Testing the Validity of Contingent Behavior Trip Responses

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Abstract: Following the prompting of Arrow et. al. (1993) and others, the number of validity tests of contingent valuation data has grown rapidly. However, to date, only several studies have examined the validity of contingent behavior data. The objective of this study is to take advantage of a unique opportunity to test the validity of contingent behavior trip data on rock climbing trips to Hueco Tanks, a premier rock climbing destination. A construct validity test of scope is conducted using data from surveys implemented before and after a policy restricting recreational access was imposed. Results from a generalized Negative Binomial regression model suggest that contingent behavior data may be a valuable supplement to revealed preference data when policy proposals are outside the range of historical conditions.

Key Words: Contingent Behavior, Rock Climbing, Test of Scope

Introduction

A recent trend in recreation demand modeling is to use contingent behavior (CB) trip data to value changes in consumer welfare under hypothetical scenarios, such as changes in management rules or environmental quality. Commonly, CB data is also combined with revealed preference (RP) data on past use levels. By definition, applications of CB questions are restricted to consideration of hypothetical use levels, and thus the measurement of use values. While potentially avoiding some of the criticisms (e.g., lack of familiarity with the good) concerning the application of contingent valuation (CV) methods and the measurement of non-use values, CB data still remains controversial due to its inherent hypothetical nature. However, given the restricted focus on use values, patterns of evidence concerning the validity of CV may not hold for CB data. Further, while CB applications have grown, there are few tests of CB validity. Thus, there is a considerable opportunity for insights from targeted CB validity studies, such as tests of scope, and comparisons of hypothetical and real behavior.

This study takes advantage of a unique opportunity to test the validity of CB data for outdoor rock climbing demand. Hueco Tanks Texas State Park, located outside of El Paso Texas, is known throughout the world as a premier climbing destination. In 1998, Texas Parks and Wildlife Department (TPWD) severely restricted open-recreational access at Hueco Tanks. TPWD believed that increased popularity of Hueco Tanks as a unique climbing destination threatened the park's ecological and cultural resources. For alternative access restrictions, a construct validity test of scope is conducted using data from surveys implemented both before and after the policy change.

The first survey was conducted in the spring of 1998, with the follow-up in the spring of 1999. In the 1998 survey, climbers who had visited Hueco Tanks were surveyed about their actual rock climbing trips <u>and</u> intended trips under alternative hypothetical policy rules restricting access (i.e., CB trip data). The 1999 survey was administered after access restrictions were imposed; climbers were surveyed about their actual post-policy rock climbing trips.

A construct validity test of scope is conducted comparing post-policy revealed preference (RP) trip data obtained from the 1999 survey and pre-policy RP and CB data obtained from the 1998 survey. To do a test of scope, each trip response is based on different levels of site access: pre-policy RP trip data are based on the least restrictive access policy; pre-policy CB trip data are based on gradual restrictions in site access; and post-policy RP data are based on the most restrictive access policy. Results from a pooled generalized Negative Binomial regression model suggest that CB data may be a valuable supplement to RP data when policy questions are outside the range of historical conditions. The value of access is significantly sensitive to scope.

Climbing at Hueco Tanks

While rock climbing has existed on public lands for the past century, recreational demand for climbing is perceived to have grown significantly over the last several decades. This growth has lead to a variety of new climbing management and access proposals (NPS 1993). Severe restrictions in access can cause significant loss in economic value to rock climbers. Hueco Tanks State park in Texas is a prominent example.

During the 1980s and 1990s, Hueco Tanks became known to climbers living throughout the world as a premier climbing destination providing numerous types of climbs, and what are referred to as boulder problems. Hueco Tanks is particularly famous for its quality and quantity of boulder problems, and ideal winter climbing conditions (i.e., dry and warm).

Unlike most types of rock climbing, bouldering does not require ropes, climbing protective gear, or knowledge about climbing protection. Strong, agile climbers climb on boulder problems generally not higher than 25 feet. Foam crash pads (approximately three inches thick and nine square feet) and spotters (i.e., other climbers) protect climbers from a fall. Climbers can generally walk off the back of boulders to descend. The "V" grading system is used to identify the difficulty of boulder problems and a climber's ability level (e.g., the ratings range from V0 through V14, where V0 represents the easiest rated boulder problem).

Due to increases in recreational use (primarily rock climbing) during the 1980s and 1990s, TPWD became concerned about the recreational impacts on park resources: Park planners with TPWD began to realize, even as they planned for increased recreational use..., that conflicts were going to occur between park users and there was a great need to protect the priceless rock art found throughout the park. The place was literally being loved to death by thousands of hikers, climbers, and picnickers. Increasing use by rock climbers from around the world is beginning to impact the park permanently...(Hueco Tanks State Historic Park 1997). In 1997, TPWD proposed a management plan recommending gradual restrictions in open-recreational access (TPWD 1997). On September 1, 1998, TPWD closed three of four mountain areas in Hueco Tanks to open-recreational access (TPWD 1998). Consequently, TPWD has greatly reduced access to a unique, world-class bouldering area.

Nonmarket Valuation and Contingent Behavior

Nonmarket valuation of environmental goods and services can be divided into revealed preference (RP) and stated preference (SP) approaches. RP approaches, such as the travel cost method (TCM), rely on observed individual behavior, often *revealed* in survey instruments, to infer values for environmental goods or services. A variety of stated preferences (SP) techniques are used to assess the economic value of nonmarket environmental goods. These methods include contingent valuation (CV) and contingent behavior (CB). In CV, respondents are asked to make statements about their willingness-to-pay (WTP), or to accept compensation, for changes in environmental quality.

CB is commonly used to assess quality or price changes at a recreational site. In the CB framework, respondents are asked to make statements about their intended behavior (e.g., visitation to a site) given a proposed change (e.g., in site quality, access, or price). Whereas CV elicits a value statement, CB is used to estimate changes in behavior or levels of use for a nonmarket good. For example, as part of the draft Environmental Impact Statement for the potential removal of the four Lower Snake River dams, Loomis (1999) uses CB trip data to estimate recreational benefits of this river restoration project to anglers and non-anglers.

A recent trend in recreation demand modeling is to combine RP and SP (RP-SP) trip data (Englin and Cameron 1996; Eiswerth et al. 2000; Loomis 1999; and Rosenberger and Loomis 1999). In the combined RP-SP recreation demand framework, individuals are asked to provide information on actual trips taken to a site under existing resource conditions or management rules (i.e., RP data), and subsequently asked to indicate the number of trips they would take to the site under alternative, hypothetical management rules (i.e., CB data). Similar to CV methods, use of CB data is controversial. Critics question the validity of SP techniques by arguing that respondents cannot accurately identify true statements about hypothetical WTP (Vatn and Bromley 1995) or intended visitation (Cicchetti and Peck 1989).

Validity is commonly thought of as accuracy in measurement (Loomis 1993). Construct validity involves the degree by which a measure relates to other measures as predicted by theory

(American Psychological Association 1974; Mitchell and Carson 1989, 191). For example, suppose an individual is confronted with a change in the level or scope of an environmental good from Q^0 to Q^1, where $Q^0 > Q^1$. Given strictly positive marginal utility for the good, then it is expected that the individual would value Q^0 more than Q^1 (Carson and Mitchell 1995, 156).

Following the prompting of Arrow et al. (1993) and others, the number of validity tests of CV has grown rapidly. These include considerable numbers of criterion (or external) validity tests (e.g., see review in Vossler and Kerkvliet 1999), and construct validity tests, such as tests of scope or temporal reliability (e.g., see reviews in Carson 1997; Carson et al. 1999).

While a growing number of researchers have examined the validity of CV methods, careful CB validity tests remain rare (Eiswerth et al. 2000; Loomis 1993; Nestor 1998). To date, the limited evidence provides qualified support for the use of CB questions and approaches.

Ideally, to assess the criterion validity of CB data that is used to estimate recreational benefits, researchers would like to compare CB trip responses that map into <u>observed</u> trips given an identical policy change (Berrens and Adams 1998; Loomis 1993). Alternatively, post-policy RP data could be compared to pre-policy CB responses. Difficulties arise in making such comparisons. For example, while *ex post* visitation data may exist, the actual change in site conditions may differ from the exact policy change proposed in CB questions. Further, the period between CB trip responses and *ex post* trips could vary considerably, in which individual preferences could have changed.

The Survey Method and Validity Test

An intercept plus follow-up mail survey was conducted in 1998 to collect data from climbers about their (pre-policy change) rock climbing trips and intentions to visit Hueco Tanks under alternative rules restricting access; the data account for over 2000 RP trips. The survey also included questions regarding details of climbers' trips to Hueco Tanks, including length of stay, lodging and travel expenses, travel accommodations (e.g., by car or airplane), the number of people traveling together on a trip, climber preferences for different climbing areas in Hueco Tanks, and purposes of visiting Hueco Tanks.

The survey was mailed first class to 752 climbers. A follow-up reminder letter was sent to nonrespondents four weeks after the original survey mailing. In addition, a follow-up survey and reminder letter was mailed to 100 random climbers who had not yet responded. The adjusted response rate (adjusted for undeliverable surveys) was 56 percent.

For pre-policy RP (PRE-RP) trip data, unrestricted access at Hueco Tanks included the following conditions: (1) all four mountain areas in the park were open to recreational access; (2) climbers were not allowed to climb in pictograph areas; (3) the park was limited to 60 vehicles, but made no restrictions on the number of individuals in the park at any one time; and (4) the entrance fee was $2, yet climbers had to pay an additional $2 activity fee (fees were reduced if climbers purchased an annual Texas Conservancy Passport).

The survey also included pre-policy CB questions. The CB questions read as follows:

> "Given West Mountain only is closed...Would your trips next season change because of this new policy? [If yes] You stated your trips would change. About how many more or fewer trips would you take next season?"

And,

> "Next suppose TPWD eliminates climbing access to both East and West Mountain...Would your trips next season change because of this new policy? [If

yes] You stated your trips would change. About how many more or fewer trips would you take next season?"

Throughout this paper, responses to the first and second set of CB questions will be referred to as SP1 and SP2 trip data, respectively. All climbers who had participated in the 1998 survey returned their survey prior to September 1, 1998.

When TPWD restricted open-recreational access at Hueco Tanks, climbers could still visit the park, but their climbing opportunities were limited. The rule limited access in the following ways: (1) open-recreational access was limited to North Mountain non-pictograph areas only, yet to guarantee a visit North Mountain, visitors had to call in advance to make a reservation; (2) North Mountain was limited to 50 visitors; (3) the total entrance fee remained at $4 (the fee was reduced if climbers purchased an annual Texas Conservancy Passport); (4) before entering, all visitors had to attend a mandatory park orientation; and (5) visitors were allowed to be guided by a park ranger to the remaining three mountain areas—East Mountain, West Mountain, and East Spur Maze—for a two hour period.

The change in access provided a unique opportunity to question original survey respondents about their trips to Hueco Tanks under this new rule. The second survey, which was mailed to climbers one year after the first survey (April 1999), contained three questions: (1) did you take any trips to Hueco Tanks in the last twelve months; (2) if yes, how many trips did you take in the last twelve months; and (3) if you took any trips to Hueco Tanks in the last twelve months, what was the average length of stay? This survey was mailed to 387 of the 413 climbers who participated in the first survey (26 of the original 413 surveys were returned as undeliverable). Of this amount, 246 climbers responded, representing a 64% response rate.[1] Table 1 summarizes the trip data collected from each survey instrument.

A construct validity test of scope is employed where pre-policy SP trip data can be compared with PRE-RP and post-policy RP (POST-RP) trip data. The test of scope is conducted by treating Hueco Tanks as a categorically nested good (Carson and Mitchell 1995). Categorical nesting exists when a good G is composed of two or more objects, such as g and its complement g', where neither g nor g' is an empty set and their intersection is empty (Carson and Mitchell 1995). For example, a park area G may be comprised of several areas within the park, where g is a proper subset of those areas. Hueco Tanks is comprised of four separate areas within the park, where access to all areas constitute the good G, and access to some subset of areas would be g. It is always possible to have multiple levels of nests, but to maintain the property of categorical nesting, in each case the lowest category in the nest must be a proper subset of the next higher nest. Table 1 describes the level of access to Hueco Tanks being evaluated, and in each case, the study design maintains the property of categorical nesting.

To assess the construct validity of SP trip responses, a few assumptions are specified. First, recreation demand for Hueco Tanks is a normal good. Second, the level of access at Hueco Tanks is assumed weakly complementary with rock climbing trips. Thus, a climber would not derive utility from an increase in access when climbing trips are zero (i.e., the value of access strictly represents a use value). As an indicator of support for this assumption, <u>all</u> climbers indicated in their completed surveys that the primary purpose of their visit was to climb or boulder. Third, the reservation system implemented in 1998 is not a binding constraint on total

[1] Sample descriptive statistics, such as years experience, climbing ability, demographic, and socioeconomic characteristics, indicate that the sample of climbers participating in both surveys is not statistically different from the sample participating in the 1998 survey only. Further, we could not reject a set of hypotheses that tested whether the average number of PRE-RP trips and SP trips taken (or stated) by both samples were equal.

trips during the season.[2] Finally, the fourth assumption is that respondents get positive utility from using g even after using its complement g'.

Based on these assumptions, the values for different elements of a good G should vary according to the level of inclusion of the good. This means that the value of the good G should be greater than the value of a subset g. Because each level of access to Hueco Tanks being evaluated maintains the property of categorical nesting, it is expected that respondents would value access to more areas in the park higher than access to fewer areas. The hypothesis is that significant changes in site access at Hueco Tanks will cause significant changes in a climber's seasonal consumer surplus (SCS) according to the following relationship:

$$\mathbf{H_1}: \mathrm{SCS}_{\mathrm{PRE\text{-}RP}} \geq \mathrm{SCS}_{\mathrm{SP1}} \geq \mathrm{SCS}_{\mathrm{SP2}} \geq \mathrm{SCS}_{\mathrm{POST\text{-}RP}}.$$

Testing $\mathbf{H_1}$, or any binary comparison of the ordered relationship, constitutes a test of scope for a categorically nested good. Evidence in support of $\mathbf{H_1}$ would be evidence of construct validity. Further, a criterion validity test can also be conducted by comparing SP to RP trip data; note that the PRE- and POST-RP access conditions bound the two SP cases.

Count Data Travel Cost Models

In testing $\mathbf{H_1}$, several single site (i.e. Hueco Tanks) travel cost demand models are estimated. In specifying the demand function, RP and SP trip data are pooled in a single model. An advantage of pooling RP and SP trip data is that the researcher can test for differences in empirical results derived from different sources of data (Eiswerth et al. 2000). In addition, use of a single site travel cost demand model is likely a defensible approach when the site is relatively unique (Eiswerth et al. 2000). Indeed Hueco Tanks is a unique climbing resource known to climbers throughout the world; climbers often indicated in their completed surveys that no substitute site for Hueco Tanks exists.

A pooled travel cost model can be represented by:

$$v_{ijt} = f\left(tc_{ij}, y_{ij}, sd_i, q_{ijt}, D_t, D_t \times tc_{ij}\right), \tag{1}$$

where v_{ijt} is the number of observed or intended visits that individual i took to site j under access conditions t, tc_{ij} is the travel cost for individual i to site j, y_{ij} is the income available to individual i on their visit to site j, sd_i is a vector of socioeconomic characteristics of individual i, q_{ijt} is a vector of site characteristics experienced by individual i at site j under access conditions t, D_t is a dummy variable indicating the access conditions (i.e., SP1, SP2, POST-RP), and $D_t \times tc_{ij}$ is the interaction of dummy variables and travel costs.

A number of count data econometric techniques have been applied to travel cost models of recreation demand (Eiswerth et al. 2000; Englin and Cameron 1996; Rosenberger and Loomis 1999; Shaw and Jakus 1996). While several econometric techniques can be applied to count

[2] An anonymous reviewer raised a concern that the introduction of the park reservation system in 1998 might be acting as an additional rationing mechanism on visitation behavior. Using total reservation and visitation data provided by TPWD for the period, we determined that the reservation system did not impose a binding constraint on total trips for the season. Based on daily averages, the number of walk-in visits to North Mountain exceeded the number of reserved visits by 27%. On days in which there were 50 visitors at North Mountain (records show that this occurred 40 out of 259 days), users had other options for entering the park, such as waiting for a visitor to leave or entering a different area of the park by guided tour.

data, this study employs pooled Poisson and Negative Binomial (NB) regression models. Pooled Poisson or NB regression models can be estimated if the systematic variation across demand equations is captured by independent variables.[3]

The Poisson regression model assumes that v_{ijt}, given a vector of regressors $\mathbf{x}_i$ defined in equation (1), is independently Poisson distributed with density (Cameron and Trivedi 1998, 20)

(2) $$f\left(v_{ijt}|\mathbf{x}_i\right) = \frac{e^{-\lambda_i}\lambda_i^{v_{ijt}}}{v_{ijt}!} \qquad v_{ijt} = 0, 1, 2, \ldots, N_i \text{ trips}$$

and mean parameter specified as an exponential link function:

(3) $$\lambda_i = \exp\left(\mathbf{x}_i'\beta\right),$$

where β are the vector of parameters to be estimated. The exponential link function ensures that the parameter λ_i is nonnegative. Further, the Poisson regression model assumes that the conditional mean, $E[v_{ijt}|\mathbf{x}_i]$, and variance $V[v_{ijt}|\mathbf{x}_i]$ are equal (i.e., equidispersed). The log-likelihood function, maximized over n individuals for the Poisson regression model is

(4) $$\ln L = \sum_{i=1}^{n}\left[-\lambda_i + v_{ijt}\left\{f\left(tc_{ij}, y_{ij}, sd_i, q_{ijt}, D_t, D_t \times tc_{ij}\right)\right\} - \ln\left(v_{ijt}!\right)\right].$$

For count data models emphasis is often placed on the assumption of the correct specification of the conditional mean and variance (Cameron and Trivedi 1998). As an alternative to Poisson, one can specify a distribution that permits more flexible modeling of the variance by relaxing the assumption that the variance equals the mean, yet maintains the assumption that the mean is $\exp(\mathbf{x}_i'\beta)$. In this framework, a gamma-distributed unobserved individual heterogeneity term is introduced in the Poisson model to take account of dispersion in the data (Cameron and Trivedi 1998, 71). Following Cameron and Trivedi (1998, 63), the NB variance, ω_i, is specified as a general variance function of the mean and dispersion scale parameter α:

(5) $$\omega_i = \lambda_i + \alpha\lambda_i^{2-\kappa}.$$

The κ parameter allows the relation between the conditional mean and variance to take a variety of forms. For $\kappa = 1$, the variance is specified as a linear function of the mean; this specification is referred to as the NB1 variance function. The NB2 variance function sets $\kappa = 0$, where the variance is quadratic in the mean. In both the NB1 and NB2 the dispersion parameter α is to be estimated. In a generalized NB (GNB) model both α and κ are estimated.

[3] As an alternative, Englin and Cameron (1996) suggest using panel data methods for RP and SP data to handle unobserved individual heterogeneity not captured by explanatory variables. In their study, Englin and Cameron (1996) estimated fixed effects Poisson regression models. Similarly, Rosenberger and Loomis (1999) apply a random effects Poisson regression model to value ranchland to tourists visiting a resort town in the Rocky Mountains.

The NB regression models are estimated by maximum likelihood. For an independent sample of n individuals, the log-likelihood function for NB models is

$$\text{(6)} \qquad \log L = \sum_{i=1}^{n}\left[\ln\left[\Gamma\left(\zeta_i + v_{ijt}\right)\right] - \ln\left[\Gamma\left(\zeta_i\right)\right] - \ln v_{ijt}! + \zeta_i \ln\left(\frac{\zeta_i}{\zeta_i + \lambda_i}\right) + v_{ijt}\ln\left(\frac{\lambda_i}{\zeta_i + \lambda_i}\right)\right],$$

where

$$\text{(7)} \qquad \zeta_i = \alpha^{-1}\lambda_i^{\kappa}.$$

When $\kappa = 1$ and $\kappa = 0$ equation (6) simplifies to the log-likelihood function for the NB1 and NB2 regression models, respectively.

In testing $\mathbf{H}_1$, estimates for SCS need to be calculated. Following Bockstael et al. (1984) and given the set of interaction terms ($D_t \times tc_{ij}$), the estimated individual SCS for each policy scenario can be calculated as:

$$\text{(8a)} \qquad SCS_{PRE-RP} = \frac{-\hat{v}_{it}}{\beta_{TC(PRE-RP)}},$$

$$\text{(8b)} \qquad SCS_{SP1} = \frac{-\hat{v}_{it}}{\left(\beta_{TC(PRE-RP)} + \beta_{TC(SP1)}\right)},$$

$$\text{(8c)} \qquad SCS_{SP2} = \frac{-\hat{v}_{it}}{\left(\beta_{TC(PRE-RP)} + \beta_{TC(SP2)}\right)},$$

$$\text{(8d)} \qquad SCS_{POST-RP} = \frac{-\hat{v}_{it}}{\left(\beta_{TC(PRE-RP)} + \beta_{TC(POST\text{-}RP)}\right)},$$

where $\hat{v}_{it}$ is the predicted number of trips taken by individual i under access conditions t. The term $\beta_{TC(\text{PRE-RP})}$ is the estimated coefficient on the base category of travel costs, and $\beta_{TC(\text{SP1})}$, $\beta_{TC(\text{SP2})}$, and $\beta_{TC(\text{POST-RP})}$ are the estimated coefficients on the interaction of data source dummy variables and travel costs.

Dependent and Explanatory Variables

For pooled Poisson and NB regression models the dependent variable, v_{ijt}, is comprised of PRE-RP, SP1, SP2, and POST-RP trip data. SP1 and SP2 intended trip data are constructed by adding (subtracting) the increase (decrease) in intended visitation to PRE-RP trips. After eliminating surveys with inconsistent or missing contingent behavior responses, the number of observations for PRE-RP, SP1, and SP2 trip data is 390. For POST-RP trip data the number of observations is 239. The mean number of trips for each data source is presented in Table 1. For ALL TRIPS (i.e., all trip data response sources combined), the size of the standard deviation-to-mean ratio of 2.575 is an indication of overdispersion (i.e., a variance in excess of mean), possibly resulting from a large number of zero observations in SP2 and POST-RP data sources. Approximately, 42 percent of climbers stated that they would not take any trips if both East and West Mountain were closed (i.e., 165 zero observations out of 390). By comparison, 199 out of 239 climbers (83 percent) did not take any trips to Hueco Tanks after the change in policy. Overall, 35 percent of 1409 observations are zero trips.

Explanatory variables used in Poisson and NB models are shown in Table 2. The independent variables include: travel costs (TC); the number of boulder problems available under various policy site access rules (BPROBLEM); whether a climber spent most of their time at Hueco Tanks climbing at North Mountain (NORTH); whether a climber had knowledge regarding TPWD's intent to propose a climbing management plan (KNOW); dummy variables denoting site access conditions (i.e., DUMSP1, DUMSP2, and DUMPOST); interaction terms between dummy variables and other explanatory variables; socioeconomic variables; and indicators of climber experience and type. Further, because some climbers with knowledge about proposed management plans may have had an incentive to influence outcomes, KNOW is interacted with SP trip responses to control for strategic responses.

Because we are primarily interested in testing the validity of CB data, we use a rather conservative specification of TC. Travel expenditures are calculated as the product of an individual's per mile travel expense and their roundtrip travel miles. In this study, $0.325 is used for per mile travel expenses.[4] The shortest road distance in miles between two zipcodes is calculated using ZIPFIP (Hellerstein et al. 1993).

It is also argued that the number and difficulty of boulder problems or climbs available at a site (BPROBLEM) will influence a climber's demand for climbing at Hueco Tanks. Because it is believed that climbers select areas at Hueco Tanks that offer boulder problems comparable with their skills, the variable BPROBLEM is constructed to take into account climber skill differences and site characteristics; thus, BPROBLEM is a continuous variable that measures changes in site access.

The dummy variables and the interaction of these variables with travel costs are included in the pooled count data regression models to measure changes in consumer surplus. It is hypothesized that major changes in site access should result in significant differences in parameter estimates on travel costs, and thus different estimates of consumer surplus (CS).

Empirical Results

The results from the GNB model are presented in Table 3. Evidence from t-tests and likelihood ratio (LR) tests indicate that the GNB model (see bottom section of Table 3) is favored over NB1 and NB2 models. Further, perhaps because of the number of zero trip observations associated with greater restrictions in site access, the Poisson model is also rejected. Thus, Table 3 reports results for the pooled GNB model only.

The GNB model performs well with a number of estimates significant at the 0.01 level. The coefficient on YRCLIMB is negative and significant at the 0.01 level, while the coefficient on the quadratic term of YRCLIMB ($YRCLIMB^2$) is positive and significant at the 0.05 level; thus suggesting a U-shaped relationship exists between the number trips and years climbing experience. Because Hueco Tanks is primarily a bouldering area and climbers generally do not need to be skilled in climbing protective gear (a skill generally associated with years of

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[4] $0.325 is the standard mileage rate allowed by the Internal Revenue Service for 1998 business travel expense deductions. This amount takes into account basic car expenses including depreciation, maintenance and repairs, gasoline, oil, insurance, and vehicle registration fees.

experience), these results are not surprising. Further, results show that those climbers who consider themselves boulderers (BOULD) will take more trips to Hueco Tanks. Socioeconomic variables that affect visits are MALE and HH; the coefficient on MALE is negative and significant at the 0.10 level and the coefficient on HH is positive and significant at the 0.05 level.

Overall the estimated coefficients on TC, BPROBLEM, NORTH, KNOW, and TCP are strong determinants of trip-taking behavior to Hueco Tanks; the coefficients on these site specific variables are significant at the 0.01 level. The estimated coefficient on TC is negative as expected. The number of boulder problems (BPROBLEM) available to an individual (depending on site characteristics and climber ability) has an expected positive sign. The estimated coefficients on NORTH, KNOW, and TCP are positive, suggesting that climbers who prefer North Mountain, who had prior knowledge regarding the possibility of site closure, and who owned a TCP were likely to take more trips to Hueco Tanks.

The coefficients of interest are those on the dummy variables and the interaction of the dummy variables with TC and KNOW. The estimated coefficients on DUMSP2 and DUMPOST are positive and significant at the 0.01 level. The coefficients on DUMSP2×TC and DUMPOST×TC are negative and highly significant at the 0.01 level; these results suggest that climber trip behavior changes significantly when an increasing number of areas at Hueco Tanks are closed. Further, it appears that climbers did not give statistically different behavioral responses to CB questions based on their prior knowledge of the possibility of site closure. (The coefficients on DUMSP1×KNOW and DUMSP2×KNOW are not statistically significant.)

To test $\mathbf{H_1}$, a Wald test is conducted to explore differences in parameter estimates. A Wald test provides the appropriate hypothesis test for differences in trip behavioral responses because of the consistency of the covariance matrix (Gourieroux et al. 1984). The null hypothesis is the following set of independent restrictions:

$\mathbf{H_2}$: $\beta_{TC} = (\beta_{DUMSP1\times TC} + \beta_{TC})$
$\mathbf{H_3}$: $\beta_{TC} = (\beta_{DUMSP2\times TC} + \beta_{TC})$
$\mathbf{H_4}$: $\beta_{TC} = (\beta_{DUMPOST\times TC} + \beta_{TC})$
$\mathbf{H_5}$: $\beta_{DUMSP1\times TC} = \beta_{DUMSP2\times TC}$
$\mathbf{H_6}$: $\beta_{DUMSP1\times TC} = \beta_{DUMPOST\times TC}$
$\mathbf{H_7}$: $\beta_{DUMSP2\times TC} = \beta_{DUMPOST\times TC}$

The set of hypotheses tests determine if visitation data exhibit statistically significant differences across substantial changes in site access. Results of these hypotheses tests are listed in Table 4.

The estimated coefficients on travel costs are –2.73 (β_{TC}), –2.81 ($\beta_{TC} + \beta_{DUMSP1\times TC}$), –3.94 ($\beta_{TC} + \beta_{DUMSP2\times TC}$), and –8.78 ($\beta_{TC} + \beta_{DUMPOST\times TC}$). According to hypotheses tests $\mathbf{H_3}$ and $\mathbf{H_5}$, closure of both East and West Mountain—a 43 percent reduction in boulder problems—leads to statistically different estimates at the 0.01 level. Hypotheses tests $\mathbf{H_4}$, $\mathbf{H_6}$ and $\mathbf{H_7}$ test whether the most restrictive policy results in statistically different estimates; $\mathbf{H_4}$ shows that $\beta_{DUMPOST\times TC}$ is statistically different from zero; $\mathbf{H_6}$ show that $\beta_{DUMPOST\times TC}$ is statistically different from $\beta_{DUMSP1\times TC}$; and $\mathbf{H_7}$ shows that $\beta_{DUMPOST\times TC}$ is statistically different than $\beta_{DUMSP2\times TC}$. Hypothesis $\mathbf{H_2}$ that the coefficients β_{TC} and $\beta_{TC} + \beta_{DUMSP1\times TC}$ are equal is not rejected. Failure to reject $\mathbf{H_2}$ is not surprising, however, because SP1 is associated with the closure of West Mountain that consists of only 9 percent of available boulder problems. Overall, these results indicate that CS will be statistically different across <u>major</u> differences in site closures at Hueco Tanks.

Estimates of per trip CS and SCS are presented in Table 5. For example, per trip CS is \$366 for access to four mountain areas versus \$114 for access to one mountain area. Given the uniqueness of Hueco Tanks, these per trip CS measures seem reasonable. Further, as hypothesized in $\mathbf{H_1}$, SCS measures get increasingly smaller as more sites are closed at Hueco Tanks. The average seasonal loss to climbers due to restricted access to two areas (East and West Mountain) is \$687 per climber, and \$1276 per climber when three areas are closed (the actual policy change). Thus, the values for access to mountain areas in Hueco Tanks are sensitive to scope.

A concern with the results, however, may be due to the one-year period between surveys, in which climate conditions may have differed. It is typically expected that higher temperatures and lower precipitation are positively correlated with trips. Climate data was not included in the regressions because this data does not vary across individuals. Average temperatures in El Paso during the POST-RP period were 2.27° Fahrenheit higher and precipitation was 0.15 inches lower than the PRE-RP period.[5] Thus, although climate conditions were favorable for climbing trips during the POST-RP period, it appears that any resulting increases in trips did not outweigh decreases in trips caused by the access restrictions.

In the case of rock climbing at Hueco Tanks, results from this study support the validity of CB trip data, and do not suggest that climbers overstate changes in their trip-taking behavior in CB responses. Climbers are able to project the direction of their behavioral response to area closures in a way that is consistent with economic theory; in this case, climbers demand for climbing at Hueco Tanks decreases as more areas are closed within the park.

Conclusions

In 1998, TPWD restricted open-recreational access at Hueco Tanks State Park, a world-class climbing site. The implementation of this policy change provided a unique opportunity to test the validity of contingent behavior data.

To collect trip data from climbers before and after the policy change, two separate surveys were implemented. The first survey was conducted prior to the restriction in open-recreational access. In this survey, climbers provided information about their pre-policy rock climbing trips to Hueco Tanks and intended trips under alternative, hypothetical policy rules restricting access. The second survey was conducted after the restriction on access was imposed; climbers were surveyed about their post-policy rock climbing trips.

A construct validity test of scope was conducted by comparing post-policy RP trip data with pre-policy RP and CB data. Results from a generalized Negative Binomial regression model indicate that climbers do not appear to overstate changes in trip behavior when presented with hypothetical questions about site access restrictions. In addition, for major decreases in site access, climbers' values for Hueco Tanks also significantly decrease. Together, these results support the conclusion that CB trip response data are sensitive to changes in scope. Thus, methods of augmenting RP data sets with SP data show promise as a tool for estimating demand, and as an input for public land management decisions.

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Table 1: Trip Data Collected From Survey Instruments

Date of Survey Instruments	Data Collected	Acronym	Site Access Conditions	Number of Available Boulder Problems	Mean Number of Trips (Standard Deviation) [number of observations]
1998 Survey	Pre-policy revealed preference climbing trip data	PRE-RP	North Mountain East Spur Maze East Mountain West Mountain	1237	5.487 (11.946) [390]
	Contingent behavior climbing trip data to hypothetical changes in site access	SP1	North Mountain East Spur Maze East Mountain	1127	5.226 (11.841) [390]
		SP2	North Mountain East Spur Maze	706	3.867 (10.838) [390]
1999 Survey	Post-policy revealed preference climbing trip data	POST-RP	North Mountain	509	1.335 (6.623) [239]
	All trip data sources combined	ALL TRIPS	—	—	4.262 (10.975) [1409]

Table 2: Description of Independent Variables

Variable	Description	Mean (Standard Deviation)
PREDUM	Dummy variable – 1 indicates if data is PRE-RP, 0 otherwise. This is the base category dropped during estimation.	
DUMSP1	Dummy variable – 1 indicates if data is SP1, 0 otherwise.	0.277
DUMSP2	Dummy variable – 1 indicates if data is SP2, 0 otherwise.	0.277
DUMPOST	Dummy variable – 1 indicates if data is POST-RP, 0 otherwise.	0.169
YRCLIMB	Number of years climbing experience. Variable scaled by 100.	0.076 (0.066)
$YRCLIMB^2$	YRCLIMB squared.	0.010 (0.018)
BOULD	Dummy variable – 1 indicates whether the person primarily is a boulderer, 0 otherwise.	0.087 (0.281)
TC	Roundtrip travel miles at $0.325 per mile. Variable scaled by 1000	0.482 (0.385)
BPROBLEM	Number of boulder problems available at Hueco Tanks based on different site access conditions and a climber's ability range using the "V" rating system. Variable scaled by 1000.	0.731 (0.306)
NORTH	Dummy variable – 1 indicates that a climber spent the majority of her time climbing and bouldering at North Mountain, 0 otherwise.	0.219 (0.413)
KNOW	Dummy variable – 1 indicates the climber had information prior to taking a trip regarding the intent of the TPWD to propose a climbing management plan for Hueco Tanks, 0 otherwise.	0.661 (0.473)
TCP	Dummy variable – 1 indicates the climber owned a Texas Conservancy Passport, which allowed them to enter Hueco at a user fee discount, 0 otherwise.	0.222 (0.416)
UNEARNY	The annual amount of a climber's unearned income scaled by 10000.	0.338 (0.992)
MALE	Dummy variable – 1 indicates the climber is male, 0 otherwise.	0.789 (0.408)
TOTHOURS	Total hours an individual worked during the year scaled by 10000.	0.158 (0.078)
HH	Number of members in climber's household.	2.137 (1.184)
PEOPLE	Average number of people traveling with climber to Hueco Tanks (including the climber)	3.140 (2.204)

Table 3: Parameter Estimates for GNB Regression Model

	GNB Regression Model		
Intercept	0.246	NORTH	0.384***
	(1.14)[a]		(4.46)
DUMSP1	0.201	KNOW	0.406***
	(1.33)		(3.58)
DUMSP2	0.712***[b]	DUMSP1×KNOW	-0.077
	(3.99)		(-0.48)
DUMPOST	0.618***	DUMSP2×KNOW	-0.044
	(2.91)		(-0.25)
YRCLIMB	-10.427***	TCP	0.719***
	(-4.92)		(8.67)
$YRCLIMB^2$	19.971**	UNEARNY	0.022
	(2.43)		(0.60)
BOULD	0.542***	MALE	-0.181*
	(3.95)		(-1.92)
TC	-2.733***	TOTHOURS	0.450
	(-16.53)		(1.14)
DUMSP1×TC	-0.077	HH	0.054**
	(-0.35)		(1.97)
DUMSP2×TC	-1.204***	PEOPLE	0.024
	(-4.29)		(1.36)
DUMPOST×TC	-6.050***	α	0.400***
	(-7.21)		(5.69)
BPROBLEM	1.856***	κ	-0.477***
	(9.17)		(-4.70)
Number of Observations	1409		
LnL	-2592.942		
Likelihood Ratio Index[c]	0.344		
Selection Test from the GNB Model[d]	t-test for Poisson [H_0: $\alpha = 0$] t = 5.69*** t-test for NB1 [H_0: $\kappa = 1$] t = –5.15*** t-test for NB2 [H_0: $\kappa = 0$] t = –4.70*** LR test for NB1 [H_0: $\kappa = 1$] $\chi^2 = 464.96$*** LR test for NB2 [H_0: $\kappa = 0$] $\chi^2 = 31.18$***		

[a] Numbers in parentheses are the ratio of the estimated coefficient to the aysmptotic standard error.

[b] ***, **, and * denote the estimate is significantly different than zero at the 0.01, 0.05, and 0.10 levels, respectively.

[c] The likelihood ratio index for Poisson is defined as $1-(LnL_{fit}/LnL_{restricted})$, where LnL_{fit} and $LnL_{restricted}$ are the LnL values for the fitted and intercept-only models (Cameron and Trivedi 1998, 155). The likelihood ratio index for the negative binomials is defined as $1-(LnL_{NB}/LnL_{fit})$, where the subscript NB refers to NB1, NB2, and GNB.

[d] The hypotheses in brackets represent the implied restrictions in the GNB model. The likelihood ratio (LR) test statistic is defined as $-2[LnL_{restricted} - LnL_{GNB}]$, where the restricted model is either NB1 or NB2. The LR test is distributed as χ^2 with $(K_{GNB} - K_{restricted})$ degrees of freedom, where K refers to the numbers of estimated coefficients in each model.

Table 4: Hypotheses Tests for Validity

Hypothesis Test	Description[a]	χ^2
H_2	$\beta_{TC} = \beta_{DUMSP1\times TC} + \beta_{TC}$	0.047
H_3	$\beta_{TC} = \beta_{DUMSP2\times TC} + \beta_{TC}$	9.32***[b]
H_4	$\beta_{TC} = \beta_{DUMPOST\times TC} + \beta_{TC}$	46.82***
H_5	$\beta_{DUMSP1\times TC} = \beta_{DUMSP2\times TC}$	15.79***
H_6	$\beta_{DUMSP1\times TC} = \beta_{DUMPOST\times TC}$	50.50***
H_7	$\beta_{DUMSP2\times TC} = \beta_{DUMPOST\times TC}$	32.21***

[a] The estimated coefficients on travel costs are -2.733, -2.813, -3.937, -8.783 for β_{TC}, $\beta_{TC} + \beta_{DUMSP1\times TC}$, $\beta_{TC} + \beta_{DUMSP2\times TC}$, and $\beta_{TC} + \beta_{DUMPOST\times TC}$, respectively.

[b] *** denotes that the β coefficients are significantly different than each other at the 0.01 level.

Table 5: Consumer Surplus Measures from GNB Model

Policy Change	Per Trip Consumer Surplus	Seasonal Consumer Surplus
Open access to four mountain areas at Hueco Tanks	$366***[a] (22.13)[b]	$1640
Open access to three mountain areas at Hueco Tanks (West Mountain closed)	$355*** (45.02)	$1553
Open access to two mountain areas at Hueco Tanks (West and East Mountain closed)	$254*** (25.44)	$953
Open access to one mountain area (North Mountain) at Hueco Tanks; however, additional access restrictions apply.	$114*** (11.46)	$364

[a] *** denotes that the estimate is significantly different than zero at the 0.01 level.

[b] Standard errors in parentheses. These standard errors are calculated using the Delta Method Approximation (Greene 1997, 278).