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Weather uncertainty effect on tourism demand

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Abstract
Despite the existence of several weather studies in the tourism literature, there remain some gaps in knowledge. Uncertainty about weather conditions persists despite the impressive improvements in modern forecasting techniques. This study is a first attempt to investigate how weather uncertainty affects tourism demand. The findings indicate that the impact of weather on tourism demand is likely to grow with the increasingly "uncertain" nature of weather with regard, for example, to temperature and rain.

Keywords
tourism demand, Taiwan, weather uncertainty

Introduction

Travel activities are the critical link between travel motivation and destination choices (Moscardo et al., 1996). Mehmetoglu (2011) points out that tourism motivation is a prerequisite in understanding tourist behaviors. In the tourism literature, travel motivation is generally studied under the framework of push and pull factors (Mehmetoglu, 2011; Mohammad and Som, 2010; Yuan and McDonald, 1990). This approach argues that tourist destination choices can be pushed by the internal forces of sociopsychological factors or pulled by the external factors of destination attributes. Climate and weather can be treated as one of the destination attributes (Becken and Wilson, 2013; Hu and Ritchie,

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1993). On the one hand, good weather serves as a pull factor that attracts tourists to destinations with favorable weather conditions. On the other hand, poor weather can serve as a push factor which drives tourists away from certain tourist locations (Agnew and Palutikof, 2006; Lise and Tol, 2002). Overall, climate and weather are expected to have a significant impact on travel demand.[1]

Existing studies on factors that influence tourism demand have frequently investigated the effects of economic variables (Crouch, 1994; Lim et al., 2008; Witt and Witt, 1995). Relatively little attention has been paid to how climate or weather factors affect tourism demand. Pike (2002) finds that only 1 out of 142 destination image papers is related to weather after reviewing literature from 1973 to 2000. The situation is changing now and the interest in the climate impact of tourism has increased remarkably over the last decade (Becken and Wilson, 2013). Most empirical studies have shown the effect of climate changes on tourism demand using data from Western countries with continental climate such as Germany, the United Kingdom and Canada (Agnew and Palutikof, 2006; Lohmann and Kaim, 1999; Mcboyle and Wall, 1987; Scott and Lemieux, 2009; Taylor and Ortiz, 2009). Little evidence is provided which uses data from noncontinental climate regions. An exception is the study by Chen and Lin (2014), which also uses data of Taiwan. However, there is a major difference between the current study and the study conducted by Chen and Lin (2014). Chen and Lin (2014) focus on the influence of different weather factors (and their moderating effects) on the Taiwanese hotel industry, while the current study focuses on investigating how the degree of uncertainty of different weather factors influences the tourism demand in Taiwan.

Uncertainty over weather conditions still exists even though the forecasting techniques have improved substantially over the past centuries (National Research Council, 2006). Taylor and Ortiz (2009) pointed out that tourism decisions may be determined by expected weather conditions. It seems reasonable to assume that the impact of weather on tourism demand is likely to increase with the increasing "uncertain" nature of weather. To account for the possibility of uncertainty, the main purpose of this article is to empirically investigate the influence of weather uncertainty on tourism demand. We hypothesize that risk-averse tourists tend to cancel their journey due to the lack of certainty and limited knowledge about weather conditions. Therefore, weather uncertainty is expected to exhibit a negative impact on tourism demand. Past research mostly focused on how certain weather factors, such as the number of rainy days, the number of bright sunshine hours, and so on, affect tourism demand. Little attention is paid on how the magnitudes of fluctuations of those weather factors, that is, the degree of weather uncertainty, impact tourism demand or affect tourist decisions. To the best of the authors' knowledge, this study represents a first attempt in understanding how weather uncertainty affects tourism demand.

The contribution of this study is thus two-fold. First, this study examines the relationship between weather uncertainty and tourism demand by explicitly defining weather uncertainty as the difference between the predicted value of a particular weather factor and its realized value. While past research on the relationship between certain weather factors and tourism demand is abundant, little is said about how uncertainties of those weather factors are related to tourism demand. As mentioned earlier, uncertainty over weather conditions still exists despite the improvement in forecasting techniques. By defining weather uncertainty explicitly, this study provides a perspective on how the unpredictability of weather factors influence tourism demand that has often been ignored by past empirical tourism research. Second, this study uses tourist data from Taiwan, which is located in the East Asia Pacific Rim and has a humid subtropical climate. In July and August, Taiwan gets abundant rainfalls with thundershowers in the afternoons. This type of weather is pretty different from that of a continental weather pattern. Thus, the empirical evidence of this study can provide useful insights to hoteliers or tourism promoting authorities in regions with similar weather patterns as those of Taiwan.

Methodology

The data were obtained from *Visitors to the Principle Scenic Spots in Taiwan* published by Taiwan Tourism Bureau. The average number of tourists in the principle scenic spots in Taiwan is 27 million per year, with peaks in February (winter vacation and Chinese New Year) and July–August (summer vacation). Tourism demand in this study is measured by the monthly number of visitors during the summer vacation (July and August) from 2004 to 2011. The monthly report lists the number of visitors to 280 scenic spots in Taiwan such as museums, zoos, national parks, beach resorts, forest recreation areas, and historical sites.[2]

Given that people often formulate their expected weather according to weather conditions observed in the past, the first stage employs a first-order autoregressive process (Taylor and Ortiz, 2009), AR (1), to model weather uncertainty.

$$WEA_{ijt} = \alpha_0 + \alpha_1 WEA_{ijt-1} + \mu_{ijt}, \quad i = 1, \ldots, 280, \; j = 1, \ldots, 4, \tag{1}$$

WEA denotes the *j*th weather factor of the *i*th principle scenic area in month *t*. The weather indicators include (1) temperature (*Temp*), (2) humidity (*Wet*), (3) rainy days (*Rain*), and (4) sunshine hours (*Sun*). This study assumes that tourists predict weather conditions in month *t* using information from the same month in the previous year (i.e. $t - 1$). For example, tourists formulate their expectations of July (August) weather in a particular year by observing the July (August) weather in the previous year.

The predicted value from equation (1) is denoted by $\hat{WEA}$. The absolute value of the difference between the actual weather condition and the forecasted weather condition represents weather uncertainty (i.e. $UWEA = |WEA - \hat{WEA}|$). All weather data were obtained from the Central Weather Bureau of Taiwan. *Temp* is the monthly average temperature (unit: °C), while temperature uncertainty is denoted by *UTemp*. *Wet* is the level of relative humidity (unit: %), while humidity uncertainty is denoted by *UWet*. *Rain* is the number of rainy days each month, while rain uncertainty is denoted by *URain*. *Sun* is the average number of hours of bright sunshine each month, while sunshine uncertainty is denoted by *USun*.

The regression model of tourism demand is formulated in the second stage as follows:

$$TOURIST_{iT} = \beta_0 + \sum_{j=1}^{4} \beta_{1j} WEA_{ijT} + \sum_{j=1}^{4} \beta_{2j} UWEA_{ijT} + \beta_3 ARR_T + \beta_4 Policy_T + u_{iT}, \tag{2}$$

where *TOURIST* denotes the number of visitors in the *i*th principle scenic spot in period *T*; *ARR* is the number of monthly leisure visitors and is used for controlling the influence of international tourism demand. *Policy* is a time dummy used for controlling the policy effect of opening up the Taiwan tourism market to Mainland Chinese tourists. Equation (2) can be estimated by pooled ordinary least squares (OLS), random effects, or fixed effects panel regression models.

Results

Table 1 reports the descriptive statistics of the variables used in the empirical analysis. The mean value of *Temp* in Taiwan summers is a slightly discomfort 27.54°C. The mean value of *Rain* is 12.56, indicating that Taiwan gets abundant rainfalls.

Table 2 shows the estimations of tourism demand from the linear static model. Before discussing whether the weather factors influence tourism demand, the fitness of the empirical specification is examined first. The Breusch and Pagan Lagrange multiplier test yields a χ^2 statistic of

Table 1. Variables, mean, and standard deviations.

Variable	Definition	Mean	Standard deviation
Tourist	Number of monthly tourists in the principle scenic spots	51,976.13	89,028.22
Temp	Monthly average temperature (unit: °C)	27.54	3.83
Rain	Number of rainy days per month	12.56	4.82
Wet	Level of relative humidity (unit: %)	78.35	5.47
Sun	Average number of hours of bright sunshine per month	203.03	46.91
ARR	Number of monthly inbound visitors to Taiwan	159,863.63	64,560.55
Policy	Policy of opening up Taiwan tourism market to Mainland Chinese tourists (dummy variable)	–	–

Table 2. Estimations of uncertain weather on tourism demand.

	Pooled data		Panel data			
	OLS		Random effects		Fixed effects	
Variable	Coefficient	*t* statistics	Coefficient	*t* statistics	Coefficient	*t* statistics
Temp	1274.23	2.07**	958.39	0.84	−4117.69	−0.96
Wet	−3329.67	−7.58***	−591.87	−1.3	160.19	0.32
Rain	−446.86	−0.71	−568.44	−1.42	−829.02	−1.99**
Sun	−358.40	−4.33***	−48.12	−0.83	16.35	0.27
UTemp	−7527.20	−1.16	−6789.43	−1.89*	−7342.78	−2.01**
UWet	−146.59	−0.17	−242.48	−0.49	−412.96	−0.83
URain	−1112.03	−1.13	−1459.21	−2.77***	−1520.02	−2.89***
USun	−158.67	−1.39	−23.20	−0.33	−44.52	−0.58
Policy	11,590.55	1.92	1692.22	0.49	1169.99	0.32
ARR	0.0031	0.07*	0.0610	2.33**	0.0753	2.85***
Constant	357,247.40	6.97***	83,526.67	1.51	154,610.20	1.18
LM test (*p*-value)	2878.34 (0.00)					
Hausman test (*p*-value)	23.57 (0.01)					

Note: OLS: ordinary least squares; LM: Lagrange multiplier.
*Significant at 10% confidence level.
**Significant at 5% confidence level.
***Significant at 1% confidence level.

2878.34. This significant value rejects the null hypothesis of a pooled OLS. The Hausman test was further conducted to yield a χ^2 statistic of 23.57, suggesting that a fixed effects model is more appropriate than a random effects model.

The main finding is that weather seems to have a significant impact on the tourism demand in Taiwan. The coefficient of *Rain* is negative and statistically significant at the 5% level. An increase in the number of rainy days lead to a decrease in the number of tourists. As expected, *UTemp* and *URain* are negatively associated with tourism demand. Visitors may cancel or delay their travel plans due to uncertainty over temperature and rain. For the coefficients of *ARR*, the empirical results imply that international tourism demand increases the tourism demand in Taiwan.

Conclusion

Existing studies have shown a significant influence of climate or weather on tourist activities. However, uncertainty is a fundamental characteristic of weather. The impact of weather on tourism demand is likely to increase with the increasing uncertainty nature of weather. Using data from the Taiwanese tourism industry, this study defines weather uncertainty explicitly and examines its relationship with tourism demand. The results of this study show that temperature uncertainty and rain uncertainty are negatively associated with tourism demand and the number of rainy days decreases tourism activities. Effective communication of weather uncertainty improves individuals' ability to make tourism decisions. Tourists' behaviors adjust to changing weather conditions as bad weather conditions negatively impact tourists' satisfactions. The findings of this study show that the degrees of uncertainty in the temperature and the number of rainy days have the greatest impact on tourism demand in Taiwan. Moreover, the weather factor rain plays an important role in determining people's decisions to visit different scenic spots. The results of this study provide useful reference for hoteliers, restaurant owners, and tourism promoting authorities by identifying the most important weather uncertainty factors that affect tourists' decisions in Taiwan. One plausible managerial suggestion is for the hoteliers or restaurant owners to make necessary adjustments in advance to prepare for the unexpected cancellations of room or seat bookings due to the unexpected changes in weather conditions. The findings of this study also provide useful reference to different managing directors or institutions located in countries with similar weather patterns as those of Taiwan.

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Notes

1. The difference between climate and weather is the measure of time. Climate is the conditions of the atmosphere that are measured as a long-term average, while weather is the manifestation of climate over a short period of time (Becken, 2010; Chen and Lin, 2014; Matzarakis, 2006). The current study focuses on the effect of weather rather than climate as it is weather rather than climate that is experienced by tourists.
2. The Taiwan Tourism Bureau uses a variety of methods to estimate the number of visitors who visit the principle scenic spots in Taiwan. These methods include, for example, counting the number of tickets bought at a particular scenic spot, the number of cars parked in a parking lot, the number of visitors at a tourist's information center, the number of people who have applied for entering permits to certain mountain areas, the number of people who made appointments for tour guide, and so on. Although the monthly report *Visitors to the Principle Scenic Spots in Taiwan* conducted by the Taiwan Tourism Bureau does not explicitly separate visitors from local residents, it is reasonable to assume that most of the visitors included in this report are nonlocal residents, given the data collection method used by the Taiwan Tourism Bureau. Unfortunately, the report does not allow the authors to separate day visitors from tourists who stay

at a particular scenic spot for more than one night. Future research could try to differentiate the effect of weather uncertainty on day visitors and overnight tourists when more detailed data become available.

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