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Summer weather conditions and tourism flows in urban and rural destinations

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Abstract This article presents new estimates of the impact of weather conditions on overnight stays of domestic and German tourists within Austria. The data consists of panel data for nine provinces for the summer seasons 1974–2012 where the variables are measured as year to year growt rates. Results using the seemingly unrelated regression model show that sunshine hours and temperatures in a given month have a significant and positive impact on domestic overnight stays in the same month for most of the provinces except for the capital of Vienna. Furthermore, sunshine hours affect German overnight stays mainly with a 1 year lag. In general, weather effects are much larger in August and September than in June and insignificant in July. An increase in temperature by 1 °C leads to an increase in domestic overnight stays in August by 1.2 %. The weather effects are largest for the province of Salzburg where current and lagged temperatures or sunshine can explain between 23 and 47 % of the variation in domestic and German overnight stays over the sample period.

1 Introduction

The relationship between weather and tourism demand has been widely investigated for different locations and different seasons (summer and/or winter season) (for recent surveys of the literature see Gössling et al. 2012; Becken 2013a; Kaján and Saarinen 2013; Pang et al. 2013; Rosselló-Nadal 2014). Favourable summer weather can have a large impact on visitor arrivals and overnight stays. Although weather and climate conditions are widely seen as an important factor for tourism, relatively little is known about the extent to which weather effects differ between rural, urban and mountain destinations during the summer months. It can be reasonably assumed that tourism inflows to urban destinations are rather independent of weather conditions, particularly in regions with moderate climate conditions. However, tourism to rural destinations is likely to depend on favourable weather conditions. This is related to the different motivations of tourists.

Several studies are available on the relationship between weather and tourism flows in regions with cooler climate conditions and moderate temperatures – such as those in central and

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northern Europe . These regions are likely to gain from climate change. Studies on rural or mountainous areas include those by Finger and Lehmann (2012) on two lidos on Lake Zurich; Otero-Giráldez et al. (2012) for Galicia; Scott et al. (2007) for visits to Waterton Lakes National Park [Canada]; Serquet and Rebetez (2011) for Swiss mountains; Rauken et al. (2010); and Denstadli et al. (2011) both for North Norway. For instance, using data on temperatures and domestic overnights stays for 40 Swiss Alpine resorts, Serquet and Rebetez (2011) find that hotter temperatures in the Swiss lowland lead to an increase in overnight stays in the Swiss mountains. Based on time series data for Austria covering 50 years, Falk (2014) also finds that warmer and sunnier summer weather leads to an increase in overnight stays. However, the study does not distinguish between different types of regions. Few studies are available that investigate the relationship between tourism flows and weather for urban destinations (for an exception see McKercher et al. 2014). To the best of the author's knowledge, no studies are available that distinguish between countryside locations and urban destinations.

The aim of the paper is to investigate the impact of weather on visitor nights for the summer months using regional data for Austria at the level of provinces for the period 1974–2012. The econometric model is based on the Seemingly Unrelated Regression (SUR) method where all variables are measured as year- to-year annual rates of change. The empirical specifications allow for lagged effects of weather. Austria is an interesting country case within which to study the impact of weather conditions on tourism demand in the summer months. Although Austria has a long tradition as a summer destination, the number of visitors began to steadily decline starting in the 1970s and has now stabilized at a lower level compared to numbers during the 1960s. In contrast, tourism to the capital city of Vienna has increased rapidly over the last 40 years (see Table 5 in the Appendix).

The empirical model distinguishes between the capital region of Vienna and eight other provinces. These provinces differ in a number of aspects. Tourism in Western Austria is primarily nature-based and attracts tourists for its spectacular mountains, lakes, rivers and glaciers. There is also an extensive network of national parks and protected areas. Trekking, mountaineering and all kinds of alpine sports are the most popular tourism activities in the Western provinces. Upper Austria is well known for its beautiful lakes (Attersee and Traunsee, Hallstatt Lake), mountains (Salzkammergut) and caves (Dachstein Caves). In Carinthia the main attractions are lakes (Wörthersee, Millstätter See, Ossiacher See and Faaker See) that are relatively large as well as a number of smaller lakes. Vienna is an attractive destination for cultural and shopping activities.

The main contribution of the paper is the use of regional data combined with a very long time series of weather data and tourism flows to investigate the relationship between summer weather conditions and overnight stays in rural and urban areas. Distinguishing between different types of destinations (urban, mountain and rural destinations) gives a more detailed picture of the weather tourism relationship. Note that the distinction between primarily urban and rural areas is generally important when studying regional tourism demand. In recent years there has been a rapid growth in international urban tourism. For instance, the number of international overnight visitors in the 132 most city destinations increased at an average annual growth rate of 8.7 % between 2009 and 2014.[1] The corresponding figure for the 10 most important city destinations in Europe is 5.7 % per year on average (based on the period 2010–2014). In contrast, total international tourism flows not distinguished by region grew at the lower rate (e.g., total nights spent by non-residents in 26 EU countries increased about 4.4 % per year on average between 2010 and 2014, source New Croons Eurostat downloaded 2015,

[1] Source: Mastercard Global Destination Cities 2010–2014 (Hedrick-Wong and Choong 2014). These data are based on overnight arrivals by foreign visitors provided by the national statistical offices.

data for November and December 2014 are interpolated based on changes for the October between 2013 and 2014).

The other goal of the paper is to investigate the impact of sunshine and rainfall rather than looking at the impact of temperatures alone. According to Gössling and Hall (2006), the effects of other weather parameters such as rainfall and hours of sunshine are largely unknown. Furthermore, we distinguish between domestic and German overnight stays. The reason for this being that tourists from different origin countries are likely to react differently to changes in weather conditions. For instance, domestic residents are likely to be more spontaneous whereas foreign tourists normally plan their summer activities well in advance (Taylor and Ortiz 2009).

The structure of this paper is as follows: Section 2 provides the background and previous literature while section 3 introduces the empirical model. In section 4, various summary statistics and a description of the data are presented before providing the empirical results in section 5. Section 6 contains concluding remarks.

2 Background and previous literature

Weather might affect tourism flows in rural and urban areas differently. It is often stated that urban tourism is largely independent of variations in weather whereas tourism in rural areas is more likely to be dependent on favourable weather conditions. Cities in central and southern Europe might be an exception, however. Here rising temperatures combined with a decrease in air quality can lead to decline in inbound tourism flows (Nicholls 2006). The reason for the differences in the weather relationships is likely to be related to differences in the motivations and profiles of tourists. Heritage and cultural tourism, shopping activities, conference and business visits and nightlife tourism are concentrated in cities. These activities do not depend on favourable weather conditions. In fact, using survey data, McKercher et al. (2014) find that tourism flows into Hong Kong are independent from changes in weather conditions. For rural areas weather conditions can have a strong impact on visitor flows. A change to warmer and drier summers in countries with moderate climate conditions would make rural areas more attractive for outdoor/sport activities and nature-based tourism pursuits such as hiking, hill walking, biking, camping, golfing, sunbathing, and swimming (de Freitas 2003; Gómez Martín 2005; Richardson and Loomis 2005; Scott et al. 2007). Thus for rural areas it is self-evident that weather unfavourable for walking, hiking or camping can lead to a decline in the number of visitors. However, the magnitude of the weather effects on overnight stays un rural areas may be small because outdoor activities may well be exchanged for visits to nearby towns (Smith 1993).

One might also argue that visitors to rural areas in Austria are generally not motivated by weather conditions because they do not expect long periods of sunny and very warm summer weather. For visitors to rural areas in Northern Norway, Denstadli et al. (2011) show that unfavourable summer weather is not considered as important for enjoyment of the holidays. Similarly, for the same area, Rauken et al. (2010) show that cool summer season weather has little impact on the deterrence of potential visitors. The reason for this is that in Northern Norway, one can expect changeable weather during any time of the summer season, particularly when one travels to higher elevations. Similarly, for mountain regions in Austria cold and wet summer seasons may have no impact on tourism since visitors expect changeable weather conditions. In rural mountainous areas in Austria tourists generally seek different experiences other than beach tourism such as mountain walks, climbing, cycling and scenery. Thus the relationship between summer weather and tourism is likely to be small. In contrast, for regions characterised by a large number of lakes such as Carinthia, tourism is highly sensitive to temperatures. Paul (1972) suggests that above temperatures of 21 °C beach use and swimming become increasingly preferred activities. Furthermore, Gómez Martín (2005) suggests that weather conditions over a longer period have little impact on tourism. However, extreme day-to-day weather variation can have large negative impacts on tourism demand and visitation patterns. This indicates that the impact of weather conditions depends on the time scale considered.

Another effect of unfavourable weather conditions is temporal substitution. For instance, using survey data for Australia, Windle and Rolfe (2013) find that the majority of travellers did not change their travel plans after the extreme weather events in Brisbane from 2010 to 2011. However, for those who changed there is greater evidence that travellers decided to postpone their trip to a later date for the same destination than decide to go to an entirely different destination altogether.

Another common finding is that the impact of weather on summer tourism is likely to be different for domestic and foreign residents. While overnight stays of domestic tourists are likely to increase due to favorable weather conditions in the same season, overnight stays of foreign tourists are likely to be affected by weather conditions after a lag of up to 1 year or season (Smith 1990; Giles and Perry 1998; Agnew and Palutikof 2006). In addition, for the winter season it is found that domestic tourists are generally more sensitive to changes in weather conditions than foreign tourists (Falk 2013).

While there are a number of studies investigating the impact of weather conditions on tourism arrivals or overnight stays using aggregate data for countries and/or regions, estimates of the tourism impact of weather conditions for different types of regions within a country remain rare. The previous literature does not reach conclusive empirical findings as to whether and to what degree weather conditions affect tourism flows in rural areas.

3 Empirical model

Time series analysis is used to describe the relationships between tourism flows and past and current weather conditions.[2] We assume that fluctuations in overnight stays as compared to the same month in the previous year are a function of changes in current and previous weather conditions. We employ a specification in long differences (to the same month in the previous year) rather than an error–correction model because ADF tests show that weather indicators are stationary in most cases whereas overnight stays for the different provinces include integrated time series. The use of differences in the same month of the previous year also eliminates seasonal variations in tourism flows which are an important feature of tourism. By using a model in differences we cannot model the long-run effects of the main determinants of tourism demand namely real income and prices. However, the regression technique of the seemingly unrelated regression models accounts for common factors such as global recessions and changes in common prices by allowing the error terms across provinces to be correlated.

We start with a log-linear regression model specified in first differences assuming that the changes in tourism demand can be expressed as a linear function of temperatures or other weather factors. The model is specified separately for each summer month and for each province:

$$\Delta \ln X_{it} = \beta_{0i} + \beta_{1i} \Delta \ln W_{it} + \beta_{2i} \Delta \ln W_{it-12} + \beta_{3i} \Delta \ln W_{it-1} + \varepsilon_{it},$$

where i=1,..,9 provinces, and t=1975,..,2012 for a given summer month (i.e., June, July, August and September). X is overnight stays (either domestic or German overnight stays) associated with

[2] For using time series analysis to study the relationship between weather and tourism flows see Rosselló, Riera and Cardenas (2011), Otero-Giráldez et al. (2012), Becken (2013b) and Falk (2014).

each province and month. W is an indicator of weather conditions measured as average monthly temperatures, monthly sunshine hours and precipitation in mm. We use weather conditions in the preceding month, W_{it-1}, and in the same month in the previous year, W_{it-12}. The coefficients β_{1i}, β_{2i} and β_{3i}, measure the current and lagged weather conditions. ε_{it} is an error term which is assumed to be iid. Given that overnight stays and temperatures are measured as differences in logarithms, the estimated coefficients can be interpreted as short-run weather elasticities. β_3 can be negative indicating that cool or cloudy weather in the previous month leads to an increase in overnight stays in the next month. This may indicate temporal substitution as suggested by Windle and Rolfe (2013).

Given that average monthly temperatures and number of sunshine hours are highly correlated with correlations of about 0.7, we estimate the equations for each weather indicator separately. Furthermore, we allow the residuals of the different provinces to be positively correlated by using Zellner's (1962) seemingly unrelated regression method. This leads to following specification:

$$\Delta \ln X_{it} = \widetilde{\beta}_{0i} + \widetilde{\beta}_{1i}\Delta \ln W_{it} + \widetilde{\beta}_{2i}\Delta \ln W_{it-12} + \widetilde{\beta}_{3i}\Delta \ln W_{it-1} + \widetilde{\varepsilon}_{it},$$

Where

$$\text{var}\,\varepsilon_{it} = \sigma_i^2\ ,\ \text{cov}\left(\varepsilon_{it}\varepsilon_{jt}\right) = E\left(\varepsilon_{it}\varepsilon_{jt}\right) = \sigma_{ij}\ ,\ \text{for all t} = 1, 2.., \text{T and cov}\ \left(\varepsilon_{it}\varepsilon_{js}\right) = E(\varepsilon_{it}\varepsilon_{is}) = 0 \qquad \text{for t} \neq \text{s.}$$

We assume the error terms to have contemporaneous covariances, σ_{ij}. In case the explanatory variables are the same for each province, OLS produces the same results as the SUR model. The SUR model can be estimated by Feasible Generalized Least Squares (FGLS) as a two-step approach or by the Maximum Likelihood estimator. Both estimators are asymptotically equivalent. We use the FGLS method to estimate the relationship between changes in overnight stays and changes in weather.

4 Data and descriptive statistics

Monthly weather data and number of overnight stays for 1974–2012 are collected for nine Austrian Federal states (Burgenland, Carinthia, Lower Austria, Salzburg, Styria, Tyrol, Upper Austria, Vienna and Vorarlberg). The Federal States are equivalent to the NUTS 2 level. The weather data is drawn from the HISTALP dataset which can be downloaded from the central institute for meteorology and geodynamics (ZAMG) (http://www.zamg.ac.at/). The dataset contains information on monthly temperatures, amount of precipitation, and sunshine hours for up to 59 weather stations up until 2014. We select eleven weather stations: Bregenz (Vorarlberg), Eisenstadt (Burgenland), Feldkirch (Vorarlberg), Graz-University (Styria), Innsbruck-University (Tyrol), Klagenfurt-airport (Carinthia), Kremsmünster (Upper Austria), Linz (Upper Austria), Salzburg-airport (Salzburg), Wien-Hohe Warte (Vienna) and Zell am See (Salzburg). For each of the provinces - Salzburg, Upper Austria and Vorarlberg - we have two weather stations. For these three provinces we use the average of the weather indicators for a given month.

Data on number of visitor nights by province and visitor country are provided by Statistics Austria. We use data on overnight stays for domestic and German tourists. We focus on German tourists only because they are still Austria's largest source market in terms of both arrivals and overnight stays with a share in overnight stays between 47 % in July and 60 % in September (data refers to 2014 based on Statistics Austria).

Descriptive statistics show that the number of German overnight stays in Vienna in the summer period increased between 1.1 and 1.5 on average between 1974 and 2012 depending on the month while the number of German overnight stays in other regions decreased slightly over the same period (Table 5 in the Appendix). For domestic overnight stays similar tendencies can be observed. Note that the distinction between rural and urban province is not clear-cut since some provinces (Salzburg) contain a significant share of cultural and festival tourists. However, the share of urban tourists is relatively small. For instance, the city of Salzburg only accounts for 15 % of all overnight stays in the province of Salzburg.

In order to provide first insight into the relationship between different weather indicators and overnight stays of domestic and German tourists, bivariate Pearson correlation coefficients are provided (see Tables 1 and 2). For German overnight stays we also provide correlations between visitor nights and changes in weather indicators lagged 1 year (see Table 2). By comparing overnight stays with those of the same month in the previous year, seasonal factors are no longer relevant. In order to illustrate the correlations we also provide scatterplots between changes in temperatures and sunshine hours and German and domestic overnight stays (see Figs. 1 and 2 in the Appendix). There is a positive relationship between both sunshine hours and average temperatures, and domestic and German overnight stays measured as percentage changes. However, the size of the correlations is rather low.

Table 1 shows that sign and significance of the correlations between domestic overnight stays and both sunshine hours and monthly temperatures depend on the summer month being considered and the province. For the capital region of Vienna we find that changes in visitor nights of domestic tourists are independent of changes in weather indicators. This holds true for all different weather indicators and also for each summer month. In contrast, based on pooled data for eight federal states excluding Vienna we find that the change in domestic overnight stays and both sunshine hours and temperatures for August and September is significantly positively related. The correlation coefficient for changes in temperatures in August and September is 0.31 and 0.27 respectively with p-values<0.01 (see Table 1). For sunshine hours we also find significant correlation coefficients for August and September with lower correlations for September than for August (0.13 and 0.17 respectively). For July we do not find a significant correlation between domestic overnight stays and both temperature and sunshine duration. However, there is positive and significant correlation between the change in domestic visitor nights and changes in temperature for the month of June. Furthermore, there is a significant and negative correlation between domestic visitor nights and changes in precipitation in August (unreported results are available upon request). Correlations for each of the eight Federal states show that the correlations between the change in domestic overnight stays and the change in average temperatures in August are strongest for Salzburg, Burgenland, Upper Austria and lower Austria with correlations between 0.4 and 0.55. For Tyrol, we do not find significant correlations. When sunshine hours and amount of precipitation are used as the weather indicator we again find the highest correlations for Salzburg, Burgenland and Upper Austria (results for precipitation are available upon request).

For German overnight stays we find few significant correlations between changes in overnight stays and changes in weather in a given month as compared to the same month in the previous year. Exceptions include changes in overnight stays and changes in temperatures for September. However, when weather indicators are lagged by 1 year (=log differences to the same month in the previous year) we find a significant correlation for temperatures and sunshine for August and September (Table 2). This indicates that German tourists are more sensitive to weather conditions of the past season (month) rather than the current season.

To sum up, correlations show that the magnitude of the associations between the different weather indicators and tourism demand is highest for August, followed by September. The correlations are larger for domestic overnight stays than for foreign overnight stays.

Table 1 Correlation between changes in overnight stays and changes in weather indicators

		Correlations between changes in log German overnight stays and changes in log weather				Correlations between changes in domestic overnight stays and changes in log weather			
		Correlation with changes in log sunshine duration in hours same month							
		June	July	August	September	June	July	August	September
Burgenland	coef	−0.14	0.17	−0.17	−0.12	0.23	0.08	0.39	0.21
	p	0.41	0.30	0.30	0.46	0.17	0.62	0.01	0.22
Carinthia	coef	−0.19	−0.18	0.08	0.12	0.07	−0.17	0.15	0.15
	p	0.26	0.29	0.65	0.47	0.66	0.32	0.38	0.36
Lower Austria	coef	0.02	0.00	0.09	−0.42	0.04	0.09	0.22	0.05
	p	0.91	1.00	0.58	0.01	0.79	0.58	0.18	0.76
Upper Austria	coef	−0.09	0.10	0.31	0.21	0.01	0.31	0.30	0.44
	p	0.59	0.57	0.05	0.21	0.97	0.06	0.06	0.01
Salzburg	coef	−0.04	−0.19	−0.02	0.20	−0.01	0.27	0.39	0.26
	p	0.82	0.26	0.90	0.22	0.95	0.10	0.02	0.12
Styria	coef	−0.05	−0.13	0.11	−0.06	0.19	−0.20	−0.12	0.35
	p	0.78	0.44	0.52	0.73	0.25	0.23	0.47	0.03
Tyrol	coef	−0.08	−0.14	0.08	0.05	0.14	−0.04	−0.14	0.27
	p	0.62	0.40	0.62	0.77	0.42	0.82	0.41	0.10
Vorarlberg	coef	−0.18	−0.01	0.15	0.11	−0.11	−0.04	0.14	−0.36
	p	0.27	0.95	0.38	0.51	0.52	0.83	0.39	0.03
Vienna	coef	0.06	0.08	−0.12	−0.05	0.18	0.19	−0.22	0.19
	p	0.74	0.65	0.47	0.79	0.29	0.24	0.19	0.26
total except	coef	−0.09	−0.03	0.08	0.00	0.06	0.06	0.17	0.13
Vienna	p	0.10	0.57	0.17	0.98	0.27	0.26	0.00	0.02
		Correlation with changes in average monthly log temperatures same month							
		June	July	August	September	June	July	August	September
Burgenland	coef	0.14	0.09	−0.09	0.07	0.27	0.16	0.50	0.42
	p	0.39	0.58	0.57	0.68	0.10	0.35	0.00	0.01
Carinthia	coef	−0.06	0.04	0.15	0.22	0.22	−0.10	0.30	0.39
	p	0.72	0.80	0.36	0.17	0.19	0.53	0.06	0.02
Lower Austria	coef	0.29	0.07	0.18	−0.02	−0.01	0.10	0.41	0.30
	p	0.07	0.68	0.27	0.92	0.96	0.57	0.01	0.07
Upper Austria	coef	0.09	0.20	0.30	0.28	0.13	0.16	0.43	0.60
	p	0.60	0.24	0.07	0.09	0.45	0.35	0.01	0.00
Salzburg	coef	−0.01	0.12	0.06	0.15	0.14	0.12	0.55	0.22
	p	0.94	0.49	0.72	0.37	0.41	0.49	0.00	0.19
Styria	coef	0.13	0.12	0.17	−0.14	0.26	−0.03	0.12	0.45
	p	0.45	0.48	0.32	0.40	0.12	0.87	0.49	0.00
Tyrol	coef	0.02	−0.01	0.02	0.14	0.25	−0.09	−0.04	0.37
	p	0.90	0.95	0.90	0.42	0.12	0.58	0.79	0.02
Vorarlberg	coef	0.01	0.11	0.03	0.28	−0.15	−0.15	0.21	−0.14
	p	0.96	0.53	0.85	0.09	0.36	0.38	0.21	0.41
Vienna	coef	0.13	−0.14	−0.15	0.19	−0.10	0.16	−0.10	0.03
	p	0.42	0.40	0.37	0.25	0.54	0.34	0.55	0.85

Table 1 (continued)

		Correlations between changes in log German overnight stays and changes in log weather				Correlations between changes in domestic overnight stays and changes in log weather			
total except	coef	0.07	0.09	0.10	0.13	0.12	0.03	0.31	0.27
Vienna	p	0.23	0.11	0.09	0.03	0.04	0.63	0.00	0.00

Variables are measured as log changes to the same month. *p* denotes the *p*-value. The time period is 1974–2012

Furthermore, correlations between weather indicators are largest for lowland regions or regions with a large number of lakes while there are no significant correlations for mountain regions (Tyrol) and urban destinations (Vienna).

5 Empirical results

Table 3 shows the estimates of the seemingly unrelated regression model for the relationship between temperatures and domestic overnight stays for the nine provinces estimated separately for four summer months (June, July, August and September). Table 7 in the Appendix shows the

Table 2 Correlation between changes in German overnight stays and changes in weather indicators lagged on year

		Changes in sunshine hours lagged one year				Changes in temperatures lagged one year			
		June	July	August	September	June	July	August	September
Burgenland	coef	0.16	−0.27	0.43	0.12	0.07	−0.06	0.21	0.12
	p	0.33	0.10	0.01	0.46	0.67	0.74	0.20	0.48
Carinthia	coef	0.07	0.16	0.43	0.03	0.16	−0.02	0.34	0.11
	p	0.67	0.34	0.01	0.84	0.34	0.92	0.04	0.50
Lower Austria	coef	0.01	0.00	0.28	0.31	−0.13	−0.05	−0.02	−0.06
	p	0.97	0.98	0.09	0.06	0.44	0.76	0.92	0.70
Upper Austria	coef	−0.07	0.07	0.38	0.07	0.06	0.09	0.27	0.00
	p	0.67	0.69	0.02	0.68	0.74	0.59	0.10	0.99
Salzburg	coef	0.10	0.29	0.35	0.01	0.11	−0.01	0.33	0.19
	p	0.55	0.08	0.03	0.96	0.51	0.95	0.05	0.26
Styria	coef	0.07	0.02	0.23	0.20	0.14	0.04	0.18	0.16
	p	0.69	0.90	0.17	0.23	0.42	0.83	0.27	0.34
Tyrol	coef	0.03	0.14	0.42	0.10	0.01	0.03	0.33	0.18
	p	0.84	0.39	0.01	0.56	0.97	0.86	0.05	0.28
Vorarlberg	coef	0.25	−0.01	0.38	0.08	0.15	−0.23	0.39	0.15
	p	0.13	0.95	0.02	0.64	0.37	0.17	0.02	0.38
Vienna	coef	0.03	−0.17	0.21	0.01	0.09	−0.01	0.03	−0.02
	p	0.84	0.32	0.20	0.95	0.59	0.93	0.86	0.89
total except	coef	0.08	0.04	0.36	0.11	0.07	−0.03	0.25	0.10
Vienna	p	0.15	0.45	0.00	0.05	0.23	0.61	0.00	0.07

Notes: The time period is 1974–2012. *p* denotes the *p*-value

Table 3 Seemingly unrelated regression estimates of the impact of temperature on domestic overnight stays

	Burgenland		Carinthia		Lower Austria		Salzburg		Upper Austria		Styria		Tyrol		Vorarlberg		Vienna	
	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t
	dep. var. log changes in domestic overnight stays between June and the same month in the previous year																	
Δlntempm6	0.43 **	2.09	0.32 ***	2.66	−0.13	−1.33	0.02	0.24	0.15 *	1.82	0.10	1.00	0.30 **	2.55	0.02	0.17	−0.11	−0.52
L1Δlntempm6	0.18	1.49	−0.07	−1.07	0.02	0.32	0.07 *	1.67	−0.05	−1.06	0.08	1.35	−0.12 *	−1.76	−0.19 **	−2.46	0.04	0.34
L12Δlntempm6	0.56 **	2.85	0.22 *	1.86	−0.18 *	−1.84	0.08	1.13	0.12	1.53	0.08	0.79	0.04	0.31	0.04	0.29	0.07	0.33
constant	0.02 *	1.66	0.02 **	2.21	0.00	−0.65	0.00	0.63	0.02 **	2.04	0.00	−0.16	0.01	1.34	0.02 *	1.72	0.04 **	2.75
R^2	0.21		0.18		0.12		0.04		0.12		0.10		0.08		0.16		0.01	
F-test joint sig. (p)	0.01		0.03		0.23		0.28		0.17		0.27		0.04		0.07		0.89	
Breusch- Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	dep. var. log changes in domestic overnight stays between July and the same month in the previous year																	
Δlntempm7	0.35 *	1.68	0.03	0.31	0.06	0.86	0.11	1.52	0.12	1.37	0.00	0.04	−0.01	−0.11	−0.07	−0.73	0.17	0.88
L1Δlntempm7	0.27	1.22	0.08	0.85	−0.03	−0.40	−0.02	−0.26	−0.02	−0.31	0.10	1.49	0.04	0.46	−0.11	−1.20	0.05	0.23
L12Δlntempm7	−0.01	−0.03	0.25 **	2.35	0.06	0.91	0.16 **	2.18	0.19 **	2.18	0.11	1.44	0.23 **	2.33	0.07	0.64	−0.18	−0.91
constant	0.03	1.64	0.00	0.20	−0.02 **	−2.41	−0.01	−0.77	0.01	0.93	−0.01 *	−1.83	0.01	0.70	0.01	1.04	0.05 **	2.68
R^2	0.04		0.12		0.04		0.14		0.12		0.10		0.13		0.06		0.05	
F-test joint sig. (p)	0.21		0.10		0.74		0.15		0.16		0.17		0.09		0.36		0.49	
Breusch-Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	dep. var. log changes in domestic overnight stays between August and the same month in the previous year																	
Δ.lntempm8	0.46 **	2.90	0.39 **	3.24	0.20 **	2.64	0.23 **	2.89	0.22 **	3.23	0.06	0.94	0.01	0.10	0.21 *	1.95	−0.28	−1.32
L1Δlntempm8	−0.10	−0.67	0.17	1.48	0.13 **	2.02	0.01	0.12	0.04	0.76	0.06	1.00	0.13	1.58	0.05	0.58	0.19	1.01
L12Δlntempm8	−0.07	−0.41	0.33 **	2.72	0.03	0.42	0.13	1.62	0.00	−0.02	0.06	1.08	0.17 *	1.85	0.19 *	1.77	−0.17	−0.78
constant	0.03 *	1.83	0.00	0.09	−0.02 **	−2.69	0.00	−0.65	0.01	1.56	−0.01	−1.57	0.01	0.73	0.01	0.64	0.05 **	2.61
R^2	0.25		0.25		0.24		0.24		0.30		0.06		0.04		0.09		0.05	
F-test joint sig. (p)	0.00		0.00		0.01		0.04		0.01		0.51		0.12		0.15		0.43	

Table 3 (continued)

	Burgenland		Carinthia		Lower Austria		Salzburg		Upper Austria		Styria		Tyrol		Vorarlberg		Vienna	
	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t
Breusch-Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	dep. var. log changes in domestic overnight stays between September and the same month in the previous year																	
Δlntempm9	0.25 **	3.14	0.28 **	3.70	0.11 **	2.11	0.26 **	5.92	0.17 **	2.66	0.18 **	3.62	0.24 **	2.93	0.01	0.12	0.06	0.49
L1Δlntempm9	0.00	−0.03	0.05	0.44	−0.03	−0.39	−0.10	−1.52	−0.07	−0.72	−0.04	−0.63	0.06	0.46	−0.10	0.25	−0.14	−0.91
L12Δlntempm9	0.09	1.13	0.20 **	2.56	0.02	0.34	0.12 **	2.70	0.20 **	3.23	0.08	1.57	0.15 *	1.78	0.22 **	2.15	0.07	0.56
constant	0.03 **	2.85	0.02 **	2.22	0.00	−0.73	0.00	0.55	0.01	1.47	0.00	0.20	0.01	1.08	0.02	1.22	0.03 **	2.14
R^2	0.21		0.26		0.10		0.47		0.24		0.24		0.20		0.11		0.02	
F-test joint sig. (p)	0.02		0.00		0.16		0.00		0.01		0.00		0.02		0.12		0.79	
Breusch-Pagan(p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	

***, ** and * denote significance at the 1, 5 and 10 % significance levels. 6,7,8 and 9 denote the month of investigation (June, July, August and September). Δ denotes the first difference operator and 1 and 12 denote the lag in monhts corresponding results for the relationship between sunshine hours and domestic overnight stays. Table 4 shows the results for German overnight stays with temperatures as the weather indicator and Table 8 the corresponding for sunshine hours. The tables contain the coefficients together with the *t*-values, the R squared and the Breusch-Pagan test of independence of the residuals (Breusch and Pagan 1980). The Breusch–Pagan test of independence of the residuals shows that the null hypothesis of independence of residuals is rejected in most cases. This indicates that overnight stays in the different provinces are correlated with each other when accounting for weather effects. Table 6 in the Appendix shows that correlations of the residuals are largest between Tyrol and Carinthia and between Upper Austria and Carinthia (for the example of domestic overnight stays for the month of August). However, the residuals between the province of Vienna and the remaining provinces are independent indicating that the evolution of urban tourism is independent from overnight stays in the more rural provinces. The significance of residuals also means that SUR is more efficient than OLS. The individual equation's goodness-of-fit measure is relatively large for a specification in first differences. For example for the relationship between change in temperatures and change in domestic overnight stays for August, the R squared for five out of nine provinces is about 0.25 (see Table 3). The R squared is lower for the remaining summer months and generally for the regression with sunshine duration as the right hand variable.

The results for domestic overnight stays show that coefficients of sunshine hours and average temperatures for August and September in the same month are significant and positive at the one per cent level in most Federal states. In contrast, changes in temperatures of the previous month are not significant in most cases. Similarly, changes in average monthly temperatures or sunshine duration lagged 1 year are also not significant in most cases. In particular, we find that a year to year change in August temperatures have a significant impact on domestic overnight stays for six out of nine provinces with *p*-values of <0.05 for Burgenland, Carinthia, Lower Austria, Salzburg and Upper Austria and a *p*-value of 0.10 for Vorarlberg. For overnight stays in September we find that changes in temperatures are significantly related to domestic overnight stays in seven out of nine provinces (at the five percent level). This indicates that sunnier and warmer August and September months lead to an increase in domestic visitor nights. However, the magnitude of the weather effects is rather small: For instance, for the province of Salzburg in August, the coefficient of temperatures of 0.23 means that an increase in temperatures of 10 % (equivalent to an increase of almost 2 °C) leads to an increase of 2.3 % in domestic overnight stays in the same month. However, we find that the magnitude of the impact of temperatures on domestic visitor nights differs widely across the different provinces and time period. In general, temperatures are less relevant in June and July than in August and September. The largest impact of temperatures can be observed for Carinthia, Salzburg and Tyrol. The average temperature coefficients for the eight non urban provinces are about 0.22 for August and 0.19 for September (unweighted).

For Vienna we find that changes in domestic visitor nights are independent of changes in temperatures. This also holds true when weather is measured as the number of sunshine hours. The finding that urban tourism is independent of weather is consistent with McKercher et al. (2014). Vienna is a popular destination for business travellers, shopping and cultural tourists. These activities are largely independent of weather conditions.

Tables 4 and 8 in the appendix show the corresponding results for German overnight stays. We find that changes in weather conditions to same month in the previous year or weather conditions lagged one month do not have an impact on year to year changes in German overnight stays. This stands in contrast to the results for domestic overnight stays. However, sunshine hours significantly affect German overnight stays with a 1 year lag. In particular, sunshine duration lagged 1 year (to same month in the previous year) has a significant effect on German overnight stays in six out of nine provinces. Again, the weather effects are larger for August than for the remaining

Table 4 Seemingly unrelated regression estimates of the impact of average temperatures on German overnight stays

	Burgenland		Carinthia		Lower Austria		Salzburg		Upper Austria		Styria		Tyrol		Vorarlberg		Vienna	
	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t
	dep. var. log changes in German overnight stays between June and the same month in the previous year																	
Δlntempm6	0.02	0.04	−0.25	−1.18	0.11	0.54	−0.01	−0.08	−0.03	−0.26	−0.02	−0.12	−0.04	−0.30	0.07	0.56	0.27	1.05
L1Δlntempm6	0.29	1.15	0.28 **	2.17	0.23 *	1.85	0.21 **	2.30	0.10	1.36	0.28 **	2.32	0.10	1.35	0.12	1.51	−0.09	−0.57
L12Δlntempm6	0.53	1.34	0.44 **	2.05	0.04	0.20	0.16	1.26	0.15	1.25	0.45 **	2.48	0.11	0.93	0.19	1.61	0.18	0.71
constant	−0.01	−0.17	−0.03	−1.08	−0.01	−0.56	−0.03	−1.23	−0.02	−0.78	−0.01	−0.46	−0.01	−0.61	−0.01	−0.58	0.01	0.58
R^2	0.02		0.01		0.10		0.04		0.01		0.03		0.01		0.05		0.06	
F-test joint sig.(p)	0.48		0.01		0.10		0.11		0.37		0.03		0.49		0.22		0.69	
Breusch-Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	dep. var. log changes in German overnight stays between July and the same month in the previous year																	
Δlntempm7	0.00	0.00	0.04	0.26	0.02	0.13	0.19 **	2.23	0.08	0.74	0.15	1.19	0.00	0.03	0.01	0.12	−0.18	−0.96
L1Δlntempm7	0.01	0.05	−0.10	−0.72	0.10	0.77	0.00	−0.05	−0.11	−1.36	−0.09	−0.72	−0.04	−0.57	0.00	0.05	−0.09	−0.44
L12Δlntempm7	−0.12	−0.65	0.07	0.42	0.04	0.30	0.27 **	3.29	0.14	1.45	0.21 *	1.66	0.05	0.61	−0.16	−1.53	−0.03	−0.15
constant	−0.02	−1.22	−0.04 *	−1.94	−0.02	−1.07	−0.04 **	−2.77	−0.03	−1.43	−0.02	−1.48	−0.02	−1.54	−0.02	−1.52	0.02	0.91
R^2	0.00		0.00		0.00		0.05		0.01		0.01		0.01		0.05		0.03	
F-test joint sig.(p)	0.92		0.86		0.85		0.01		0.25		0.32		0.83		0.36		0.77	
Breusch-Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	dep. var. log changes in German overnight stays between August and the same month in the previous year																	
Δlntempm8	−0.09	−0.66	0.23 *	1.83	0.17	1.15	0.41 **	3.65	0.09	0.88	0.24 *	1.88	0.03	0.27	0.04	0.38	−0.24	−1.36
L1Δlntempm8	−0.06	−0.48	−0.16	−1.38	−0.23 *	−1.80	−0.06	−0.75	−0.13	−1.59	−0.10	−0.84	−0.18 **	−2.16	−0.09	−1.03	−0.10	−0.63
L12Δlntempm8	0.13	1.02	0.37 **	2.99	0.01	0.06	0.31 **	2.78	0.14	1.37	0.15	1.17	0.13	1.32	0.32 **	2.77	−0.10	−0.54
constant	−0.02 *	−1.85	−0.04 **	−2.74	−0.02	−1.52	−0.04 **	−3.53	−0.02 *	−1.74	−0.03 **	−1.79	−0.02 **	−1.68	−0.02 **	−1.69	0.01	0.85

Table 4 (continued)

	Burgenland		Carinthia		Lower Austria		Salzburg		Upper Austria		Styria		Tyrol		Vorarlberg		Vienna	
	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t
R^2	0.04		0.20		0.10		0.26		0.11		0.09		0.11		0.16		0.03	
F-test joint sig.(p)	0.31		0.01		0.21		0.00		0.22		0.25		0.09		0.03		0.51	
Breusch- Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	dep. var. log changes in German overnight stays between September and the same month in the previous year																	
Δlntempm9	0.16	1.08	0.17 *	1.79	−0.01	−0.10	0.20 **	2.21	0.11 *	1.68	−0.07	−0.90	0.08	1.25	0.19 **	2.71	0.14 *	1.67
L1Δlntempm9	−0.20	−1.00	0.11	0.81	−0.21 *	−1.86	−0.05	−0.39	−0.06	−0.65	−0.03	−0.33	−0.08	−0.85	−0.10	−1.05	−0.29 **	−2.55
L12Δlntempm9	0.12	0.79	0.05	0.57	−0.07	−0.79	0.02	0.27	0.06	0.93	−0.03	−0.36	0.04	0.61	0.07	1.05	0.06	0.70
constant	0.00	−0.14	−0.02 *	−1.70	−0.01	−0.64	−0.02 *	−1.91	−0.02	−1.41	−0.01	−1.06	−0.01	−0.95	−0.01	−1.00	0.01	0.96
R^2	0.04		0.12		0.06		0.08		0.07		0.00		0.04		0.13		0.16	
F-test joint sig.(p)	0.57		0.23		0.20		0.13		0.37		0.81		0.56		0.06		0.04	
Breusch- Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	

***, ** and * denote significance at the 1, 5 and 10 % significance levels. See Table 3 summer months. The coefficients range between 0.07 and 0.13 indicating that an increase in sunshine duration of 10 % in August leads to an increase in German overnight stays in the next year's August between 0.7 and 1.3 %. Overall, this is consistent with the literature that weather affects foreign overnight stays only with a 1 year lag. Furthermore, the weather effects differ greatly across regions. Larger weather effects can be observed for lake destinations (e.g., Carinthia, Upper Austria) and generally for provinces with significant part of lowlands (e.g., Lower Austria) and Salzburg. For mountain regions like Tyrol, weather conditions do not have a significant impact on tourism flows. The number of German tourist overnight stays in Vienna is again independent from weather factors. An exception is September where we find that less sunshine and lower temperatures lead to an increase in overnight stays.

The results are consistent with previous studies for countries with a moderate climate. Serquet and Rebetez (2011) find that hotter temperatures in the Swiss lowland lead to an increase in overnight stays in the Swiss mountains. Our study finds that not only mountain destinations but also low land destinations benefit from an increase in sunshine hours and higher temperatures.

Overall, the results stand in contrast with studies for other regions. For Northern Norway, Rauken et al. (2010) show that a cool summer season has no impact on visitor flows. Similarly, for the Franz Josef glacier in New Zealand, Becken and Wilson (2013) find that weather conditions based on a comparison to the same season in the previous year have no effect on the number of visits.

We have conducted several robustness checks. First, we include the squared term of the weather indicators in order to account for non-linear effects. It might be that there is an inverted u-shape relationship between weather conditions and overnight stays (Rosselló-Nadal 2014). Unreported results show that there is an inverted u-shape relationship between temperatures and overnight stays in half of the cases. For the remaining cases there is no clear pattern. Second, we have simultaneously re-estimated the equations including the temperature and sunshine variables. Unreported results show that temperatures remain significant while the impact of sunshine hours decreases in size and significance. This indicates that temperatures are more relevant in determining overnight stays.

6 Conclusions

The paper has contributed to the literature on the relationship between weather conditions and tourism flows in countries with moderate summer climate conditions such as Austria. In the literature there is no agreement on the extent to which weather has an effect on tourism flows in rural regions with moderate or cooler climates. Using panel data for nine Federal States in Austria for the period 1974–2012 we find a statistically significant relationship between the change in sunshine duration and temperatures, and the change in domestic overnight stays in the same months - August and September - for most of the provinces except for the capital city of Vienna. On average, an increase in temperature in August of 1 °C (from 18 to 19 °C) as compared to the same month in the previous year leads to an increase in domestic overnight stays in August by 1.2 % as compared to the same month in the previous season. Sunshine duration also has a significant impact on domestic overnight stays and to a lesser extent on German tourism demand for most of the provinces. However, sunshine hours affect German overnight stays mainly with a 1 year lag.

In general, weather effects are larger in August and September than in June and are mainly insignificant for July. This suggests that the sensitivity of tourism demand to changes in temperatures is more significant during the later summer period and in the first autumn month than in the earlier summer months. Furthermore, weather effects differ largely across regions with larger effects for rural destinations with plenty of lakes (Salzburg and Upper Austria) and also for low land destinations (Burgenland and Lower Austria). Here, current and lagged sunshine hours or temperature can explain between 23 and 47 % of the variation of domestic and German overnight stays. In contrast, weather conditions are less relevant for tourism in mountainous regions such as Tyrol.

The results indicate that Austria's tourism industry benefits from a warmer and sunnier climate with the exception of the capital region and Tyrol. In particular, domestic residents are more likely to spend their holidays in their home country during warmer and sunnier summer months. There is also a positive relationship between sunshine duration and German overnight stays. However, these effects mainly occur in the subsequent summer season and the magnitude of effects is lower than those for domestic overnight stays. Given the results we conclude that the estimates might be useful in predicting future tourism demand using different climate scenarios.

The paper has some limitations. First, investigated was the impact of average monthly temperatures, precipitation and sunshine hours on overnights stays for the summer months of June to September. By using monthly data, extreme weather events within a given month such as heat waves or thunderstorms were not taken into account. Second, the use of averages of both temperature and sunshine hours may hide the distribution of the variables. Third, the empirical analysis is based on data for Federal states (NUTS 2) which is a quite high level of regional aggregation. Future work should employ municipality or district data to analyze the relationships. In addition, it is suitable to use the number of days above a certain temperature threshold or number of rain days per month rather than total precipitation.

7 Appendix

Table 5 Descriptive statistics for overnights stays by domestic and German tourists, 1974-2012

	Average annual change in domestic overnight stays				Average annual change in German overnight stays			
	mean	std dev	min	max	mean	std dev	min	max
				June				
Burgenland	3.0	10.4	−16.1	38.3	−0.5	28.7	−53.7	66.9
Carinthia	2.3	6.4	−13.0	15.2	−2.6	15.3	−28.3	28.2
Lower Austria	−0.6	4.8	−20.5	9.0	−0.8	12.2	−18.6	27.3
Salzburg	0.5	4.1	−9.6	9.6	−2.5	14.0	−33.0	23.3
Styria	1.8	5.6	−6.9	12.9	−1.6	13.8	−24.6	25.9
Tyrol	0.0	4.7	−16.8	9.2	−0.8	14.9	−30.4	33.1
Upper Austria	1.6	7.1	−16.9	23.2	−1.3	13.6	−28.5	27.2
Vorarlberg	2.1	8.6	−17.6	17.8	−1.0	12.3	−19.3	27.2
Vienna	3.9	9.0	−19.4	20.9	1.3	12.6	−26.1	34.8
				July				
Burgenland	3.5	12.7	−18.4	61.6	−2.4	12.2	−29.7	22.0
Carinthia	0.3	5.6	−9.2	13.2	−3.8	12.0	−43.9	30.1
Lower Austria	−1.5	4.0	−13.5	6.5	−1.5	9.3	−24.7	18.9
Salzburg	−0.6	5.0	−11.6	10.0	−4.2	9.9	−34.8	18.8
Styria	0.9	5.9	−12.7	16.1	−2.6	11.3	−40.0	30.3
Tyrol	−1.0	3.9	−10.7	7.9	−2.4	10.4	−31.8	18.6

Table 5 (continued)

	Average annual change in domestic overnight stays				Average annual change in German overnight stays			
	mean	std dev	min	max	mean	std dev	min	max
Upper Austria	0.7	6.3	−12.8	13.7	−2.5	10.1	−38.2	22.0
Vorarlberg	1.0	6.9	−13.1	17.4	−2.5	10.5	−30.7	22.3
Vienna	4.7	11.0	−18.1	32.8	1.5	10.9	−33.0	26.5
				August				
Burgenland	2.6	10.4	−20.5	47.8	−2.3	7.9	−21.4	20.5
Carinthia	0.3	7.2	−16.4	10.4	−3.4	9.0	−18.6	17.3
Lower Austria	−1.6	4.4	−11.9	6.3	−2.0	8.3	−20.6	14.2
Salzburg	−0.4	4.6	−11.7	12.6	−4.1	8.7	−21.8	20.0
Styria	1.0	4.5	−8.5	17.3	−2.5	9.7	−21.1	35.6
Tyrol	−0.7	3.3	−11.5	5.5	−2.5	9.4	−21.5	27.0
Upper Austria	0.7	5.5	−16.9	9.7	−2.3	9.2	−20.1	30.4
Vorarlberg	0.7	6.4	−12.0	16.2	−2.2	8.8	−16.9	25.1
Vienna	4.7	11.5	−23.7	32.2	1.1	9.0	−26.8	16.7
				September				
Burgenland	3.0	7.2	−13.5	14.0	−0.2	12.7	−31.9	47.6
Carinthia	2.1	6.5	−12.4	15.1	−2.1	8.7	−14.4	23.6
Lower Austria	−0.4	4.3	−13.8	7.3	−0.7	7.1	−13.5	12.0
Salzburg	0.3	4.6	−9.5	11.1	−2.5	8.6	−18.3	21.0
Styria	1.4	6.6	−17.7	15.5	−1.6	7.6	−12.6	25.3
Tyrol	0.2	4.1	−8.0	12.7	−1.1	6.5	−15.9	12.5
Upper Austria	1.3	8.3	−13.9	18.4	−1.1	7.4	−16.6	16.8
Vorarlberg	1.7	9.1	−16.2	19.6	−1.0	7.1	−18.2	15.8
Vienna	3.2	9.2	−22.2	20.5	1.1	7.1	−11.2	25.1

Source: Statistics Austria, own calculations

Table 6 Correlation matrix of the residuals for domestic nights stays and temperatures for August

	Burgenland	Carinthia	Lower Austria	Salzburg	Styria	Tyrol	Upper Austria	Vorarlberg	Vienna
Burgenland	1.00								
Carinthia	−0.35	1.00							
Lower Austria	−0.20	0.05	1.00						
Salzburg	0.40	−0.01	0.06	1.00					
Styria	0.43	0.07	0.05	0.44	1.00				
Tyrol	−0.48	0.57	0.24	0.10	0.03	1.00			
Upper Austria	−0.24	0.59	0.28	−0.02	0.16	0.65	1.00		
Vorarlberg	−0.27	0.42	0.01	0.15	0.32	0.41	0.50	1.00	
Vienna	0.50	−0.27	−0.13	0.18	0.23	−0.21	−0.15	−0.05	1.00

The correlations are based on the seemingly unrelated regression methods for domestic overnight stays in August with average temperatures as the weather indicators

Table 7 Seemingly unrelated regression estimates of the impact of sunshine hours on domestic overnight stays

	Burgenland		Carinthia		Lower Austria		Salzburg		Upper Austria		Styria		Tyrol		Vorarlberg		Vienna	
	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t
	dep. var. log changes in domestic overnight stays between June and the same month in the previous year																	
Δlnsunm6	0.10	1.39	0.02	0.56	−0.01	−0.42	0.00	0.11	0.02	0.54	0.11 **	3.21	0.03	0.65	−0.04	−0.66	0.07	0.99
L1Δlnsunm6	0.10 **	2.22	0.01	0.22	0.04 **	2.05	0.03 *	1.86	−0.01	−0.45	0.05 **	2.09	0.01	0.40	−0.04	−1.01	−0.07	−1.50
L12Δlnsunm6	0.12 *	1.66	0.05	1.18	−0.07 **	−2.00	0.03	1.18	0.05	1.52	0.09 **	2.65	0.00	−0.02	−0.01	−0.12	−0.06	−0.75
constant	0.03 *	1.87	0.02 **	2.32	−0.01	−0.82	0.00	0.66	0.02 **	2.12	0.00	−0.32	0.02	1.40	0.02	1.57	0.04 **	2.95
R^2	0.21		0.06		0.12		0.06		0.07		0.24		0.02		0.04		0.11	
F-test f. joint sig.(p)	0.03		0.71		0.04		0.20		0.46		0.00		0.85		0.68		0.16	
Breusch-Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	dep. var. log changes in domestic overnight stays between July and the same month in the previous year																	
Δlnsunm7	0.12	1.38	0.02	0.38	0.02	0.78	0.07 **	2.84	0.07 **	1.97	0.00	−0.15	−0.03	−0.74	0.04	0.74	0.11	1.40
L1Δlnsunm7	0.00	0.00	0.03	1.03	0.01	0.38	−0.01	−0.28	0.02	0.46	0.06 **	2.14	0.02	0.78	−0.01	−0.14	−0.06	−0.67
L12Δlnsunm7	0.02	0.19	0.10 **	2.03	−0.01	−0.24	0.03	1.02	0.04	1.27	0.05 *	1.80	0.08 **	1.99	0.10 **	2.04	0.04	0.50
constant	0.03 *	1.74	0.00	0.24	−0.02 **	−2.41	−0.01	−0.76	0.01	0.99	−0.01 *	−1.82	0.01	0.70	0.01	1.01	0.05 **	2.74
R^2	0.00		0.04		0.01		0.15		0.12		0.14		0.10		0.11		0.05	
F-test f. joint sig.(p)	0.56		0.14		0.82		0.04		0.22		0.02		0.09		0.23		0.46	
Breusch-Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	dep. var. log changes in domestic overnight stays between August and the same month in the previous year																	
Δlnsunm8	0.14 *	1.70	0.09 **	1.98	0.05	1.27	0.05 *	1.71	0.03	1.22	−0.02	−0.93	−0.05	−1.55	0.04	1.05	−0.11	−1.02
L1Δlnsunm8	0.00	0.02	0.06	1.08	0.03	1.04	0.01	0.50	0.02	0.89	−0.01	−0.50	−0.03	−0.69	0.00	−0.12	0.04	0.46
L12Δlnsunm8	0.00	0.01	0.14 **	2.99	0.01	0.35	0.06 *	1.71	−0.01	−0.29	0.01	0.54	0.04	1.38	0.07	1.82	0.07	0.68
constant	0.03 *	1.66	0.00	0.12	−0.02 **	−2.42	0.00	−0.59	0.01	1.55	−0.01	−1.46	0.01	0.77	0.01	0.66	0.05 **	2.66
R^2	0.14		0.24		0.07		0.11		0.13		0.05		0.09		0.11		0.05	
F-test f. joint sig.(p)	0.17		0.02		0.43		0.26		0.31		0.46		0.07		0.30		0.26	

Table 7 (continued)

	Burgenland		Carinthia		Lower Austria		Salzburg		Upper Austria		Styria		Tyrol		Vorarlberg		Vienna	
	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t
Breusch-Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	dep. var. log changes in domestic overnight stays between September and the same month in the previous year																	
ΔInsunm9	0.04	1.21	0.07 *	1.73	−0.01	−0.80	0.04 **	2.57	0.07 **	2.69	0.03	1.47	0.10 **	2.20	−0.06	−1.34	0.05	1.28
L1ΔInsunm9	−0.02	−0.32	−0.02	−0.38	−0.04	−1.38	−0.04	−1.53	−0.05	−1.58	−0.04	−1.54	−0.02	−0.47	−0.03	−0.59	−0.09	−1.31
L12ΔInsunm9	0.03	0.92	0.07 *	1.81	−0.02	−0.97	0.01	0.54	0.10 **	3.83	−0.02	−0.98	0.06	1.36	0.12 **	2.68	0.02	0.54
constant	0.03 **	2.75	0.02 **	2.05	0.00	−0.59	0.00	0.56	0.01 *	1.65	0.00	0.35	0.01	1.08	0.02	1.26	0.03 **	2.26
R^2	0.08		0.06		−0.03		0.23		0.27		0.20		0.11		0.19		0.07	
F-test f. joint sig.(p)	0.68		0.27		0.27		0.03		0.00		0.01		0.18		0.00		0.35	
Breusch-Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	

***, ** and * denote significance at the 1, 5 and 10 % significance levels

Table 8 Seemingly unrelated regression estimates of the impact of changes in sunshine hours on changes in German overnight stays

	Burgenland		Carinthia		Lower Austria		Salzburg		Upper Austria		Styria		Tyrol		Vorarlberg		Vienna	
	coef	t	coef.	t	coef	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t
	dep. var. log changes in German overnight stays between June and the same month in the previous year																	
Δlnsunm6	−0.03	−0.23	−0.18 **	−2.53	0.05	0.75	−0.05	−1.03	−0.04	−0.91	−0.05	−0.80	−0.06	−1.16	0.03	0.62	0.10	1.09
L1Δlnsunm6	−0.01	−0.14	0.02	0.33	0.10 **	2.29	0.07 **	2.40	0.03	0.97	0.08 **	1.98	0.05 *	1.71	0.01	0.24	−0.01	−0.24
L12Δlnsunm6	−0.07	−0.45	0.01	0.16	−0.08	−1.16	−0.01	−0.23	0.04	0.96	0.05	0.81	0.00	−0.02	0.06	1.31	−0.02	−0.24
constant	0.00	−0.09	−0.02	−1.03	−0.01	−0.46	−0.03	−1.24	−0.02	−0.76	−0.01	−0.39	−0.01	−0.66	−0.01	−0.54	0.01	0.64
R^2	−0.01		0.03		0.06		0.10		0.03		0.05		0.10		0.04		−0.02	
F-test joint sig. (p)	0.97		0.04		0.02		0.11		0.31		0.09		0.19		0.61		0.57	
Breusch-Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	dep. var. log changes in German overnight stays between July and the same month in the previous year																	
Δlnsunm7	0.00	−0.01	0.09	1.06	−0.01	−0.11	0.08 **	3.13	0.06 **	1.98	0.02	0.44	0.01	0.35	0.01	0.20	−0.01	−0.18
L1Δlnsunm7	−0.01	−0.08	−0.07	−1.45	0.08	1.49	−0.05 *	−1.72	−0.05	−1.42	−0.12 **	−2.74	−0.03	−1.46	−0.02	−0.59	0.05	0.64
L12Δlnsunm7	−0.12 *	−1.70	0.09	1.20	0.00	0.06	0.11 **	4.56	0.09 **	2.88	0.08	1.54	0.08 **	2.96	−0.03	−0.58	−0.10	−1.20
constant	−0.02	−1.29	−0.04 **	−1.98	−0.02	−1.08	−0.04 **	−2.67	−0.03	−1.51	−0.02	−1.38	−0.02	−1.57	−0.02	−1.46	0.01	0.80
R^2	0.07		−0.01		0.04		0.03		0.05		−0.05		0.03		−0.01		0.04	
F-test joint sig. (p)	0.22		0.31		0.40		0.00		0.02		0.03		0.01		0.77		0.67	
Breusch-Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	dep. var. log changes in German overnight stays between August and the same month in the previous year																	
Δlnsunm8	−0.01	−0.11	0.09 *	1.95	0.12 *	1.71	0.16 **	4.64	0.00	0.10	0.06	1.46	−0.01	−0.36	0.04	0.88	−0.01	−0.14
L1Δlnsunm8	−0.01	−0.27	−0.08	−1.37	−0.08	−1.58	−0.01	−0.27	−0.04	−1.48	−0.03	−0.65	−0.09 **	−2.58	−0.05	−1.16	0.02	0.32
L12Δlnsunm8	0.12 **	1.97	0.14 **	2.99	0.16 **	2.20	0.13 **	3.64	0.05	1.59	0.05	1.17	0.07 **	2.13	0.13 **	3.27	0.07	0.76

Table 8 (continued)

	Burgenland		Carinthia		Lower Austria		Salzburg		Upper Austria		Styria		Tyrol		Vorarlberg		Vienna	
	coef	t	coef.	t	coef	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	t
constant	−0.02 **	−2.01	−0.04 **	−3.01	−0.02 *	−1.75	−0.04 **	−4.05	−0.03 *	−1.84	−0.03 *	−1.80	−0.02 *	−1.94	−0.02 *	−1.81	0.01	0.82
R^2	0.18		0.26		0.24		0.37		0.13		0.09		0.22		0.21		0.04	
F-test joint sig. (p)	0.05		0.01		0.01		0.00		0.10		0.33		0.00		0.01		0.75	
Breusch-Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	
	dep. var. log changes in German overnight stays between September and the same month in the previous year																	
Δlnsunm9	−0.05	−0.92	0.01	0.23	−0.08 **	−2.72	0.03	1.05	0.01	0.52	−0.01	−0.34	−0.02	−0.95	0.02	0.55	−0.01	−0.21
L1Δlnsunm9	0.11	1.20	0.07	1.35	0.00	0.09	−0.02	−0.52	−0.03	−1.29	0.01	0.30	0.04	1.35	−0.01	−0.25	−0.11 **	−2.20
L12Δlnsunm9	0.01	0.10	0.03	0.57	0.01	0.50	0.06 **	2.08	0.04 *	1.68	0.03	0.98	0.02	0.69	0.03	1.19	0.03	0.88
constant	0.00	−0.12	−0.02	−1.58	−0.01	−0.69	−0.02 *	−1.88	−0.02	−1.38	−0.01	−1.12	−0.01	−0.92	−0.01	−0.93	0.01	1.07
R^2	0.02		0.03		0.17		0.05		0.02		0.03		−0.01		0.02		0.12	
F-test joint sig. (p)	0.35		0.47		0.00		0.22		0.25		0.46		0.27		0.70		0.13	
Breusch-Pagan (p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	

***, ** and * denote significance at the 1, 5 and 10 % significance levels

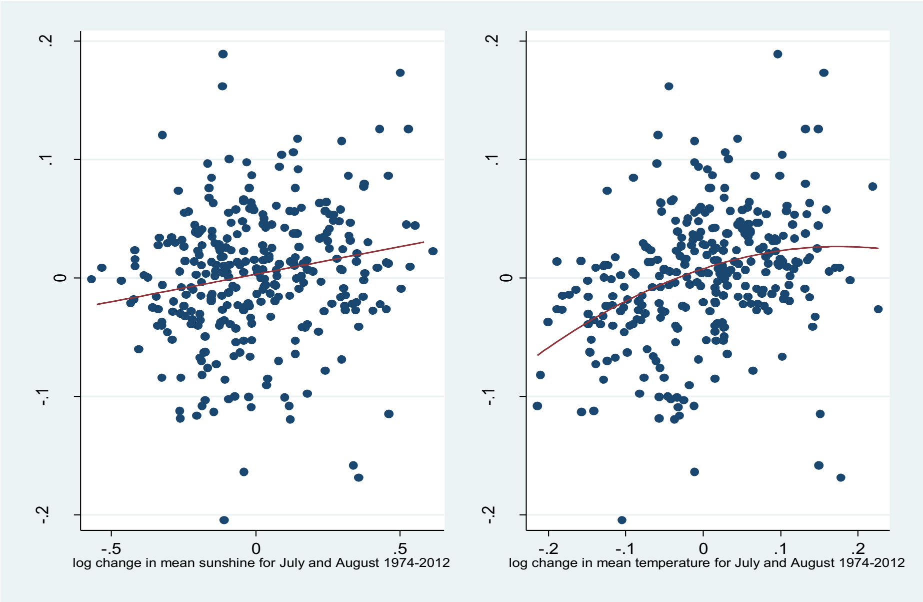

Fig. 1 Scatter plot of the relationship between change in sunshine and temperatures and change in domestic overnight stays

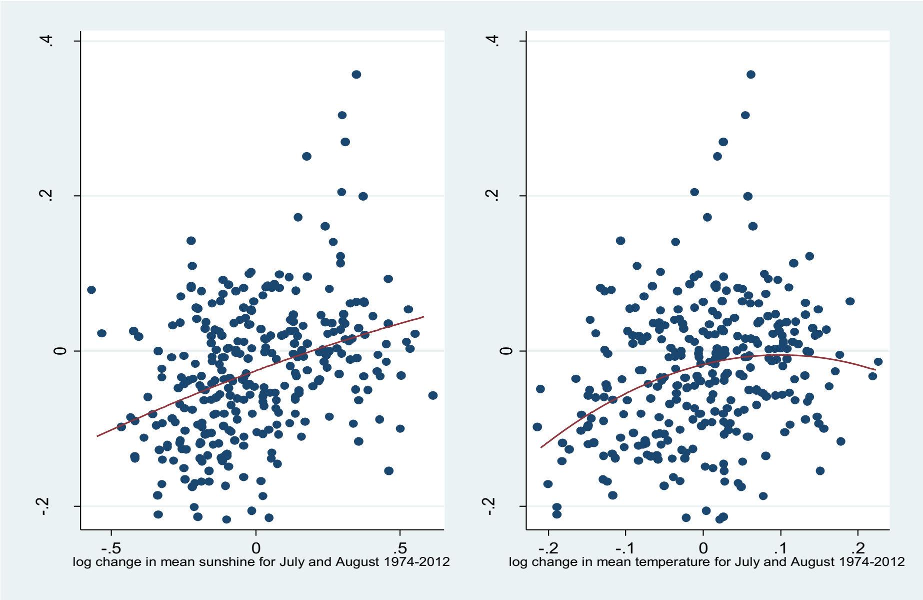

Fig. 2 Scatter plot of the relationship between change in sunshine and temperatures, and change in German overnight stays. Source: Histalp, Statistics Austria, own calculations

References

Agnew MD, Palutikof J (2006) Impacts of short-term climate variability in the UK on demand for domestic and international tourism. Clim Res 31:109–120

Becken S (2013a) A review of tourism and climate change as an evolving knowledge domain. Tour Manag Perspectives 6:53–62

Becken S, Wilson J (2013) The impacts of weather on tourist travel. Tour Geogr 15(4):620–639

Becken S (2013b) Measuring the effect of weather on Tourism A destination-and activity-based analysis. J Travel Res 52(2):156–167

Breusch TS, Pagan AR (1980) The Lagrange multiplier test and its applications to model specification in econometrics. Rev Econ Stud 47:239–253

De Freitas CR (2003) Tourism climatology: evaluating environmental information for decision making and business planning in the recreation and tourism sector. Int J Biometeorol 48:45–54

Denstadli JM, Jacobsen JK, Lohmann M (2011) Tourist perceptions of summer weather in Scandinavia. Ann Tour Res 38(3):920–940

Falk M (2013) Impact of long-term weather on domestic and foreign winter tourism demand. Int J Tour Res 15(1):1–17

Falk M (2014) Impact of weather conditions on tourism demand in the peak summer season over the last 50 years. Tour Manag Perspectives 9:24–35

Finger R, Lehmann N (2012) Modeling the sensitivity of outdoor recreation activities to climate change. Clim Res 51:229–236

Giles AR, Perry AH (1998) The use temporal analogue to investigate the possible impact of projected global warming on the UK tourism industry. Tour Manag 19(1):75–80

Gómez Martín MB (2005) Weather, climate and tourism: a geographical perspective. Ann Tour Res 32(3):71–91

Gössling S, Hall CM (2006) Uncertainties in predicting tourist flows under scenarios of climate change. Clim Chang 79(3–4):163–173

Gössling S, Scott D, Hall CM, Ceron J, Dubois G (2012) Consumer behaviour and demand response of tourists to climate change. Ann Tour Res 39:36–58

Hedrick-Wong Y, Choong D. various issues. Mastercard Global Destination Cities Index. MasterCard Worldwide Insights

Kaján E, Saarinen J (2013) Tourism, climate change and adaptation: a review. Curr Issues Tourism 16(2):167–195

McKercher B, Shoval N, Park E, Kahani A (2014) The [limited] impact of weather on tourist behavior in an urban destination. J Travel Res, ahead of print

Nicholls S (2006) Climate change, tourism and outdoor recreation in Europe. Manag Leis 11(3):151–163

Otero-Giráldez MS, Álvarez-Díaz M, González-Gómez M (2012) Estimating the long-run effects of socioeconomic and meteorological factors on the domestic tourism demand for Galicia (Spain). Tour Manag 33(2):1301–1308

Pang FH, McKercher B, Prideaux B (2013) Climate change and tourism: an overview. Asia Pac J Tourism Res 18(1–2):4–20

Paul AH (1972) Weather and the daily use of outdoor recreation areas in Canada. In: Taylor JA (Ed) Weather forecasting for agriculture and industry David and Charles. Newton Abbot, 132–146

Rauken T, Kelman IS, Jacobsen JK, Hovelsrud GK (2010) Who can stop the rain? Perceptions of summer weather effects among small tourism businesses. Anatolia 21(2):289–304

Richardson RB, Loomis JB (2005) Climate change and recreation benefits in an alpine national park. J Leis Res 37(3):307–320

Rosselló-Nadal J (2014) How to evaluate the effects of climate change on tourism. Tour Manag 42:334–340

Scott D, Jones B, Konopek J (2007) Implications of climate and environmental change for nature-based tourism in the Canadian Rocky Mountains: a case study of Waterton Lakes National Park. Tour Manag 28(2):570–579

Serquet G, Rebetez M (2011) Relationship between tourism demand in the Swiss Alps and Hot summer air temperatures associated with climate change. Clim Chang 108:291–300

Smith K (1990) Tourism and climate change. Land Use Policy 7(2):176–180

Smith K (1993) The influence of weather and climate on recreation and tourism. Weather 48:398–404

Taylor T, Ortiz R (2009) Impacts of climate change on domestic tourism in the UK: a panel data estimation. Tour Econ 15(4):803–812

Windle J, Rolfe J (2013) The impacts of the 2011 extreme weather events on holiday choices of Brisbane residents. Aus J Environ Manag 20(4):338–350

Zellner A (1962) An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. J Am Stat Assoc 57:348–368