for the segment *Swimsun*. This could be explained by the fact that countries that have more protected area within their territory may have less beach available for recreational and tourism purposes. The coefficient on HERITAGE is significant for the *Outdoors* and *Sights* segment at the 1% level and for the *Swimsun* segment at the 10% level. In addition, for the *Swimsun* segment, the coefficient for DISTANCE although negative, is not significant. The distance of the countries from Germany was less of a restriction for the people who were swimming or sunbathing on their holiday. Table 6 shows the results of the Chow test. As before, the Chow test confirms that the demand equations are different.

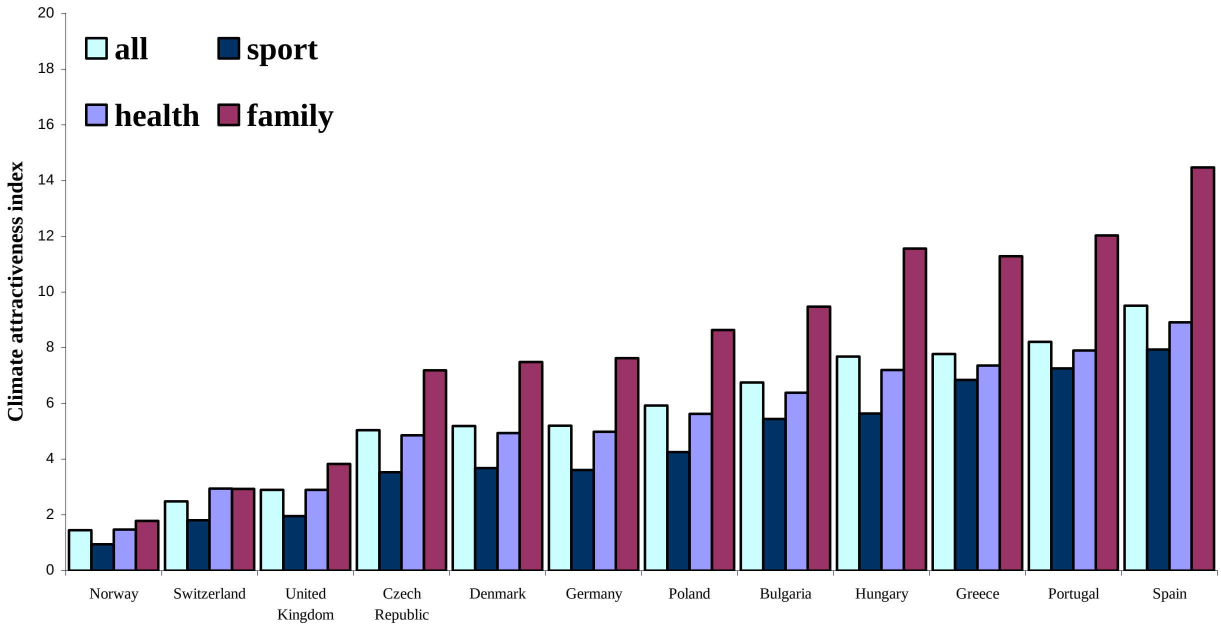

Figure 3: Climate index values for the motivation segments

It is possible to calculate climate optima for all of the activity segments. These can be seen in table 4. As with the previously discussed segments, the greatest differences in the optima can be seen in the precipitation minimum, which range from 120mm (*Outdoors*) to 134mm (*Swimsun*). *Sights* has the lowest temperature optimum at 22°C, whereas *Swimsun* and *Outdoors* have optima of 23°C. As before there are differences in the steepness of the temperature-demand relationships. *Swimsun* has the steepest relationship; in particular, demand falls rapidly when the temperature goes above 23°C.

The *Sights* segment has the lowest climate index values, whereas the *Swimsun* has the highest values. For example, the climate values for Spain for the *Swimsun* segment are almost double that of the values for the *Sights* segment. This is as expected: swimming and sunbathing are weather dependent recreation activities In addition, the segment *Outdoors* has very similar values to that of the complete model. Again, there are slight differences in the ranking of the countries according to the index values. Figure 4 shows the calculated index values for the activity segments for a set of European countries for the month of July.

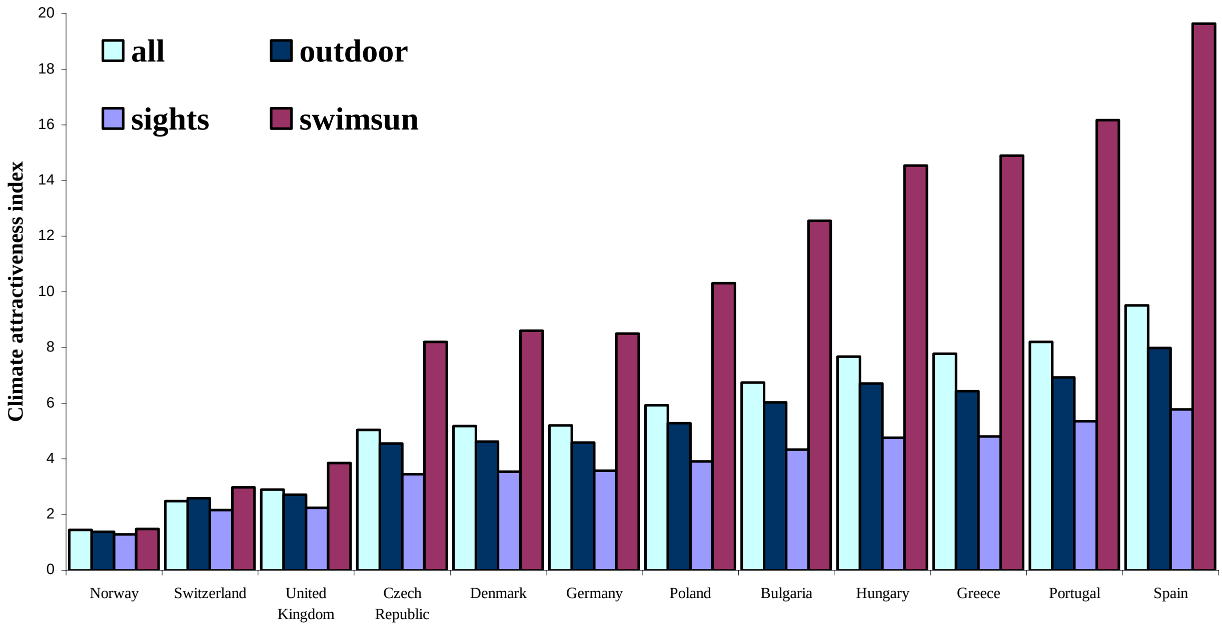

Figure 4: Climate index values for the activity segments

5 Discussion and conclusion

The aim of this study is to examine the climate-demand relationships of various segments, in order to provide a quantitative basis for tourism scenarios, which can then be used in climate impact research. Expanding the work of Hamilton (2003), this study presents three separate methods to segment the original data set and goes on to estimate the demand function for these segments in terms of destination characteristics such as climate, natural and cultural resources as well as socio-economic characteristics. Using a Chow test, the demand functions of all of the 28 segments were found to be significantly different from that of the complete model.

Certain variables were found to have a consistent relationship across all the segments. Domestic tourism was a positive factor in all of the estimated equations. There were, however, differences in size. For older tourists, those looking to do something for their health, those from the East or those wanting to take part in outdoor activities domestic tourism is particularly popular. For younger people, those motivated to participate in sport on their holiday or for those who were sunbathing or swimming domestic tourism is less important. Beach length was also an important factor for younger tourists. After younger tourists, the segments of tourists from the North and the West of Germany had the highest coefficient for beach length. It is not clear from this analysis if this is caused by the region of residence having beaches or being close to countries with beaches. The number of heritage sites also has a positive effect on demand, especially for those tourists who went sightseeing.

The temperature optima ranged from 21°C to 24°C. There were, however, differences in the steepness of the temperature-demand relationship. This was markedly so for the segments of tourists with dependent children and for those whose activities included sunbathing and swimming. Moving away from the optimal temperature leads to a sharp drop in demand, particularly for temperatures above the optimal. The optimal wet day frequency ranges from 11 to 13 wet days per month. Again, there were differences in the steepness of the relationship with demand. Almost one third of month with a rain day may seem high for an optimal holiday climate. It must be borne in mind that a wet day is one where there is more than 1mm of rain and a frequency of 11 days per month is normal for a central European summer or early and late summer in southern Europe. Moreover, climate is not just a thermal or physical factor it is also an aesthetic one, in that it affects, for example, the appearance and type of flora and fauna, the appearance of the built environment and visibility. Occasional rain is not necessarily detrimental for tourism demand. There are also some more practical effects of regular rain, such as the water availability, which may be considered by the tourist.

The ranking of tourist destinations, using the climate index, did not differ significantly across the segments. Nevertheless, the size of the climate index, on average and for the individual destinations, did differ. For the majority of the segments, the destination with the highest index value was Spain.

The results of this study confirm many of the results of previous segmentation studies. This can be seen in the differences in preferences across the life cycle or across activities. Like Mykletun *et al*. (2001), this study examines several kinds of segmentation and uses regression analysis to provide detail on the different preferences of the different groups. Previous studies that examined destination image preferences did so using a ranking of attributes. In this study, demand for a destination has been estimated with respect to the environmental characteristics, such as climate or beaches. This not only provides information on what is important for each segment but also how this quantitatively affects demand.

For climate change impact studies, a segmentation approach can provide useful information. Scenarios of population and economic change are only two aspects that will shape the development of tourism in the future. New trends or structural changes in the population will also affect demand. This study provides quantitative relationships, for different segments, such as seniors, health tourists or from different geographic regions. It was shown that regions with a warmer climate generate tourists that are more particular about their holiday destination climate. If this is applied to countries, it can be expected that warmer countries would also produce tourists that are less tolerant of temperatures away from the optimal. A similar result was obtained by Bigano *et al*. (2004) in a study of global demand. This has implications for climate change impact studies. Climate change may result in many origin countries having a climate closer to their optimal temperature, which combined with a preference, ceteris paribus, for domestic tourism, would result in a reduction in international tourism. Moreover, as a warmer climate becomes the norm, the tourists may also become more particular about their holiday destination climates.

This study examines the destination choices of German tourists in a single year. To obtain a more complete picture it would be useful to repeat the study for different years but also for different countries or look at smaller regions. The results of this study, however, provide a starting point for the development of quantitative tourism-climate scenarios.

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References

Bethencourt, M., Diaz, F, Alvarez, T.A. and Gonzalez, O. (2002) The segmentation of the Canarian tourism market with regard to expenditure: an empirical study of La Palma. Congress CD-Rom of the 42nd Congress of the European Regional Science Association Dortmund ERSA 2002.

Bigano, A., Hamilton, J. M. and Tol, R.S.J. (2004) The impact of climate on holiday destination choice. *Research Unit Sustainability and Global Change Working Paper FNU-55*, Hamburg: Hamburg University and Centre for Marine and Atmospheric Science.

Collins, D. and Tisdell, C. (2002) Age-related lifecycles: Purpose variations. *Annals of Tourism Research*, 29(3), 801-818.

Dann, G.M.S. (1993) Limitations in the use of `nationality` and `country of residence` variables. *In:* D.G. Pearce and R.W. Butler (eds.), *Tourism research: Critiques and challenges*. London: Routledge. 88-112

Fleischer, A. & Pizam, A. (2002) Tourism Constraints among Israeli seniors. *Annals of Tourism Research,* 29(1), 106-122.

Forschungsgemeinschaft Urlaub und Reisen e.V. (FUR) (1998) *Die Reiseanalyse RA 98* [CD-ROM]. Köln: Zentralarchiv für empirische Sozialforschung.

Gibson, H. & Yiannakis, A. (2002) Tourist roles: needs and the lifecourse. *Annals of Tourism Research*, 29(2), 358-383.

Hamilton, J.M. (2003) Climate and the destination choice of German tourists, *Research Unit Sustainability and Global Change Working Paper FNU-15* (revised). Hamburg: Hamburg University and Centre for Marine and Climate Research.

Hamilton, J.M., Maddison, D.J. and Tol, R.S.J. (2005) Climate change and international tourism: a simulation study. *Global Environmental Change Part A*, 15(3), 253-266.

Hu, Y. and Ritchie, J.B.R. (1993) Measuring destination attractiveness: A contextual approach. *Journal of Travel Research,* 32 (2), 25-34.

IMAGE Team (2001) *The IMAGE 2.2 Implementation of the SRES Scenarios: A Comprehensive Analysis of Emissions, Climate Change and Impacts in the 21st Century* [CD-ROM] RIVM CD-ROM Publication 481508018. Bilthoven: National Institute for Public Health and the Environment.

Kozak, M. (2002) Comparative analysis of tourist motivations by nationality and destinations. *Tourism Management*, 23, 221-232.

Lawson, R. (1991) Patterns of tourist expenditures and types of vacation across the family life cycle. *Journal of Travel Research*, 29 4, 12-18.

Lise, W. and Tol, R.S.J. (2002) Impact of climate on tourism demand. *Climatic Change*, 55(4), 429-449.

Maddison, D. (2001) In search of warmer climates? The impact of climate change on flows of British tourists. *Climatic Change*, 49, 103-208.

Mok, C. and Iverson, T.J. (2000) Expenditure-based segmentation: Taiwanese tourists to Guam. *Tourism Management*, 21(3), 299-305.

Mykletun, R.J., Crotts, J.C. and Mykletun, A. (2001) Positioning an island destination in the peripheral area of the Baltics: a flexible approach to market segmentation. *Tourism Management*, 22 (5), 493-500.

Oppermann, M. (1992) Intranational tourist flows in Malaysia. *Annals of Tourism Research*, 19, 482-500.

Oppermann, M. (1994) Relevance of nationality in tourism research. *Annals of Tourism Research*, 21(1), 165-168.

Oppermann, M. (1995) Travel life cycle. *Annals of Tourism Research*, 22(3), 535-552.

Perez, E.A. and Sampol, C.J. (2000) Tourist expenditure for mass tourism markets. *Annals of Tourism Research*, 27(3), 624-637.

Shoemaker, S. (1989) Segmentation of the senior pleasure travel market. *Journal of Travel Research*, 27(3), 14-19.

Shoemaker, S. (1994) Segmenting the U.S. travel market according to benefits realized, *Journal of Travel Research*, 32 (3), 8-21.

Wickens, E. (2002) The sacred and the profane: A tourist typology. *Annals of Tourism*

Research, 29(3), 834-851.

Williams, R.L. (2000) A note on robust variance estimation for cluster-correlated data. *Biometrics*, 56, 645-646.

Yuan, S. and MacDonald, C. (1990) Motivational determinants of international pleasure time. *Journal of Travel Research*, 29 (1), 42-44.

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Heinzow, T., R.S.J. Tol and B. Brümmer (2005), Offshore-Windstromerzeugung in der Nordsee -eine ökonomische und ökologische Sackgasse? **FNU-85** (forthcoming, *Energiewirtschaftliche Tagesfragen*)

Röckmann, C., U.A. Schneider, M.A. St.John, and R.S.J. Tol (2005), *Rebuilding the Eastern Baltic cod stock under environmental change - a preliminary approach using stock, environmental, and management constraints*, **FNU-84** (submitted)

Tol, R.S.J. and G.W. Yohe (2005), *Infinite uncertainty, forgotten feedbacks, and cost-benefit analysis of climate policy*, **FNU-83** (submitted)

Osmani, D. and R.S.J. Tol (2005), *The case of two self-enforcing international agreements for environmental protection*, **FNU-82** (submitted)

Schneider, U.A. and B.A. McCarl, (2005), *Appraising Agricultural Greenhouse Gas Mitigation Potentials: Effects of Alternative Assumptions*, **FNU-81** (submitted)

Zandersen, M., M. Termansen, and F.S. Jensen, (2005), *Valuing new forest sites over time: the case of afforestation and recreation in Denmark*, **FNU-80** (submitted)

Guillerminet, M.-L. and R.S.J. Tol (2005), *Decision making under catastrophic risk and learning: the case of the possible collapse of the West Antarctic Ice Sheet*, **FNU-79** (submitted)

Nicholls, R.J., R.S.J. Tol and A.T. Vafeidis (2005), *Global estimates of the impact of a collapse of the West Antarctic Ice Sheet: An application of FUND*, **FNU-78** (submitted)

Lonsdale, K., T.E. Downing, R.J. Nicholls, D. Parker, A.T. Vafeidis, R. Dawson and J.W. Hall (2005), *Plausible responses to the threat of rapid sea-level rise for the Thames Estuary*, **FNU-77** (submitted, *Climatic Change*)

Poumadère, M., C. Mays, G. Pfeifle with A.T. Vafeidis (2005), *Worst Case Scenario and Stakeholder Group Decision: A 5-6 Meter Sea Level Rise in the Rhone Delta, France*, **FNU-76** (submitted, *Climatic Change*)

Olsthoorn, A.A., P.E. van der Werff, L.M. Bouwer and D. Huitema (2005), *Neo-Atlantis: Dutch Responses to Five Meter Sea Level Rise*, **FNU-75** (submitted, *Climatic Change*)

Toth, F.L. and E. Hizsnyik (2005), *Managing the inconceivable: Participatory assessments of impacts and responses to extreme climate change*, **FNU-74** (submitted)

Kasperson, R.E. M.T. Bohn and R. Goble (2005), *Assessing the risks of a future rapid large sea level rise: A review*, **FNU-73** (submitted, *Climatic Change*)

Schleupner, C. (2005), *Evaluation of coastal squeeze and beach reduction and its consequences for the Caribbean island Martinique*, **FNU-72** (submitted)

Schleupner, C. (2005), *Spatial Analysis As Tool for Sensitivity Assessment of Sea Level Rise Impacts on Martinique*, **FNU-71** (submitted)

Sesabo, J.K. and R.S.J. Tol (2005), *Factor affecting Income Strategies among households in Tanzanian Coastal Villages: Implication for Development-Conservation Initiatives*, **FNU-70** (submitted)

Fisher, B.S., G. Jakeman, H.M. Pant, M. Schwoon. and R.S.J. Tol (2005), *CHIMP: A Simple Population Model for Use in Integrated Assessment of Global Environmental Change*, **FNU-69** (submitted, *Integrated Assessment Journal*)

Rehdanz, K. and R.S.J. Tol (2005), *A No Cap But Trade Proposal for Greenhouse Gas Emission Reduction Targets for Brazil, China and India*, **FNU-68** (submitted)

Zhou, Y. and R.S.J. Tol (2005), *Water Use in China's Domestic, Industrial and Agricultural Sectors: An Empirical Analysis*, **FNU-67** (submitted)

Rehdanz, K. (2005), *Determinants of Residential Space Heating Demand in Germany*, **FNU-66** (submitted)

Ronneberger, K., R.S.J. Tol and U.A. Schneider (2005), *KLUM: A Simple Model of Global Agricultural Land Use as a Coupling Tool of Economy and Vegetation*, **FNU-65** (submitted, *Climatic Change*)

Tol, R.S.J. (2005), *The Benefits of Greenhouse Gas Emission Reduction: An Application of* FUND, **FNU-64** (submitted, *Global Environmental Change*)

Röckmann, C., M.A. St.John, U.A. Schneider, F.W. Köster, F.W. and R.S.J. Tol (2006), *Testing the implications of a permanent or seasonal marine reserve on the population dynamics of Eastern Baltic cod under varying environmental conditions*, **FNU-63-revised**

Letsoalo, A., J. Blignaut, T. de Wet, M. de Wit, S. Hess, R.S.J. Tol and J. van Heerden (2005), *Triple Dividends of Water Consumption Charges in South Africa*, **FNU-62** (submitted, *Water Resources Research*)

Zandersen, M., Termansen, M., Jensen,F.S. (2005), *Benefit Transfer over Time of Ecosystem Values: the Case of Forest Recreation*, **FNU-61** (submitted)

Rehdanz, K., Jung, M., Tol, R.S.J. and Wetzel, P. (2005), *Ocean Carbon Sinks and International Climate Policy*, **FNU-60** (forthcoming, *Energy Policy*)

Schwoon, M. (2005), *Simulating The Adoption of Fuel Cell Vehicles*, **FNU-59** (submitted)

Bigano, A., J.M. Hamilton and R.S.J. Tol (2005), *The Impact of Climate Change on Domestic and International Tourism: A Simulation Study*, **FNU-58** (submitted)

Bosello, F., R. Roson and R.S.J. Tol (2004), *Economy-wide estimates of the implications of climate change: Human health*, **FNU-57** (forthcoming, *Ecological Economics*)

Hamilton, J.M. and M.A. Lau (2004) *The role of climate information in tourist destination choice decision-making*, **FNU-56** (forthcoming, Gössling, S. and C.M. Hall (eds.), Tourism and Global Environmental Change. London: Routledge)

Bigano, A., J.M. Hamilton and R.S.J. Tol (2004), *The impact of climate on holiday destination choice*, **FNU-55** (forthcoming, *Climatic Change*)

Bigano, A., J.M. Hamilton, M. Lau, R.S.J. Tol and Y. Zhou (2004), *A global database of domestic and international tourist numbers at national and subnational level*, **FNU-54** (submitted)

Susandi, A. and R.S.J. Tol (2004), *Impact of international emission reduction on energy and forestry sector of Indonesia*, **FNU-53** (submitted)

Hamilton, J.M. and R.S.J. Tol (2004), *The Impact of Climate Change on Tourism and Recreation*, **FNU-52** (forthcoming, Schlesinger et al. (eds.), Cambridge University Press)

Schneider, U.A. (2004), *Land Use Decision Modelling with Soil Status Dependent Emission Rates*, **FNU-51** (submitted)

Link, P.M., U.A. Schneider and R.S.J. Tol (2004), *Economic impacts of changes in fish population dynamics: the role of the fishermen's harvesting strategies*, **FNU-50** (submitted)

Berritella, M., A. Bigano, R. Roson and R.S.J. Tol (2004), *A General Equilibrium Analysis of Climate Change Impacts on Tourism*, **FNU-49** (forthcoming, *Tourism Management*)

Tol, R.S.J. (2004), *The Double Trade-Off between Adaptation and Mitigation for Sea Level Rise: An Application of* FUND, **FNU-48** (forthcoming, *Mitigation and Adaptation Strategies for Global Change*)

Erdil, Erkan and Yetkiner, I. Hakan (2004), *A Panel Data Approach for Income-Health Causality*, **FNU-47**

Tol, R.S.J. (2004), *Multi-Gas Emission Reduction for Climate Change Policy: An Application of* FUND, **FNU-46** (forthcoming, *Energy Journal*)

Tol, R.S.J. (2004), *Exchange Rates and Climate Change: An Application of* FUND, **FNU-45** (forthcoming, *Climatic Change*)

Gaitan, B., Tol, R.S.J, and Yetkiner, I. Hakan (2004), *The Hotelling's Rule Revisited in a Dynamic General Equilibrium Model*, **FNU-44** (submitted)

Rehdanz, K. and Tol, R.S.J (2004), *On Multi-Period Allocation of Tradable Emission Permits*, **FNU-43** (submitted)

Link, P.M. and Tol, R.S.J. (2004), *Possible Economic Impacts of a Shutdown of the Thermohaline Circulation: An Application of* FUND, **FNU-42** (*Portuguese Economic Journal*, **3**, 99-114)

Zhou, Y. and Tol, R.S.J. (2004), *Evaluating the costs of desalination and water transport*, **FNU-41** (f*Water Resources Research*, **41** (3), W03003)

Lau, M. (2004), *Küstenzonenmanagement in der Volksrepublik China und Anpassungsstrategien an den Meeres-spiegelanstieg*,**FNU-40** (*Coastline Reports*, Issue 1, pp.213-224.)

Rehdanz, K. and Maddison, D. (2004), *The Amenity Value of Climate to German Households*, **FNU-39** (submitted)

Bosello, F., Lazzarin, M., Roson, R. and Tol, R.S.J. (2004), *Economy-wide Estimates of the Implications of Climate Change: Sea Level Rise*, **FNU-38** (submitted, *Environmental and Resource Economics*)

Schwoon, M. and Tol, R.S.J. (2004), *Optimal CO_2-abatement with socio-economic inertia and induced technological change*, **FNU-37** (submitted, *Energy Journal*)

Hamilton, J.M., Maddison, D.J. and Tol, R.S.J. (2004), *The Effects of Climate Change on International Tourism*, **FNU-36** (*Climate Research*, **29**, 255-268)

Hansen, O. and R.S.J. Tol (2003), *A Refined Inglehart Index of Materialism and Postmaterialism*, **FNU-35** (submitted)

Heinzow, T. and R.S.J. Tol (2003), *Prediction of Crop Yields across four Climate Zones in Germany: An Artificial Neural Network Approach*, **FNU-34** (submitted, *Climate Research*)

Tol, R.S.J. (2003), *Adaptation and Mitigation: Trade-offs in Substance and Methods*, **FNU-33** (forthcoming, *Environmental Science and Policy*)

Tol, R.S.J. and T. Heinzow (2003), *Estimates of the External and Sustainability Costs of Climate Change*, **FNU-32** (submitted)

Hamilton, J.M., Maddison, D.J. and Tol, R.S.J. (2003), *Climate change and international tourism: a simulation study*, **FNU-31** (*Global Environmental Change*, **15** (3), 253-266)

Link, P.M. and R.S.J. Tol (2003), *Economic impacts of changes in population dynamics of fish on the fisheries in the Barents Sea*, **FNU-30** (submitted)

Link, P.M. (2003), *Auswirkungen populationsdynamischer Veränderungen in Fischbeständen auf die Fischerei-wirtschaft in der Barentssee*, **FNU-29** (*Essener Geographische Arbeiten*, **35**, 179-202)

Lau, M. (2003), *Coastal Zone Management in the People's Republic of China – An Assessment of Structural Impacts on Decision-making Processes*, **FNU-28** (*Ocean & Coastal Management*, No. 48 (2005), pp. 115-159.)

Lau, M. (2003), *Coastal Zone Management in the People's Republic of China – A Unique Approach?*, **FNU-27** (*China Environment Series*, Issue 6, pp. 120-124; http://www.wilsoncenter.org/topics/pubs/7-commentaries.pdf)

Roson, R. and R.S.J. Tol (2003), *An Integrated Assessment Model of Economy-Energy-Climate – The Model Wiagem: A Comment*, **FNU-26** (forthcoming, *Integrated Assessment*)

Yetkiner, I.H. (2003), *Is There An Indispensable Role For Government During Recovery From An Earthquake? A Theoretical Elaboration*, **FNU-25**

Yetkiner, I.H. (2003), *A Short Note On The Solution Procedure Of Barro And Sala-i-Martin for Restoring Constancy Conditions*, **FNU-24**

Schneider, U.A. and B.A. McCarl (2003), *Measuring Abatement Potentials When Multiple Change is Present: The Case of Greenhouse Gas Mitigation in U.S. Agriculture and Forestry*, **FNU-23** (submitted)

Zhou, Y. and Tol, R.S.J. (2003), *The Implications of Desalination to Water Resources in China - an Economic Perspective*, **FNU-22** (*Desalination*, **163** (4), 225-240)

Yetkiner, I.H., de Vaal, A., and van Zon, A. (2003), *The Cyclical Advancement of Drastic Technologies*, **FNU-21**

Rehdanz, K. and Maddison, D. (2003) *Climate and Happiness*, **FNU-20** (*Ecological Economics*, **52** 111-125)

Tol, R.S.J., (2003), *The Marginal Costs of Carbon Dioxide Emissions: An Assessment of the Uncertainties*, **FNU-19** (*Energy Policy*, **33** (16), 2064-2074).

Lee, H.C., B.A. McCarl, U.A. Schneider, and C.C. Chen (2003), *Leakage and Comparative Advantage Implications of Agricultural Participation in Greenhouse Gas Emission Mitigation*, **FNU-18** (submitted).

Schneider, U.A. and B.A. McCarl (2003), *Implications of a Carbon Based Energy Tax for U.S. Agriculture*, **FNU-17** (submitted).

Tol, R.S.J. (2002), *Climate, Development, and Malaria: An Application of* FUND, **FNU-16** (forthcoming, *Climatic Change*).

Hamilton, J.M. (2003), *Climate and the Destination Choice of German Tourists*, **FNU-15** (revised and submitted).

Tol, R.S.J. (2002), *Technology Protocols for Climate Change: An Application of* FUND, **FNU-14** (*Climate Policy*, **4**, 269-287).

Rehdanz, K (2002), *Hedonic Pricing of Climate Change Impacts to Households in Great Britain*, **FNU-13** (forthcoming, *Climatic Change*).

Tol, R.S.J. (2002), *Emission Abatement Versus Development As Strategies To Reduce Vulnerability To Climate Change: An Application Of* FUND, **FNU-12** (forthcoming, *Environment and Development Economics*).

Rehdanz, K. and Tol, R.S.J. (2002), *On National and International Trade in Greenhouse Gas Emission Permits*, **FNU-11** (*Ecological Economics*, **54**, 397-416).

Fankhauser, S. and Tol, R.S.J. (2001), *On Climate Change and Growth*, **FNU-10** (*Resource and Energy Economics*, **27**, 1-17).

Tol, R.S.J.and Verheyen, R. (2001), *Liability and Compensation for Climate Change Damages – A Legal and Economic Assessment*, **FNU-9** (*Energy Policy*, **32** (9), 1109-1130).

Yohe, G. and R.S.J. Tol (2001), *Indicators for Social and Economic Coping Capacity – Moving Toward a Working Definition of Adaptive Capacity*, **FNU-8** (*Global Environmental Change*, **12** (1), 25-40).

Kemfert, C., W. Lise and R.S.J. Tol (2001), *Games of Climate Change with International Trade*, **FNU-7** (*Environmental and Resource Economics*, **28**, 209-232).

Tol, R.S.J., W. Lise, B. Morel and B.C.C. van der Zwaan (2001), *Technology Development and Diffusion and Incentives to Abate Greenhouse Gas Emissions*, **FNU-6** (submitted).

Kemfert, C. and R.S.J. Tol (2001), *Equity, International Trade and Climate Policy*, **FNU-5** (*International Environmental Agreements*, **2**, 23-48).

Tol, R.S.J., Downing T.E., Fankhauser S., Richels R.G. and Smith J.B. (2001), *Progress in Estimating the Marginal Costs of Greenhouse Gas Emissions*, **FNU-4**. (*Pollution Atmosphérique – Numéro Spécial: Combien Vaut l'Air Propre?*, 155-179).

Tol, R.S.J. (2000), *How Large is the Uncertainty about Climate Change?*, **FNU-3** (*Climatic Change*, **56** (3), 265-289).

Tol, R.S.J., S. Fankhauser, R.G. Richels and J.B. Smith (2000), *How Much Damage Will Climate Change Do? Recent Estimates*, **FNU-2** (*World Economics*, **1** (4), 179-206)

Lise, W. and R.S.J. Tol (2000), *Impact of Climate on Tourism Demand*, **FNU-1** (*Climatic Change*, **55** (4), 429-449).