Measuring the Impact of Weather Variability on Golfing Activity in Michigan

By Sarah Nicholls, Jeonghee Noh and Donald F. Holecek

Introduction

Climate variability and change were recently recognized by the US National Research Council as one of eight "grand challenges" in the environmental sciences (Committee on Grand Challenges in Environmental Sciences, 2001). According to the Council, the need for improved assessment of the impacts of climate variability and change on human and natural systems is especially important. The modern outdoor recreation and tourism (ORT) system is likely to be substantially impacted by projected climate change, due both to changes in the preferred climatic conditions for ORT activities, and to the distribution and quality of the natural resource base upon which ORT relies. Climate change projections therefore suggest the need for the tourism industry to more carefully consider the implications of this phenomenon for the planning of new enterprises, as well as the adaptation of existing ones (Hall & Higham, 2005).

However, as noted by de Freitas (2005), consideration of the potential impacts of climate change on ORT activity is impossible without first understanding present-day relationships between weather and ORT, relationships which are currently based far more on assumption and anecdotal evidence than empirical data. Thus, this paper focuses on the development of models that explore the association between participation in ORT activity (specifically, golf), weather conditions, and other important influences on participation such as economic factors and time. Such research directly addresses de Freitas's call for the development of "a coherent set of research methods and models … that might bridge observations with theory and help build a coherent basis for understanding, explanation and prediction" (de Freitas, 2005, p. 42).

The authors were able to identify only three studies that have modeled the relationships between golfing activity and weather conditions (Loomis & Crespi, 1999; Mendelsohn & Markowski, 1999; Scott & Jones, 2005). However, all three papers contain methodological deficiencies that minimize the utility of their results, due primarily to their inability to capture the fluctuations in golf participation that occur as a result of fine-scale spatial and temporal variations in weather conditions.

Purpose

The purpose of the research presented here was to determine the influence of weather variations on the daily number of golf rounds sold at a golf course in south-west Michigan (Figure 1). These analyses for a single course represent the first known attempt to model daily golf activity and, thus, a substantial improvement on the limited amount of existing research.

Methods

The daily number of golf rounds sold was obtained for an eleven-year period, 1994-2004. The independent variables available for inclusion in the regression models were: daily minimum and maximum temperatures (in °F); daily precipitation (in inches); average daily heat index and wind speed; general economic conditions (based on the monthly Consumer Confidence Index published by The Conference Board); average weekly gas prices (as per the American Automobile Association); time of week (weekday or weekend); public holidays; and, year (to account for time series issues). However, consideration of multicollinearity between the variables led to the dropping of heat index and wind speed from the variable pool. Weather data were acquired from the recording station closest to the golf course (Figure 1). Separate regressions were run for the peak (May to September) and off-peak seasons, and experimentation with various forms indicated that a linear model produced the most useful output.

Findings

Table 1 illustrates results of the regression analyses for the peak season data, while Table 2 focuses on non-peak months. The meaning of each of the coefficients derived is described in the 'Interpretation' column of each table. Model performance was slightly better for the off-peak season ($R^2 = 0.279$, compared to 0.243 for peak months). The variable representing economic conditions was dropped from the final models due to its consistent lack of statistical significance.

As Table 1 shows, the number of rounds sold per day in the peak season did vary significantly with the weather, temporal and price variables entered into the model. As expected, an increase in maximum temperature was associated with an increase in rounds sold, though an increase in minimum temperature produced a decline in activity. Precipitation also had a marked negative impact on activity. While weekends were associated with an increase in rounds sold, holidays saw a decrease. A negative time trend was also identified. Results for the off-peak season (Table 2) showed a similar pattern in the directions and magnitudes of the coefficients, the only important variation being the non-significance of minimum temperature.

Table 1. Results of Regression Analysis for Peak Season (May-September), 1994-2004

Independent Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Interpretation
	B	Std. Error	Beta			
(Constant)	32625.99	3361.43		9.70	0.00	
Maximum Temperature (°F)	5.817	0.701	0.28	8.30	0.00	For every one degree increase in the daily maximum temperature during the peak season, approximately six more rounds of golf will be sold that day. Conversely, for every one degree decrease, approximately six fewer rounds will be sold.
Minimum Temperature (°F)	-1.362	0.688	-0.07	-1.98	0.04	For every one degree increase in the daily minimum temperature during the peak season, approximately one less round of golf will be sold that day. Conversely, for every one degree decrease, approximately one more round will be sold.
Precipitation (inches)	-92.267	13.379	-0.15	-6.90	0.00	Each inch of precipitation during the peak season is likely to result in a reduction of approximately 92 rounds of golf sold that day.
Holiday	-116.086	18.256	-0.13	-6.27	0.00	On holidays and holiday weekends (Memorial Day, Independence Day and Labor Day), the number of rounds sold declines by approximately 116 rounds relative to non-holidays.
Weekend (Sat-Sun)	132.652	9.165	0.31	14.47	0.00	On a Saturday or Sunday during the peak season, approximately 133 more rounds of golf are sold than on weekdays.
Gas Price ($)	139.267	44.010	0.09	3.16	0.00	For every one cent increase in weekly average state-wide gas price during the peak season we can expect to sell one or two more rounds of golf per day (equivalent to 139 more rounds per dollar increase).
Year	-16.283	1.695	-0.27	-9.60	0.00	Between 1994 and 2004, the number of rounds of golf sold per annum declined by approximately 16 rounds per day during the peak season.

* Dependent variable = golf rounds sold per day; $R^2 = 0.243$

Table 2. Results of Regression Analysis for Non-Peak Season (April, October-November), 1994-2004

Independent Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Interpretation
	B	Std. Error	Beta			
(Constant)	10026.04	2634.28		3.81	0.00	
Maximum Temperature (°F)	5.40	.38	.52	14.35	0.00	For every one degree increase in the daily maximum temperature during the non-peak season, approximately five more rounds of golf will be sold that day. Conversely, for every one degree decrease, approximately five fewer rounds will be sold.
Minimum Temperature (°F)	-.47	.47	-.04	-1.00	0.31	In the non-peak season, minimum temperature has an insignificant impact on the number of golf rounds sold per day.
Precipitation (inches)	-27.12	13.73	-.05	-1.97	0.04	Each inch of precipitation during the non-peak season is likely to result in a reduction of approximately 27 rounds of golf sold that day.
Holiday	46.25	7.03	.16	6.58	0.00	On holidays and holiday weekends during the non-peak season (Easter and Thanksgiving), the number of rounds sold increases by approximately 46 rounds relative to non-holidays.
Weekend (Sat-Sun)	99.01	35.36	.09	2.80	0.00	For every one cent increase in weekly average state-wide gas price during the non-peak season we can expect to sell approximately one more round of golf per day (equivalent to 99 more rounds per dollar increase).
Gas Price ($)	-5.16	1.33	-.13	-3.89	0.00	Between 1994 and 2004, the number of rounds of golf sold per annum declined by approximately 5 rounds per day during the non-peak season.

* Dependent variable = golf rounds sold per day; $R^2 = 0.279$

Application of Results

While the results presented above may at first glance suggest several unexpected relationships, further description of this particular course may explain some of these anomalies. For example, the negative nature of the holiday variable may be explained by the course's location in the southern portion of the state, since it is extremely common for residents of this region to head north on holiday weekends. The positive sign on the gas price variable, in contrast, may represent increased local patronage of the course as gas prices rise, rather than traveling to a course further afield. The negative coefficient on the year variable is probably indicative of the rising number of courses, and, hence, increased competition, during the time period analyzed .

More detailed examination of the differences between the two models constructed – for the peak and off-peak seasons – reveals an interesting difference in the relative importance of the variables. Specifically, while the weekend variable was the most significant factor in the peak season, followed by maximum temperature, in the off-peak season maximum temperature was the most dominant. Such a finding is intuitive: maximum temperature is likely to be relatively less influential during the peak season simply because during the summer months the temperature is typically always comfortable enough to play. During off-peak months it may fluctuate much more substantially, however, having a greater influence on rounds sold.

Though a number of statistically significant variables were identified in the models, the R-squares obtained suggest a large proportion of the variance remained unexplained. In our opinion, this unexplained variation is the result of interaction between multiple, more minor factors, rather than the omission of any one, highly significant, influence. It is also important to acknowledge the reality that even daily weather data may not be of a fine enough resolution to detect all relationships between weather conditions and golf rounds sold. For example, the precipitation variable only allows identification of the impact of every inch of rain on a daily basis, it does not differentiate between the effects of a short downpour and a prolonged drizzle. The impacts of such scenarios require far more detailed data than we currently possess.

Figure 1. United States and Michigan

Conclusions

The results presented here highlight both the problems and opportunities associated with modeling the relationships between ORT participation and weather conditions. While the models constructed suggest that weather variables do have a significant impact on daily golfing activity, the overall performance of the models was quite low. However, we argue that daily models offer far more realistic pictures of the complex relationships between participation, weather conditions, and other relevant factors than can those based on temporally coarser (weekly, monthly or annual) data. Similarly, given the substantial spatial variations that exist in both golfing activity and weather patterns, models specific to individual golf courses offer far higher potential for accurate and useful results than can those based on larger regions.

Unfortunately, the uniqueness of the analyses presented means that comparison with other study areas is not possible at this juncture. However, it is hoped that they precipitate further research into this important and understudied area, especially given the potential utility of such information for the short and longer term planning and management of ORT enterprises.

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