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Summer weather conditions and tourism flows in urban and rural destinations

Martin Falk (WIFO)

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. 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 one year lag. In general, weather effects are much larger in August and September than in June and July. An increase in temperature by 1°C leads to an increase in domestic overnight stays in August by 1.2 percent. The weather effects are largest for the province of Salzburg where current and lagged sunshine or temperatures can explain between 23 and 47 percent of the variation of domestic and German overnight stays.

Keywords: Tourism demand, overnight stays, weather conditions, Austria, regions, rural and urban areas, seemingly unrelated regression methods.

Introduction

The relationship between weather and tourism demand has been widely investigated for different locations and different seasons (summer and/or winter season) (see Becken, 2013a; Gössling et al., 2012; Kaján & Saarinen, 2013; Pang, McKercher & Prideaux, 2013; Rosello 2014 for recent surveys of the literature). 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. It is likely that tourism inflows to urban destinations are rather independent of weather conditions whereas tourism to rural destinations strongly depends on favourable weather conditions. This is related to the different motivations of tourists.

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 which makes it possible to account for cross-regional correlations. We also 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 A7 in the Appendix).

In the empirical model we distinguish 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, and all kinds of alpine sports and mountaineering are the most popular tourism activities in the Western provinces. Upper Austria is well known for his beautiful lakes (Mondsee, Attersee and Traunsee, Hallstatt Lake), mountains (Salzkammergut) and caves (Dachstein Caves). The main attractions in Carinthia 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 (from 1974-2012) so as to investigate the relationship between summer weather conditions and overnight stays. Distinguishing between different types of destinations (urban, mountain and rural destinations) gives a more detailed picture of the weather tourism relationships. The other goal of the paper is distinguishing 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 & Ortiz, 2009). Therefore, it is likely that foreign tourists react with a varying time lag to changes in weather conditions. Furthermore, we 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.

However, the majority of studies are based on rural, summer and sun destinations (see e.g. Álvarez-Díaz & Rosselló-Nadal 2010 for the Balearic Islands, Becken 2013b for the West Coast of the South Island of New Zealand; Becken and Wilson, 2013 for the Franz Josef glacier in New Zealand; Finger and Lehmann 2012 for two lakes on Lake Zurich; Otero-Giráldez et al., 2012 for Galicia; Ridderstaat et al., 2014 for Aruba; Scott et al., 2007 for visits to Waterton Lakes National Park [Canada]; Serquet and Rebetez 2011 for Swiss mountains). Few studies are available that investigate the relationship between tourism flows and weather for urban destinations. An exception is the study by McKercher et al. (2014) which finds that tourism flows into Hong Kong are independent of weather conditions.

In addition, few studies have investigated the impact of summer weather on tourism demand in regions with cooler climate conditions and moderate temperatures – those in central and northern Europe, for instance, which are likely to gain from climate change (Denstadli et al., 2012; Falk, 2014; Serquet & Rebetez, 2011 are exceptions). 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. For Austria, 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. Previous studies for Austria mainly focused on the relationship between weather and winter tourism (eg. Falk, 2013; Steiger, 2011). To the best of the author's knowledge, no studies are available that distinguish between countryside locations and urban destinations.

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

Empirical model

Temperature, sunshine, and rainfall have been identified as important tourism factors in the summer season. A change to warmer and drier summers in countries with moderate climate conditions would make them 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 & Loomis, 2005; Scott & Jones, 2006; Scott, Jones & Konopek, 2007). This indicates that tourism to rural destinations is particularly weather sensitive unlike tourism to urban destinations. 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 one year or seasons (Smith, 1990; Giles & Perry, 1998; Agnew & Palutikof, 2006). In addition, 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. Distinguishing between rural regions and urban destinations is important when studying

the relationship between tourism flows and weather conditions. It is likely that changes in visitor nights in urban destinations are independent of changes in weather conditions because of the different tourist profiles (cultural and shopping tourism, business travelers, conference and congress tourism, night-lift tourism) (Asworth & and page 2011). In fact, using survey data for Hong Kong, McKercher et al. (2014) find that tourism is independent of weather conditions. In Austria, Vienna is the most important destination for cultural tourists. (Smeral, 2014). Between the summer months of June to September the number of overnight stays is about 1.5 million and increasing over time (see table A7 for descriptive statistics). Similarly, for mountain regions cold and wet summer seasons may have no impact on tourism since visitors expect changeable weather conditions. Denstadli, Jacobsen and Lohmann (2011) find that unfavourable summer weather in North Scandinavia does not lead to changes in visitor patterns.

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 to the same month in the previous year also wipes out seasonal variations in tourism which are an important feature of tourism. Note that seasonal variations are often caused by seasonal variations in mean weather conditions (Kulendran & Dwyer, 2012). 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 account for common factors such as global recessions and change 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 change 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, $t=1975,...,2012$ measured as each summer month (June, July, August and September). X is overnight stays (either domestic or German overnight stays) associated with 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 impact 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.

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. We allow the residuals of the different provinces to be positively correlated by using Zellner's (1962) method of seemingly unrelated regression method.

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

$$\text{var } \varepsilon_{it} = \sigma_{ii}^2 \quad \text{covar } \varepsilon_{it} \varepsilon_{jt} = \sigma_{ij}^2.$$

We assume the error terms to have contemporaneous covariances σ_{ij}^2 . In case the regressors on the right hand side 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.

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 (see

Figure A3 in the Appendix for the map). The weather data is drawn from the HISTALP dataset (Auer et al., 2007). 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 three weather stations. We use the average of these weather stations for a given province and month. All weather data are freely available and all weather variables are continuous (see Table A8 in appendix for descriptive statistics of the weather indicators).

Data on number of visitor nights by province and visitor country are provided by Statistics Austria. Overnight stays are measured as the change in the logarithm of overnight stays as compared to those of the same month in the previous year for the period 1974–2012 (see Table A7 in the Appendix). One can see that the number of overnight stays in Vienna increased on average in the summer period 1974–2012 while the number of overnight stays in other regions decreased slightly over the same period. This is consistent with the general increase in urban tourism in the world (Ashworth & Page, 2011). 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 is relatively small. For instance the city of Salzburg only accounts for 15 percent 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 Table 1 and 2). For German overnight stays we also provide correlations between visitor nights and the change in weather indicators lagged one 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 provide scatterplots between changes in temperatures and sunshine hours and German and domestic overnight night stays

(see Figure A1 and A2 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 regression line is rather flat.

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 the change in visitor nights of domestic tourists is 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 are significantly positively related. The correlation coefficient for change in temperatures in August and September are 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 change in temperature for the month of June. Furthermore, there is a significant and negative correlation between domestic visitor nights and change in precipitation in August (see table in Appendix). Correlations for each of the eight Federal states show that the correlations between the change in domestic overnight stays and 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.

For German overnight stays we find few significant correlations between the change in overnight stays and change in weather in a given month as compared to the same month in the previous year. An exception is the change in overnight stays and change in temperatures for September. However, when weather indicators are lagged by one year (=log differences to the same month in the previous year) we find a significant correlation for the three weather

indicators for August and September (Table 2 and Table A9 in the Appendix). This indicates that German tourists are more sensitive to weather conditions of the past season (month) rather than the current season.

Table 1: Correlation between change in domestic overnight stays and changes in weather indicators

		Correlations between change in log German overnight stays and changes in log weather				Correlations between change in domestic overnight stays and change in log weather			
		Correlation with change 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 Vienna	coef	-0.09	-0.03	0.08	0.00	0.06	0.06	0.17	0.13
	p	0.10	0.57	0.17	0.98	0.27	0.26	0.00	0.02
		Correlation with change 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
total except Vienna	coef	0.07	0.09	0.10	0.13	0.12	0.03	0.31	0.27
	p	0.23	0.11	0.09	0.03	0.04	0.63	0.00	0.00

Notes: Variables are measured as log change to the same month. P denotes the p-value. The time period is 1974-2012.

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.

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).

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

		change in the number of sunshine hours lagged one year				change 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 Vienna	coef	0.08	0.04	0.36	0.11	0.07	-0.03	0.25	0.10
	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.

Empirical results

Table 3 shows the estimates of the seemingly unrelated regression model of the relationship between temperatures and domestic overnight stays for the nine provinces estimated separately for four summer months (June, July, August and September). Table 4 shows the corresponding results for the relationship between sunshine hours and domestic overnight stays. Table 5 and Table 6 show the corresponding results for German overnight stays. The tables contain the coefficients together with the t-values, the R squared and the Breusch-Pagan Test of independence of the residuals (Breusch & 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 of the different provinces are correlated with each other when accounting for weather effects. Table A10 in

the Appendix shows that correlations of the residuals are largest between Tyrol and Carinthia and between Upper Austria and Carinthia (here for the example of domestic overnight stays for the month 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 (see Table A10 in Appendix). 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 the relationship between temperature and domestic overnight stays the R squared for six 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 left hand variable.

The results show that coefficients of sunshine hours and average temperatures for August and September in the same month are significant and positive at the one percent 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 one year are also not significant in most cases. In particular, we find that a change in temperature has 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 the change in temperatures are significantly related to domestic overnight stays in seven out of nine provinces. This indicates that sunnier and warmer August and September months lead to an increase in domestic visitor nights. 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 per cent (equivalent to an increase of almost 2°C) leads to an increase of 2.3 percent in domestic overnight stays in the same month. However, we find that 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. However, for Vienna we find that the change in

domestic visitor nights is 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) who use survey data for visitors to Hong Kong. The average coefficients for the eight non urban provinces are about 0.22 for August and 0.19 for September (unweighted).

Table 5 and 6 shows the corresponding results for German overnight stays. We find that changes in weather conditions in the same month or the previous month do have an impact on changes in German overnight stays in the same month. This stands in contrast to the results for domestic overnight stays. Again, the weather effects are larger for August than for the remaining summer months. Here, sunshine hours affect German overnight stays only with a one year lag. In particular, sunshine duration lagged one year (same month in the previous year) has a significant effect on German overnight stays in six out of nine provinces. The coefficients range between 0.07 and 0.13 indicating that an increase in sunshine duration of 10 percent in August leads to an increase in German overnight stays in the next year's August between 0.7 and 1.3 percent. This is consistent with the literature that weather affects foreign overnight stays only with a one year lag. Furthermore, the weather effects differ greatly across regions. Larger weather effects can be observed for lake destinations and generally for the lowlands (Carinthia, Lower Austria, Salzburg and Upper Austria). For mountains 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.

We have conducted several robustness checks. In addition to sunshine hours and temperatures we have also estimated the impact of precipitation. Unreported results show that precipitation is negative but not significant in most cases. This indicates that temperatures and sunshine hours are better predictors for domestic overnight stays. Furthermore, 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 and

weather conditions. However, unreported results show that the inclusion of the squared terms does not lead to an improvement of the adjusted R squared.

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			
dep. var. log change in domestic overnight stays between June and the same month in the previous year																										
D1.Intempm6	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		
D1.Intempm6	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		
D12.Intempm6	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-P.(p)	0.00			0.00			0.00		0.00		0.00			0.00		0.00			0.00			0.00				
dep. var. log change in domestic overnight stays between July and the same month in the previous year																										
D.Intempm7	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		
D1.Intempm7	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		
D12.Intempm7	-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-P.t.(p)	0.00			0.00			0.00		0.00			0.00			0.00		0.00			0.00			0.00			
dep. var. log change in domestic overnight stays between August and the same month in the previous year																										
D.Intempm8	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	
D1.Intempm8	-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	
D12.Intempm8	-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			
Breusch-P.t.(p)	0.00			0.00			0.00		0.00			0.00			0.00		0.00			0.00			0.00			
dep. var. log change in domestic overnight stays between September and the same month in the previous year																										
D.Intempm9	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
D1.Intempm9	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	
D12.Intempm9	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-P. t.(p)	0.00			0.00			0.00		0.00			0.00			0.00		0.00			0.00			0.00			

Notes: ***, ** and * denotes significance at the 1, 5 and 10 per cent significance levels.

Table 4: *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 change in domestic overnight stays between June and the same month in the previous year																										
D.Insunm6	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					
D1.Insunm6	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			
D12.Insunm6	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 t.(p)	0.00				0.00				0.00			0.00			0.00			0.00		0.00		0.00		0.00		
dep. var. log change in domestic overnight stays between July and the same month in the previous year																										
D.Insunm7	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			
D1.Insunm7	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		-0.67			
D12.Insunm7	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			0.10		0.11		0.05		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 t.(p)	0.00				0.00				0.00			0.00			0.00			0.00		0.00		0.00		0.00		
dep. var. log change in domestic overnight stays between August and the same month in the previous year																										
D.Insunm8	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		
D1.Insunm8	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						
D12.Insunm8	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		
Breusch-Pagan t.(p)	0.00				0.00				0.00			0.00			0.00			0.00		0.00		0.00		0.00		
dep. var. log change in domestic overnight stays between September and the same month in the previous year																										
D.Insunm9	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	
D1.Insunm9	-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				-1.31		
D12.Insunm9	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 t.(p)	0.00				0.00				0.00			0.00			0.00			0.00		0.00		0.00		0.00		

Notes: ***, ** and * denotes significance at the 1, 5 and 10 per cent significance levels.

Table 5: *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 change in German overnight stays between June and the same month in the previous year																			
D.Intempm6	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	
D1.Intempm6	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	
D12.Intempm6	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	
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-P.(p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		
dep. var. log change in German overnight stays between July and the same month in the previous year																			
D.Intempm7	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	
D1.Intempm7	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	
D12.Intempm7	-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	
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	
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-P.(p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		
dep. var. log change in German overnight stays between August and the same month in the previous year																			
D.Intempm8	-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	
D1.Intempm8	-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	
D12.Intempm8	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	**	
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	**
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-P.t.(p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		
dep. var. log change in German overnight stays between September and the same month in the previous year																			
D.Intempm9	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	**
D1.Intempm9	-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	**
D12.Intempm9	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
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-P. t.(p)	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		

Notes: ***, ** and * denotes significance at the 1, 5 and 10 per cent significance levels.

Table 6: *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 change in German overnight stays between June and the same month in the previous year																		
D.Insunm6	-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
D1.Insunm6	-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	*
D12.Insunm6	-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
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 change in German overnight stays between July and the same month in the previous year																		
D.Insunm7	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	0.20	-0.01
D1.Insunm7	-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
D12.Insunm7	-0.12	*	-1.70	0.09	1.20	0.00	0.06	0.11	**	4.56	0.09	**	2.88	0.08	**	2.96	-0.03	-0.58
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
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 change in German overnight stays between August and the same month in the previous year																		
D.Insunm8	-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
D1.Insunm8	-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
D12.Insunm8	0.12	**	1.97	0.14	**	2.99	0.16	**	2.20	0.13	**	3.64	0.05	1.17	0.07	**	2.13	**
Constant	-0.02	**	-2.01	-0.04	**	-3.01	-0.02	*	-1.75	-0.04	**	-4.05	-0.03	*	-1.84	-0.02	*	-1.81
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 change in German overnight stays between September and the same month in the previous year																		
D.Insunm9	-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
D1.Insunm9	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	**
D12.Insunm9	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
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
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	

Notes: ***, ** and * denotes significance at the 1, 5 and 10 per cent significance levels.

Conclusions

The main contribution of this article is to provide new empirical estimates of the relationship between weather conditions and foreign and domestic overnight stays in Austria at the level of provinces for the period 1974-2012. The main novelty of the study is that we have distinguished between rural and urban destinations in studying the relationship between weather and overnight stays. The empirical model is based on a seemingly unrelated regression model where overnight stays are measured as percentage change to the same month in the previous year. The results show a statistically significant relationship between the change in weather conditions (sunshine duration and temperatures) and change in domestic overnight stays in the same months for August and September for most of the provinces. The relationships are significant for most Austrian regions except for the largest urban destination, Vienna. On average, an increase in temperatures in August of 1°C (from 18°C 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 percent 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 one year lag.

In general, weather effects are larger in August and September than in June and 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 early 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 in low land destinations (Burgenland and Lower Austria). Here, current and lagged sunshine hours or temperature can explain between 23 and 47 percent of the variation of domestic and German overnight stays. In contrast, weather conditions are less relevant for tourism in mountainous regions such as Tyrol where tourists expect changeable weather conditions. Furthermore, weather conditions are not relevant in determining visitor nights in the capital region of Vienna.

The estimates suggest 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. Overall, one can conclude that such estimates are useful in predicting future tourism demand. This mainly holds true for domestic overnight stays and to a lesser extent for foreign overnight stays.

The paper has some limitations. First, this paper investigated the impact of average monthly temperatures, precipitation and sunshine hours for the summer months June to September on overnights stays. By using monthly data, extreme weather events within a given month such as heat waves or thunderstorms were not taken into account. Second, the analysis is based on NUTS 2 level which is a quite high level of regional aggregation. Future work should employ municipality or district data to analyze the relationships.

Literature

- Agnew, M.D., & Palutikof, J. (2006). Impacts of short-term climate variability in the UK on demand for domestic and international tourism, *Climate Research*, 31, 109–120.
- Álvarez-Díaz, M., & Rosselló-Nadal, J. (2010). Forecasting British tourist arrivals in the Balearic Islands using meteorological variables, *Tourism Economics*, 16(1), 153–168.
- Ashworth, G., & Page, S. (2011). Urban Tourism Research: Recent Progress and Current Paradoxes, *Tourism Management*, 32(1), 1–15.
- Auer, I., Böhm R., Jurkovic A., Lipa W., Orlik A., Potzmann R., Schöner W., Ungersböck M., Matulla C., Briffa K., Jones P., Efthymiadis D., Brunetti M., Nanni T., Maugeri M., Mercalli L., Mestre O., Moisselin J.M., Begert M., Muller-Westermeier G., Kveton V., Bochnicek O., Stastny P., Lapin M., Szalai S., Szentimrey T., Cegnar T., Dolinar M., Gajic-Capka M., Zaninovic K., Majstorovic Z., & Nieplová E. (2007). HISTALP – historical instrumental climatological surface time series of the Greater Alpine Region. *International Journal of Climatology*, 27, 17–46, DOI: 10.1002/joc.1377.
- Becken, S. (2013a). A review of tourism and climate change as an evolving knowledge domain, *Tourism Management Perspectives*, 6, 53–62.
- Becken, S. (2013b). Measuring the Effect of Weather on Tourism: A Destination- and Activity-Based Analysis, *Journal of Travel Research* 52(2) 156–167.
- Becken, S., & Wilson, J. (2013). The impacts of weather on tourist travel, *Tourism Geographies*, in press.
- De Freitas, C. R. (2003). Tourism climatology: evaluating environmental information for decision making and business planning in the recreation and tourism sector. *International Journal of Biometeorology*, 48, 45–54.
- Denstadli, J.M., Jacobsen J.K., & Lohmann, M. (2011). Tourist perceptions of summer weather in Scandinavia, *Annals of Tourism Research*, 38(3), 920–940.
- Falk, M. (2013). Impact of Long-Term Weather on Domestic and Foreign Winter Tourism Demand. *International Journal of Tourism Research*, 15(1), 1–17.
- Falk, M. (2014). Impact of Weather Conditions on Tourism Demand in the Peak Summer Season over the Last 50 Years, *Tourism Management perspectives*, 9, 24–35.
- Finger R., & Lehmann, N. (2012). Modeling the sensitivity of outdoor recreation activities to climate change. *Climate Research*, 51, 229–236.
- Giles, A. R., & Perry, A. H. (1998). The use temporal analogue to investigate the possible impact of projected global warming on the UK tourism industry. *Tourism Management*, 19(1) 75–80.
- Gómez Martín, M. B. (2005). Weather, Climate and Tourism: A Geographical Perspective. *Annals of Tourism Research*, 32 (3), 571–91.
- Gössling, S., & Hall, C. M. (2006). Uncertainties in Predicting Tourist Flows under Scenarios of Climate Change. *Climatic Change*, 79 (3–4), 163–173.
- Gössling, S., Scott, D., Hall, C. M., Ceron, J., & Dubois, G. (2012). Consumer behaviour and demand response of tourists to climate change. *Annals of Tourism Research*, 39, 36–58.
- Jørgensen, F., & Solvoll, G. (1996). Demand models for inclusive tour charter: The Norwegian case, *Tourism Management*, 17(1), 17–24.
- Kaján, E., & Saarinen, J. (2013). Tourism, climate change and adaptation: a review. *Current Issues in Tourism*, 16, 2, 167–195.
- Kulendran, N., & Dwyer, L. (2012). Modeling seasonal variation in tourism flows with climate variables, *Tourism analysis: an interdisciplinary journal*, 17(2) 121–137.
- McKercher, B., Shoval, N., Park, E., & Kahani, A. (2014). The [limited] impact of weather on tourist behavior in an urban destination. *Journal of Travel Research*, 0047287514522880.
- Otero-Giráldez, M. S., 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). *Tourism Management*, 33(2), 1301–1308.
- Pang, F. H., McKercher, B., & Prideaux, B. (2013). Climate change and tourism: An overview. *Asia Pacific Journal of Tourism Research*, 18(1–2), 4–20.
- Perry, A. (1972). Weather, Climate and Tourism. *Weather*, 27, 199–203.
- Richardson, R.B. & Loomis, J. B. (2005). Climate Change and Recreation Benefits in an Alpine National Park. *Journal of Leisure Research*, 37(3), 307–320.
- Ridderstaat, J., Oduber, M., Croes, R., Nijkamp, P., & Martens, P. (2014). Impacts of seasonal patterns of climate on recurrent fluctuations in tourism demand: Evidence from Aruba. *Tourism Management*, 41, 245–256.

- Rosselló-Nadal, J., Riera-Font A., & Cardenas, V. (2011). The Impact of Weather Variability on British Outbound Flows. *Climatic Change*, 105, 281–292.
- Rosselló-Nadal, J. (2014). How to evaluate the effects of climate change on tourism, *Tourism Management*, 42, 334–340, <http://dx.doi.org/10.1016/j.tourman.2013.11.006>.
- Scott, D., & Jones, B. (2006). The Impact of Climate Change on Golf Participation in the Greater Toronto Area (GTA): A Case Study. *Journal of Leisure Research*, 38(3), 363–380.
- 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. *Tourism Management*, 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. *Climatic Change*, 108, 291–300.
- Smeral, E. (2014), Forecasting City Tourism, *Tourism Analysis*, forthcoming.
- 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.
- Steiger, R. (2011). The impact of snow scarcity on ski tourism. An analysis of the record warm season 2006/07 in Tyrol (Austria). *Tourism Review*, 66, 4e13.
- Taylor, T., & Ortiz, R. (2009). Impacts of climate change on domestic tourism in the UK: a panel data estimation. *Tourism Economics*, 15(4), 803–812.
- Zellner, A. (1962). An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias. *J. American Statist. Assoc.* 57, 348–68.

Appendix

Table A7: 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
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 A8: Descriptive statistics for weather indicators, 1974-2012 (percentage change)

	monthly precipitation in mm				total monthly sunshine hours			
	mean	st. Dev	min	max	mean	st. Dev	min	max
Juni	-0.1	57.0	-129.1	115.9	0.7	22.3	-41.5	52.6
July	1.1	63.7	-169.7	149.8	0.0	22.1	-40.5	45.7
August	1.0	67.2	-156.6	141.1	0.5	23.0	-41.3	48.2
September	1.2	78.7	-162.0	173.5	0.2	36.6	-74.7	89.7
monthly average temperatures in Celsiusus								
Juni	0.7	9.5	-24.2	19.2				
July	0.0	0.0	0.0	0.0				
August	-0.1	57.0	-129.1	115.9				
September	1.1	63.7	-169.7	149.8				

Source: Histapls. Auer et al. 2007.

Figure A1: Scatter plot of the relationship between change in sunshine and temperatures and change in domestic overnight stays

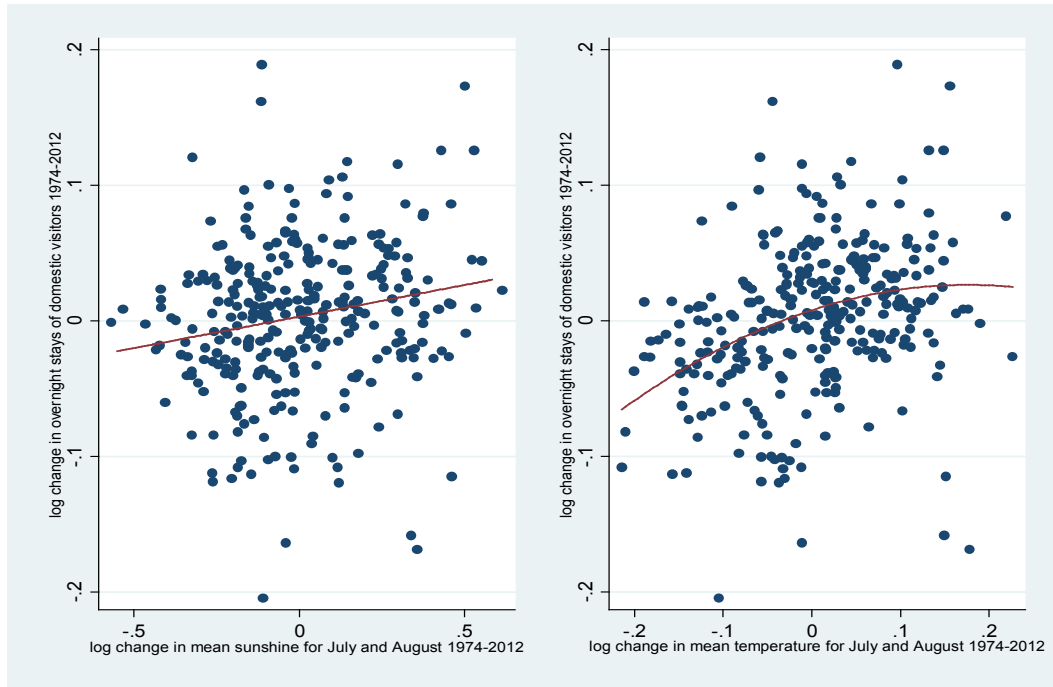
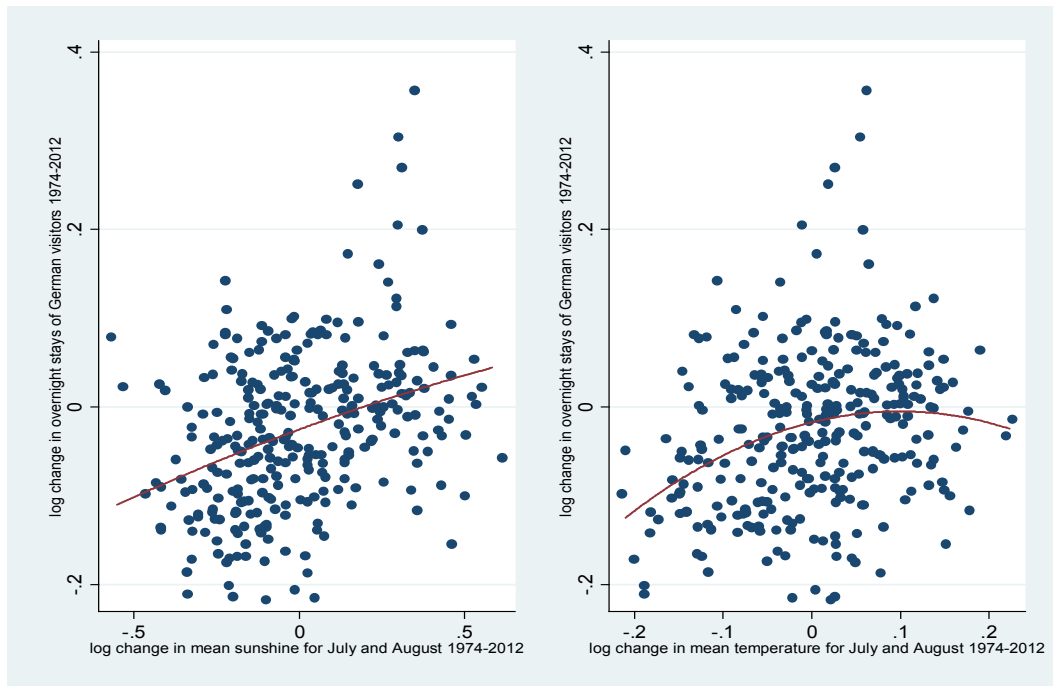


Figure A2: Scatter plot of the relationship between change in sunshine and temperatures and change in German overnight stays



Source: Histałps, Statistics Austria, own calculations.

Table A9: Correlation between change in domestic and German overnight stays and changes in precipitation

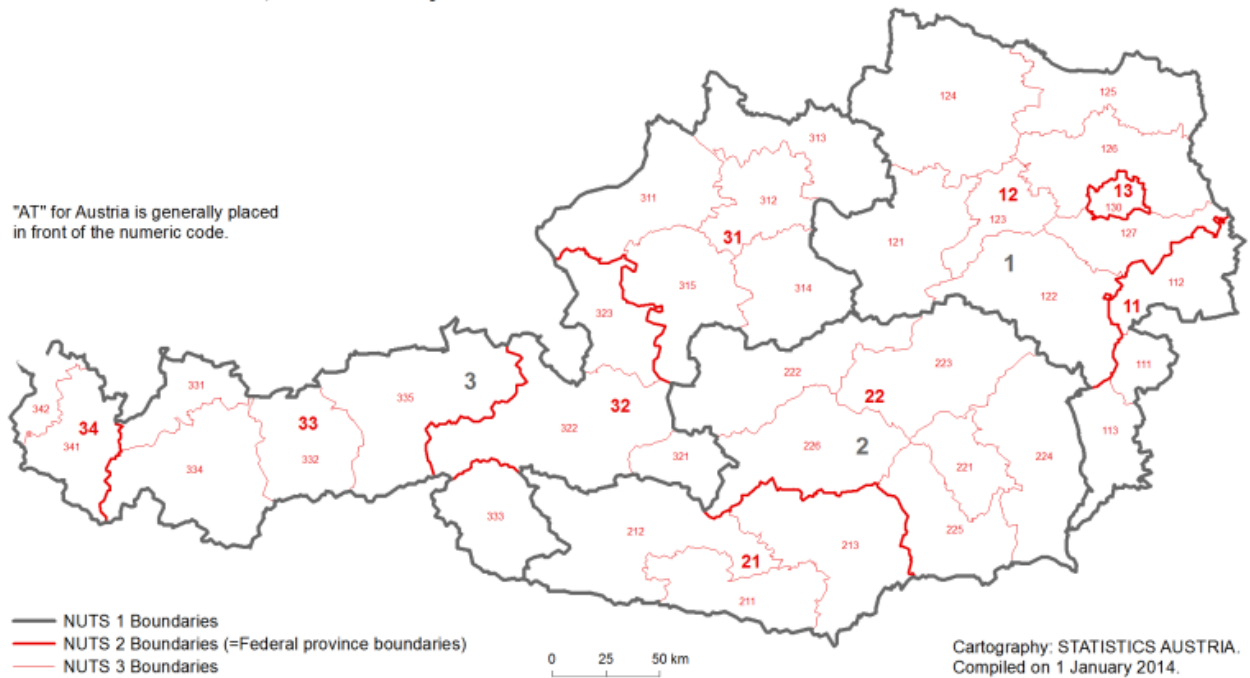
		Correlations between change in log German overnight stays and				Correlations between change in domestic overnight stays and			
		change in log precipitation in the same month in the current year							
		June	July	August	September	June	July	August	September
Burgenland	coef	0.12	0.03	0.18	0.06	-0.13	-0.06	-0.49	-0.28
	p	0.47	0.86	0.28	0.72	0.45	0.73	0.00	0.09
Carinthia	coef	0.06	0.03	0.14	0.04	-0.11	-0.06	0.04	0.02
	p	0.71	0.87	0.41	0.83	0.53	0.74	0.81	0.89
Lower Austria	coef	0.04	-0.17	-0.14	0.13	0.18	0.02	-0.16	-0.15
	p	0.80	0.31	0.41	0.44	0.29	0.90	0.34	0.37
Upper Austria	coef	0.02	0.07	-0.25	0.10	-0.07	-0.32	-0.43	-0.21
	p	0.92	0.70	0.14	0.57	0.68	0.05	0.01	0.20
Salzburg	coef	0.20	-0.13	-0.06	-0.08	-0.29	-0.23	-0.38	-0.15
	p	0.22	0.43	0.74	0.65	0.08	0.16	0.02	0.38
Styria	coef	-0.10	0.23	0.17	0.06	-0.05	0.00	0.14	-0.23
	p	0.57	0.16	0.31	0.73	0.79	0.99	0.42	0.16
Tyrol	coef	0.00	0.15	-0.33	0.24	0.18	-0.10	-0.01	0.15
	p	0.99	0.37	0.04	0.15	0.28	0.53	0.94	0.38
Vorarlberg	coef	-0.04	0.01	-0.20	0.05	0.24	-0.06	-0.13	0.30
	p	0.79	0.95	0.23	0.79	0.14	0.70	0.42	0.06
Vienna	coef	0.04	-0.04	-0.24	-0.09	-0.21	-0.23	0.05	-0.09
	p	0.80	0.81	0.15	0.58	0.21	0.17	0.75	0.61
total except Vienna	coef	0.05	0.02	-0.04	0.07	0.00	-0.07	-0.22	-0.04
	p	0.40	0.71	0.49	0.21	0.99	0.20	0.00	0.48
		Correlations between change in log German overnight stays and							
		change in log precipitation in the same month last year							
		June	July	August	September				
Burgenland	coef	-0.16	0.24	-0.34	-0.12				
	p	0.34	0.15	0.04	0.46				
Carinthia	coef	-0.35	0.06	-0.16	-0.06				
	p	0.03	0.71	0.33	0.70				
Lower Austria	coef	0.04	0.25	-0.17	0.11				
	p	0.81	0.13	0.30	0.50				
Upper Austria	coef	-0.36	-0.17	-0.03	-0.25				
	p	0.03	0.31	0.84	0.12				
Salzburg	coef	-0.36	-0.04	-0.09	-0.11				
	p	0.03	0.80	0.57	0.51				
Styria	coef	-0.01	-0.12	-0.20	0.14				
	p	0.97	0.48	0.22	0.39				
Tyrol	coef	-0.02	-0.02	0.08	-0.19				
	p	0.91	0.93	0.65	0.25				
Vorarlberg	coef	-0.25	0.16	-0.08	-0.14				
	p	0.14	0.33	0.64	0.40				
Vienna	coef	-0.01	0.10	0.02	0.08				
	p	0.97	0.55	0.90	0.65				
total except Vienna	coef	-0.16	0.08	-0.14	-0.08				
	p	0.00	0.18	0.02	0.15				

Table A10: 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

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

Figure A3: Scatter plot of the relationship between change in sunshine and temperatures and
NUTS 3 units in Austria, as of 1 January 2014



Notes: Statistics Austria.

AT11 Burgenland

AT12 Lower Austria (Niederösterreich)

AT13 Vienna (Wien)

AT21 Carinthia (Kärnten)

AT22 Styria (Steiermark)

AT31 Upper Austria (Oberösterreich)

AT32 Salzburg

AT33 Tyrol (Tirol)

AT34 Vorarlberg