The price elasticity of the demand for visits to Yellowstone National Park

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— The author acknowledges the research assistance provided by Aaron Enriquez.

— The author discloses the receipt of the following financial support for the research, authorship, and/or publication of this report: Stephen Newbold's work on this study was carried out under contract with financial support from the Property and Environment Research Center (PERC).

— Data and code sufficient to reproduce all results reported in this manuscript are included in a GitHub repository at `https://github.com/scnewbold/YNP-elasticities`, with access upon request and author approval.

[This version: June 6, 2025]

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Summary

I used data from the 2016 and 2018 Yellowstone National Park (YNP) Visitor Use Surveys to estimate how different demographic segments of visitors would respond to changes in the price of visiting the park. Eight segments were defined by income (above/below $75,000 per year), race (white/non-white), and age (above/below 40 years old). I used maximum likelihood to estimate parameters of a trip demand function that predicts the average probability that people in each demographic segment would visit YNP from each of the lower 48 states plus Washington, DC in the survey months. Due to unknown features of the visits—namely, the mode of travel to YNP and whether visits to the park were single-destination trips or part of multi-destination trips—I used two sets of travel cost estimates intended to bound these uncertainties. The first set was developed by Enriquez and Richardson (E&R) in a study of the demand for visits to 100 top National Park Service sites using mobility data, and the second set was developed by Carr and Newbold (C&N) in a study of congestion in Yellowstone National Park. The travel cost estimates by E&R varied between $100 and $800 among states, roughly double the C&N travel cost estimates. I used both sets of travel cost data to produce a range of elasticities, and I used the average of the two sets to produce central estimates.

The central estimates of price elasticities varied between 1.67–3.74 among demographic groups, with an overall average of 2.51. This suggests that visitors would reduce their frequency of trips to YNP by between 2.51 percent if everyone's total cost of access to the park increased by 1 percent. More relevant for visitor management, the estimated elasticities among demographic groups with respect to the entry fee alone were in the range 0.003–0.034, with an overall average of 0.020.

I used the estimated trip demand function to evaluate six hypothetical changes in entrance fees. The scenarios are distinguished by the sizes of the fee changes applied to all visitors, visitors from states bordering YNP, and international visitors. The results using the averaged travel cost estimates suggest that a differentiated price structure comprising free entry for local visitors (from Wyoming, Montana, and Idaho), a $10 per person surcharge for visitors from other states, and a $20 surcharge for international visitors would lead to 5.1% fewer visits to the park and 282% additional fee revenues. Applying a surcharge of $100 per international visitor would lead to 1.3% fewer visits and 388% additional fee revenues. In a sensitivity analysis, I calculated the relative changes in visits and revenues over a wide range of entrance fees using the averaged travel costs, which revealed that a surcharge would need to be increased beyond $200 per visitor before revenues would decline. These results follow from the combined effects of the estimated price elasticities and the fact that the entrance fee is a relatively small component of the total cost that most visitors pay to reach Yellowstone National Park.

Statement of work

I will use data from the 2016, 2018, and 2024 Yellowstone National Park (YNP) Visitor Use Surveys to study the potential influence of changes in park entry fees on the demand for visits to YNP by different visitor segments. To do so, I will estimate travel cost models using variation in the share of survey respondents from each U.S. state in each survey year and travel costs imputed from the population centroids of each state. The estimation approach will be similar to the first stage of the estimator used by Carr and Newbold (2024) to study the effect of congestion on the demand for trips to Yellowstone National Park. In the present work, the model will be adapted to accommodate estimation of distinct price elasticities for different visitor segments.

I will separate visitors into eight mutually exclusive and exhaustive segments by age ($<$ or $\geq$ 45 years old), income ($<$ or $\geq$ \$100,000 per year), and race (white, other). Other segmentations are possible, but there will be a limit to how many distinct elasticities can be estimated reliably. Preliminary power analysis suggests eight is near the upper limit of what we should expect to be feasible.

I will estimate price elasticities for all visitor segments in 2016, 2018, and 2024 to examine any changes over time between these years. If only small differences are found among years, I will pool all three years of survey data to generate more precise estimates of the price elasticities for each visitor segment. I will use the price elasticity estimates to study the potential impacts on park revenues and visitor numbers for several hypothetical scenarios. For example,

1. entry fee increase of \$15 per vehicle for all visitors
2. entry fee decrease of \$25 per vehicle for residents of bordering states + an increase of \$25 per vehicle for all other visitors
3. entry fee increase of \$40 per vehicle for international visitors only

Other scenarios or fee changes can also be examined. For each scenario, I will project changes in total revenues and visitation rates for each visitor segment. When making revenue projections, I will assume that the shares of visitors who purchase a 7-day pass or an America the Beautiful pass will not change.

I do not anticipate estimating a separate price elasticity for international visitors due to uncertainty about travel costs for that visitor segment, so for the third scenario I will assume that international visitors share the same price elasticity as the high-income/white/older visitor segment.

I will describe my methods and findings in a written report to be completed by March 14, 2025. I will include a link to an online repository with all data and code needed to replicate my results. If feasible in the allotted time, I will create an R Shiny web app to allow easy analysis of alternative entry fee changes for all three scenarios.

The study proposed here is distinct from previous work by Carr and Newbold (2024) in several ways. In the present study, I will not examine the effect of congestion on trip demands, I will use three years of survey data instead of one, I will estimate price elasticities for eight distinct visitor segments, and I will use the estimated elasticities to examine the revenue impacts and the incidence of visitation changes among the visitor segments.

Introduction

Effective management of our most popular national parks requires a robust understanding of visitor behaviors and trip demands. Yellowstone National Park (YNP) is a prime example, attracting millions of visitors every year from the US and abroad. Understanding the factors that influence visitation demand is crucial for park managers and policymakers seeking to make informed decisions regarding resource allocation, visitor management, and revenue generation. The price elasticity of demand for trips to the park is a critical metric in this context, as it quantifies the responsiveness of visitor demand to changes in the price of accessing the park. Entrance fees are one policy lever that park managers can use to influence demand and generate revenue. However, entrance fees typically constitute a relatively small component of the total cost of visiting the park, which also includes travel, lodging, and other expenses. Therefore, it is important to understand how visitors respond to changes in entrance fees in the context of the full costs of visiting the park.

This study aims to provide useful insights for park managers seeking to balance visitor experiences with financial sustainability by examining how different demographic segments may respond to changes in entrance fees. This report proceeds as follows. In the Methods section, I describe the data and econometric model used to estimate the price elasticity of demand for visits to YNP. In the Results section, I present the estimated price elasticities and analyze the potential impacts of several hypothetical entrance fee scenarios on park visitation and revenues. The Discussion section includes an interpretation of the results, highlighting key findings and limitations. In the Conclusions section, I provide a brief summary of the main lessons and their implications for the management of Yellowstone National Park. All figures and tables appear after the References. Readers using a digital device can click the embedded hyperlinks to move back and forth between the figures and tables and their corresponding first mentions in the main text.

Methods

Data

For all analyses presented in this report, I used data collected from Yellowstone National Park Visitor Use Surveys conducted in 2016 [1] and 2018 [2].[1,2] I combined the survey data with supplemental information from two additional sources: state-level demographic data from the Public Use Microdata Sample [3], and estimates of travel costs from each U.S. state to YNP from the studies by Enriquez et al. [4] and Carr and Newbold [5]. In the remainder of this subsection, I describe how I processed and merged the data from these distinct sources into a combined dataset suitable for estimation.

I began by filtering the 2016 and 2018 Yellowstone visitor survey data to include only those respondents who reported a valid home US zip code. This excluded all respondents who reported

1. Raw data from the 2016 and 2018 survey were provided by the Resource Systems Group and the University of Montana Institute for Tourism and Recreation Research, respectively.
2. Data from the 2024 Visitor Use Survey were also available, but in that year the questions asked of respondents about their demographic characteristics were insufficient to categorize them into the eight segments used for analysis based on the 2016 and 2018 surveys, so I was not able to use the 2024 survey data in this study.

visiting from a foreign country or who did not report a home zip code. These steps reduced the number of respondents in the 2016 dataset from 1,257 to 1,043 and in the 2018 dataset from 2,723 to 2,140.

Next, I used responses to demographic questions about income, race, and age to categorize respondents into mutually exclusive and exhaustive demographic segments. The original survey questions, including answer options, were worded as follows:

- "Which category best represents your annual household income?" (1 = less than \$25,000; 2 = \$25,000 to \$49,999; 3 = \$50,000 to \$74,999; 4 = \$75,000 to \$99,999; 5 = \$100,000 to \$149,999; 6 = \$1500,00 to \$199,999; 7 = \$200,000 or more).
- "Which of these categories best describes your race?" (American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Pacific Islander, White).
- "What is your age?" (open-ended).

Data from responses to the above survey questions were used to create three dummy variables:

1. Income dummy: equal to 1 if the respondent indicated an annual household income of \$75,000 or greater, 0 otherwise.
2. White dummy: equal to 1 if the respondent reported their race as white, 0 otherwise.
3. Age dummy: equal to 1 if the respondent reported that their age was 40 years or older, 0 otherwise.

To define the demographic segments for which price elasticities are to be estimated, I separated the respondents into eight groups, one for each possible combination of the three demographic dummy variables.

I excluded 327 respondents who did not report their income and 50 respondents who did not report their age from the 2018 dataset, and 179 respondents who did not report their income, 4 respondents who did not report their race, and 51 respondents who did not report their age from the 2016 dataset. The final dataset included 831 respondents from 2016 and 1,802 respondents from 2018. I also recorded the month in which each respondent was surveyed. The 2016 survey was conducted in August and the 2018 survey was conducted over a five-month period, from May through September.

The most important explanatory variable in any outdoor recreation demand study is the cost of travel faced by each visitor to the target site(s). I used a publicly available database of US zip codes [6] to match all zip codes reported by the visitor use survey respondents to their home county and state. The crosswalk between zip codes, counties, and states was used to associate an estimated travel cost to each visitor based on the correspondence between their home zip code, the county containing their zip code, and their home state. I used travel cost estimates for representative individuals in each US county or state from two previous studies. The first set of estimates was developed by Enriquez and Richardson [4] ("E&R") in a study of the demand for visits to 100 top National Park Service sites using mobility data, and the second set was developed by Carr and Newbold [5] ("C&N") in a study of the effect of congestion on the demand for trips to Yellowstone

National Park. E&R estimated travel costs from each county in the US to each of 100 National Park Service sites by computing a weighted average of estimated driving costs and flying costs from the county to the airport nearest to each site. C&N estimated travel costs by first estimating the cost of driving from a large central city in each state to YNP, and then applying a concave exponential transformation to the driving costs, which had the effect of reducing the estimated driving costs by a fraction that increases with the distance from each city of origin to YNP. This approach was intended to account for two reasons that driving costs will likely overestimate the cost of travel to YNP, especially for farther origins: 1) farther visitors are more likely to fly at least part of the distance to the park, and 2) farther visitors are more likely to visit YNP as one stop on a multi-destination trip. The E&R travel cost estimates explicitly accounted for the cost of airfare and the increasing probability of flying for farther visitors, but did not account for the possibility of multi-destination trips.

Figure 1 shows a scatterplot of three sets of travel cost estimates developed by Carr and Newbold, including the exponentially transformed driving costs used in the present study, versus the travel cost estimates developed by Enriquez and Richardson. Figure 2 shows histograms of both sets of travel cost estimates. The E&R travel cost estimates vary between \$100 and \$800 per visit between states, roughly double the C&N travel cost estimates, which vary between \$50 and \$350 per visit.[3] I take the spread between these sets of estimates to represent a plausible range of travel costs that should be attributed to YNP visits considering the uncertainty about the true frequencies of driving versus flying and single- versus multi-destination trips that end or pass through the park. To examine the robustness of the results to these travel cost alternatives, I estimated the trip demand model and analyzed the hypothetical policy scenarios described below separately using each set of travel cost estimates in turn and using a simple average of the two travel cost datasets. In light of this and other key uncertainties, I offer the results based on the two sets of travel cost data as “plausibility intervals” that likely bracket the true values. In applications where a single point estimate is desired, I would emphasize the results using the averaged travel cost data.

To facilitate statistical analysis, the survey data were organized in an array with 49 rows (one for each of the lower 48 US states plus the District of Columbia), eight columns (one for each demographic segment), and six layers (one for each month during which the 2016 and 2018 surveys were conducted). The cells in this data array contain the number of survey respondents from the corresponding state and in the corresponding demographic segment that were intercepted in the corresponding month, denoted below as Y_{jkt}. The demographic information at the state level obtained from the PUMS data set was arranged in a conformable table with 49 rows (one for each state) and eight columns (one for each demographic segment). The cells in this data table contain the number of people who live in the corresponding state and are classified into the corresponding demographic segment, D_{jk}. The total numbers of visits to Yellowstone National Park were arranged into a column vector with 6 rows (one for each survey month), V_t. Finally, travel cost estimates were arranged into a column vector with 49 rows (one for each state). The cells in this data vector contain the estimated average cost of traveling from each state to Yellowstone National Park, X_j.

3. In this study, a “visit” is meant to represent one individual traveling to the park from their home state, spending one or more days in the park, then traveling back home to their state of origin.

Model

This subsection describes the model used to analyze the combined visitor use survey data and supplemental information described above. The goal is to estimate parameters for the following logistic probability model, which describes the demand for trips to Yellowstone National Park by individuals who live in different states, indexed by $j = 1, 2, ..., J$, and belong to different demographic segments, indexed by $k = 1, 2, ..., K$, in each survey month, indexed by $t = 1, 2, ..., T$,

$$p_{jkt} = \frac{1}{1 + e^{-(\theta_t + \gamma_k - \lambda_k X_j)}}, \tag{1}$$

where p_{jkt} is the average probability that individuals who live in state j and belong to demographic segment k will visit YNP in month t, and X_j is the average cost of visiting the park for individuals who live in state j. The parameters to be estimated are:

θ_t — the log of the odds of visiting the park in month t for individuals in the base demographic segment (for which γ_k is normalized to 0 for identification) and zero travel cost ($X_j = 0$), akin to a demand curve intercept,

γ_k — the log-odds (demand curve intercept) shifter for demographic segment k, and

λ_k — the travel cost coefficient (proportional to the marginal utility of income) for demographic group k.

The number of parameters to be estimated depends on the number of survey months included in the dataset and the number of demographic segments used to distinguish survey respondents. In this study, I pooled the data from the 2016 and 2108 visitor surveys, so there are $T = 6$ survey months, and in all cases I used $K = 8$ demographic segments as defined above. Thus, there are 6 θ_t's, 7 γ_k's (with γ_1 normalized to 0), and 8 λ_k's, which add up to 21 parameters to be estimated.

To connect the model in equation (1) to the available data, note that the probability that a randomly selected park visitor in month t is from state j and belongs to demographic segment k is

$$\mathbb{P}[y_{itj} y_{itk} = 1] = \frac{p_{jkt} D_{jk}}{V_t}, \tag{2}$$

where y_{itj} is an indicator variable equal to 1 if survey respondent i was intercepted in month t and visited from state j or 0 otherwise, y_{itk} is an indicator variable equal to 1 if survey respondent i was intercepted in month t and is categorized in demographic segment k or 0 otherwise, D_{jk} is the number of people who live in state j and belong to demographic segment k, and V_t is the total number of visitors to the park in month t.[4]

This formulation naturally leads to a maximum likelihood estimation approach. The main advantages of maximum likelihood are that, assuming correct specification of the likelihood function,

4. To make this idea concrete, think of the visitors in the park in month t as marbles in a jar, and assume the marbles are distinguished by different colors corresponding to their different states of origin j and demographic segments k. V_t is the total number of marbles that have been placed in the jar, D_{jk} is the total number of marbles that live in state j and belong to demographic segment k, and p_{jkt} is the probability that each marble that lives in state j and belongs to segment k would have been placed in the jar in month t. If the marbles in the jar are well mixed and one is drawn at random, then the probability that a marble colored jk is pulled from the jar is $\mathbb{P}[y_{itj} y_{itk} = 1]$.

the resulting parameter estimates will be *consistent*, which means repeated samples would produce estimates centered on the true values, and *efficient*, which means that parameter estimates from repeated samples would have the lowest possible variances given the study design [7, p 21-22].

To specify the likelihood function, we assumed that the numbers of sampled visitors from state j and demographic segment k in month t, Y_{jkt}, follow a binomial distribution, i.e.,

$$\mathbb{P}[Y_{jkt}] = \binom{N_t}{Y_{jkt}} \left(\frac{p_{jkt} D_{jk}}{V_t}\right)^{Y_{jkt}} \left(1 - \frac{p_{jkt} D_{jk}}{V_t}\right)^{N_t - Y_{jkt}}, \tag{3}$$

where N_t is the number of visitors surveyed in the park during month t. Equation (3) follows logically from the probability defined in equation (1) and the assumption of random sampling in the park, which motivated equation (2) above. The log-likelihood function to be maximized is

$$\ell = \sum_{t=1}^{T} \sum_{j=1}^{J} \sum_{k=1}^{K} \log \left(\mathbb{P}\left[Y_{jkt}\right]\right), \tag{4}$$

and the parameters that maximize equation (4) are the maximum likelihood estimates.

I used the estimated parameters to calculate the price elasticity of demand for each demographic segment, ε_k, as follows:

$$\varepsilon_k = \frac{\sum_{j=1}^{J} \left[\lambda_k \left(1 - p_{jk}\right) X_j\right] Y_{jk}}{\sum_{j=1}^{J} Y_{jk}}. \tag{5}$$

The quantity enclosed in square brackets in the numerator of equation (5) is the price elasticity for individuals who live in state j and belong to demographic segment k, which follows from differentiating equation (1) with respect to X_j. Therefore, ε_k is the average of the state-level price elasticities weighted by the share of visits originating from each state. ε_k indicates the percent reduction in visits by people in demographic segment k that would be induced by a one percent increase in the cost of accessing the park (inclusive of the cost of travel and the entrance fee) from all states. That is, ε_k answers the question: If all prices were to increase by one percent, by how many percentage points would the total visits by individuals belonging to demographic segment k be reduced? The overall price elasticity is the average of the state- and segment-level elasticities weighted by the share of visits contributed by each segment in each state,

$$\varepsilon = \frac{\sum_{j=1}^{J} \sum_{k=1}^{K} \left[\lambda_k \left(1 - p_{jk}\right) X_j\right] Y_{jk}}{\sum_{j=1}^{J} \sum_{k=1}^{K} Y_{jk}}. \tag{6}$$

The overall price elasticity, ε, answers the question: If all prices were to increase by one percent, by how many percentage points would the total visits to YNP be reduced?

In addition to computing price elasticities, I used the parameter estimates to compute the average consumer surplus per trip for individuals in each demographic segment k using the approximation $1/\lambda_k$ [8], and to estimate the relative changes in total visits to the park and total fee revenues collected from visitors under six hypothetical entrance fee scenarios. The scenarios are distinguished by the sizes of the fee surcharges applied to all visitors, or visitors from states bordering YNP, or international visitors. The current entrance fee for passenger vehicles to Yellowstone National Park is \$35 per vehicle, and the average number of visitors per vehicle is around 3.6, which gives an average entry fee of roughly \$10 for visitors who enter in private passenger vehicles. However, many YNP visitors enter the park using one of several annual park passes purchased earlier and so pay fees at the gate, or they enter as part of a commercial tour and pay a discounted fee based on vehicle capacity, or they enter for free if they are under 16 years of age. In recent years, YNP has received roughly 4 million visitors per year and raised revenues from gate fees of around \$14 million per year, so for the baseline I assumed an average entry fee of \$3.5 per person. The hypothetical entry fee scenarios were framed as new surcharges for each visitor, to be applied on top of the existing entry fee structure regardless of age or mode of entry, as follows:

Scenario	*Details*
1	\$5 per person surcharge for all visitors.
2	\$10 per person surcharge for non-local visitors, free entry for locals (residents of WY, MT, and UT).
3	\$20 per person surcharge for international visitors.
4	\$10 per person surcharge for non-local domestic visitors, \$20 surcharge for international visitors, free entry for locals.
5	\$50 per person surcharge for international visitors.
6	\$100 per person surcharge for international visitors.

Only domestic visitors are included in the dataset used to estimate the trip demand function, but some of the scenarios to be assessed include distinct surcharges for international visitors. To fill this gap, I calibrated a trip demand function for international visitors based on the following assumptions: 1) N_I = 100 million people living outside of the United States have a non-zero probability of visiting YNP; 2) the travel cost for a representative international visitor is X_I = \$2,500 per trip;[5] under the current entrance fee, 3) international visits comprise $\rho_I = 15\%$ of total park visits [9, p vii], and 4) the price elasticity of demand for international visitors, ε_I, is the same as that for domestic visitors who are in the high income, white, and 40 years and older demographic segment. These assumptions are sufficient to specify two equations with two unknowns, which can be solved for two parameters of a trip demand function in the form of equation (1) for international visitors, θ_I and λ_I. The resulting calibration equations are

$$\lambda_I = \frac{\varepsilon_1}{\left(1 - \frac{\rho_I}{1-\rho_I}\frac{V_D}{N_I}\right) X_I} \tag{7}$$

and

$$\theta_I = \lambda_I X_I - \ln\left(\frac{1-\rho_I}{\rho_I}\frac{N_I}{V_D} - 1\right), \tag{8}$$

where ε_1 is the price elasticity for the wealthy, white, and old domestic demographic segment, and V_D is the total number of domestic visits in the month.

5. This is a ballpark number between the cost of a roundtrip flight between Paris and Jackson, WY and between Beijing and Jackson, WY.

Results

The maximum likelihood results, including parameter estimates, standard errors, and t-statistics for the trip demand model specified using both the E&R and C&N travel costs, are shown in the pair of displays in Table 1. In both cases, nearly all parameter estimates have t-statistics that are larger than 2, indicating rejection of the null hypothesis that the corresponding parameter is equal to 0 at the conventional type I error rate of 5%. The magnitudes of the estimated θ's, which are the month-specific demand intercept coefficients, vary only modestly across months, which reflects that the visitor surveys were conducted in peak summer months with high and relatively steady visits. The magnitudes of the estimated γ's are somewhat more variable, indicating heterogeneous preferences to visit Yellowstone among the eight demographic segments. The patterns of these estimates are closely aligned with the shares of sample visits contributed by each demographic segment as shown in Table 3 below. Note that γ_1 is excluded from the tables because this parameter was fixed at 0 to allow identification of the full set of θ's and the remaining γ's.[6] The last row in each table shows McFadden's pseudo-R^2 value, $1 - \ln L/\ln L_0$ where $\ln L$ is the log-likelihood of the full model and $\ln L_0$ is the log-likelihood of a restricted model including only a single θ value, which implies that all US residents have an equal probability of visiting YNP in all months.

Note that the estimating equation includes separate travel cost coefficients for each demographic segment. To facilitate interpretation of these estimates, I performed an auxiliary regression of the $\hat{\lambda}_k$'s on a constant and dummy variables for each of the three demographic variables that were interacted to define the eight segments. The auxiliary estimating equation was specified as follows:

$$\hat{\lambda}_k = \beta_0 + \beta_1[\geq\$70\text{K}]_k + \beta_2[\text{White}]_k + \beta_3[\geq 40\text{y}]_k. \tag{9}$$

The auxiliary regression results using the E&R C&N, and averaged travel cost estimates are shown in Table 2, and scatterplots of the primary $\hat{\lambda}_k$ estimates and their auxiliary fitted values using the E&R and C&N travel cost data are shown in Figure 3. The coefficients on the constant, the income dummy variables, and the age dummy variables in the auxiliary regressions have t-statistics greater than 2, but the t-statistics for the race dummy variables are very small. The income and age coefficients also are substantially larger than the race coefficient. Therefore, the associations between the λ_k estimates are with income and age. The sign of the income coefficient is negative, which is consistent with the idea that the marginal utility of income decreases as income increases. The sign of the age coefficient is positive, which indicates that the average age of YNP Visitor Use Survey respondents was greater than 40 years old. The R^2 values in Table 2 and the scatter plots in Figure 3 show that the auxiliary regression models explain a large share of the variation among the primary $\hat{\lambda}_k$ estimates, which suggests that a simpler primary model that included only the main effects of the demographic dummy variables might fit nearly as well as the fully saturated demographic segmented model used in this study.

Estimates of consumer surplus (CS) per visit and the price elasticity of demand for each demo-

6. If all θ's and all γ's are estimated freely, then any fixed increment added to all members of either set of parameters could be exactly offset by an opposing increment subtracted from all members of the other set. Pinning down one of the parameters prevents this freedom of adjustment and, therefore, allows identification of all remaining parameters.

graphic segment are shown in Table 3. Here, the differences between the E&R and C&N results are substantial. CS estimates per visit using the E&R travel cost data are more than three times larger than those based on the C&N travel cost data, and the C&N elasticities are between 1.5 and 2 times larger than the E&R elasticities. The directions of these differences are easy to understand. The E&R specification implies that visitors spend substantially more money to purchase visits to YNP, implying a higher value per trip and a lower responsiveness to variations in travel costs relative to the C&N specification. The E&R results would be more accurate if most visits to YNP are single-purpose trips, while the C&N results would be more accurate if most visits to YNP are stops on larger multi-destination trips. Such trips may include one or more other national parks that are close enough to YNP that the incremental travel costs between the chained destinations are substantially lower than the E&R travel cost estimates. Under this interpretation, the directional differences between the two sets of estimates also suggest that other destinations on the same trip function as substitutes rather than complements to YNP visits. The results in the final columns of Table 3, based on the average of the E&R and C&N travel cost estimates, are in between the results shown in the first two sets of columns. If equal credences are assigned to the E&R and C&N travel cost estimates, then the Average results provide the best available point estimates of the price and fee elasticities.

The main results of this study are presented in Table 4, which shows estimates of the relative changes in total park visits, $\Delta V/V$, and total fee revenues, $\Delta R/R$, for the six hypothetical entrance fee scenarios. Here again, results are shown using the E&R, C&N, and averaged travel cost estimates. Using the averaged travel costs, baseline visits are predicted to decrease between 0.3 and 5.1 percent across the six scenarios. Scenario 3, which applies a surcharge of $20 per person for international visitors only, leads to the smallest decrease in park visits, while Scenarios 2 and 4, which involve the largest surcharges for non-local visitors, lead to the largest predicted decreases in visits. The predicted relative increases in fee revenues are between 84 and 388 percent of the baseline revenues, which are much larger than the predicted decreases in park visits. The large contrast between the relative changes in park visits and fee revenues is explained by the fact that the average entrance fee of $3.50 per visitor represents only a small fraction of the total price of reaching the park for most YNP visitors—a fact also reflected in the differences between the price elasticities and the entry fee elasticities in Table 3. The hypothesized surcharges represent far smaller percentage changes to the full price of visiting the park than to the baseline entry fee.

Curves showing predicted changes in visits and revenues for a wide range of entrance fees using the averaged travel cost estimates are shown in Figure 4. These results suggest that the entrance fees would have to be increased to very high levels before the total fee revenues would start to decline. The implied revenue-maximizing surcharge is $233 per person. This value is far larger than any reasonable entrance fee, so the practical significance of these results is that any realistic increases in entrance fees would almost surely lead to increased fee revenues with virtually no risk of overshooting the point of revenue maximization. The gray lines in the figures show the relative changes in park visits and fee revenues for the constituent demographic segments, which add up to the black curves showing the total effects. The largest $\Delta R/R$ curve is for the predicted international visits. This suggests that very high entrance fees would lead to far fewer park visitors composed of a much larger share of international rather than domestic visitors.

Discussion

The results of this study provide new insights into the price elasticity of demand for visits to Yellowstone National Park (YNP) among different demographic segments. The estimated price elasticities, ranging from 1.38 to 3.16 using the E&R travel costs and from 1.67 to 4.99 using the C&N travel costs, suggest that the demand for visits to YNP is generally elastic, which means that visitors are sensitive to changes in travel costs. These findings are consistent with economic theory, which posits that demand for recreational goods tends to be elastic [10], as these goods are often considered discretionary. However, the estimated entry fee elasticities are much smaller, between 0.0083 and 0.0217 using the E&R travel costs and between 0.0136 and 0.0341 using the C&N travel costs, which reflects the fact that the current average entry fee is a small fraction of the total price of accessing the park for most visitors.

The differences in elasticity estimates derived from the E&R and C&N travel cost data highlight the sensitivity of the results to the assumptions made about travel behavior. The E&R estimates, which are higher, likely reflect single-destination trips and the inclusion of air travel costs, while the C&N estimates, which are lower, are compatible with a large share of visits being part of multi-destination trips. Although neither set of estimates is clearly superior, the differences between them likely produce a plausible range for the true elasticity values. For applications where point estimates are desired, the results based on the averaged travel cost estimates can be used.

The analysis of hypothetical entrance fee changes reveals that higher entrance fees, particularly for non-local and international visitors, can generate substantial revenue increases with relatively small decreases in visitation. This finding stems from the fact that entrance fees constitute a small portion of the overall cost of visiting YNP for most visitors. The sensitivity analysis further demonstrates that revenue maximization would require implausibly high entrance fees, suggesting that YNP could increase fees substantially without risking a decline in revenue.

This study has several limitations. First, the analysis is based on data from 2016 and 2018, and visitor behavior may have changed since then. I was unable to use the available data from the 2024 visitor use survey because that version did not include questions about respondents' attributes sufficient to classify the 2024 respondents into the eight demographic segments used in this analysis. Second, the travel cost estimates are subject to uncertainty stemming from the unknown shares of visits that represent single-destination trips or parts of multi-destination trips, as discussed above. Third, the study does not explicitly model international visitor behavior due to data limitations, instead relying on assumptions to calibrate an auxiliary demand function for this group. Future research could address some of these limitations by incorporating more recent data, refining travel cost estimates, and developing more robust models of international visitor demand. Additionally, future studies could examine the impact of other interventions on trip demands and visitor behaviors in Yellowstone National Park, such as providing real-time information through a mobile app about waiting times at park entrance gates, the availability of parking at popular viewing destinations, or the amount of foot traffic on popular hiking trails within the park.

Conclusions

This study provides new estimates of the price elasticity of demand for visits to Yellowstone National Park (YNP) in different demographic segments. The results indicate that the demand is heterogeneous among demographic segments of visitors, is highly elastic with respect to the total cost of visiting, but is inelastic with respect to the entry fee alone. The estimated values vary substantially depending on the assumptions made about travel costs. The analysis of hypothetical entrance fee changes suggests that YNP could increase revenue by implementing a differentiated fee structure, particularly one that targets non-local and international visitors. However, any policy decisions related to entrance fees should be made with careful consideration of possible impacts on different visitor segments and the overall park experience. More research would be useful to refine the price elasticity estimates and explore other factors that may influence visitation demand at Yellowstone and other marquis national parks.

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Figures and Tables

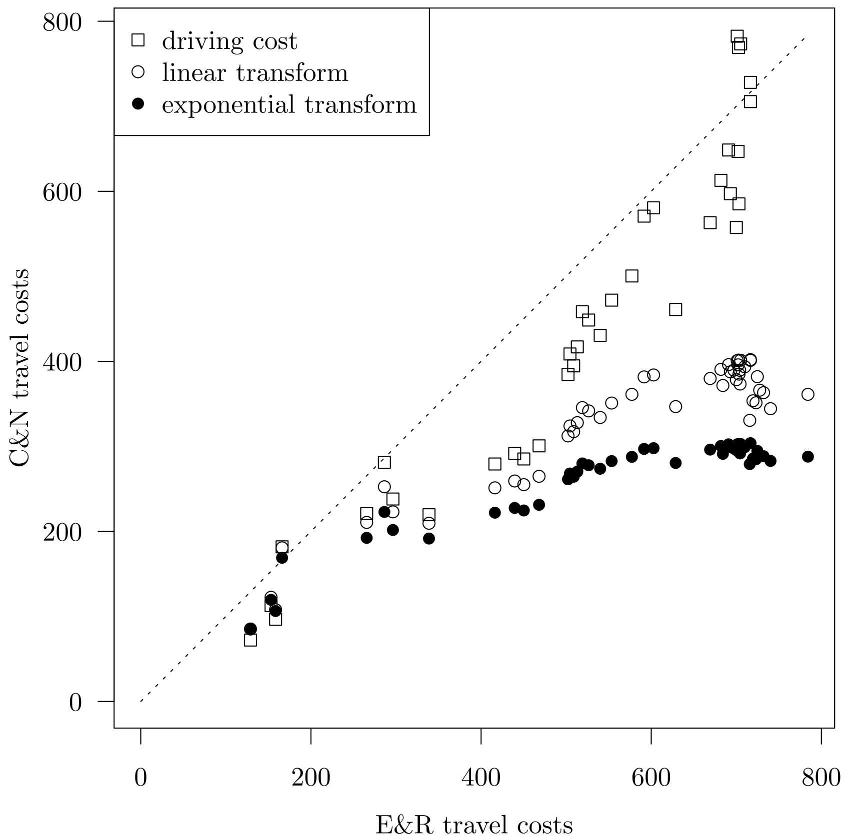

Figure 1. Scatter plot of three measures of travel costs, X [$/visit], from 49 U.S. states to Yellowstone National Park developed by Carr and Newbold (C&N) versus travel cost estimates developed by Enriquez and Richardson (E&R). Most of the C&N estimates fall below the dotted 1:1 line, and the exponentially transformed estimates are the lowest of them all and therefore provide the highest contrast with the E&R estimates.

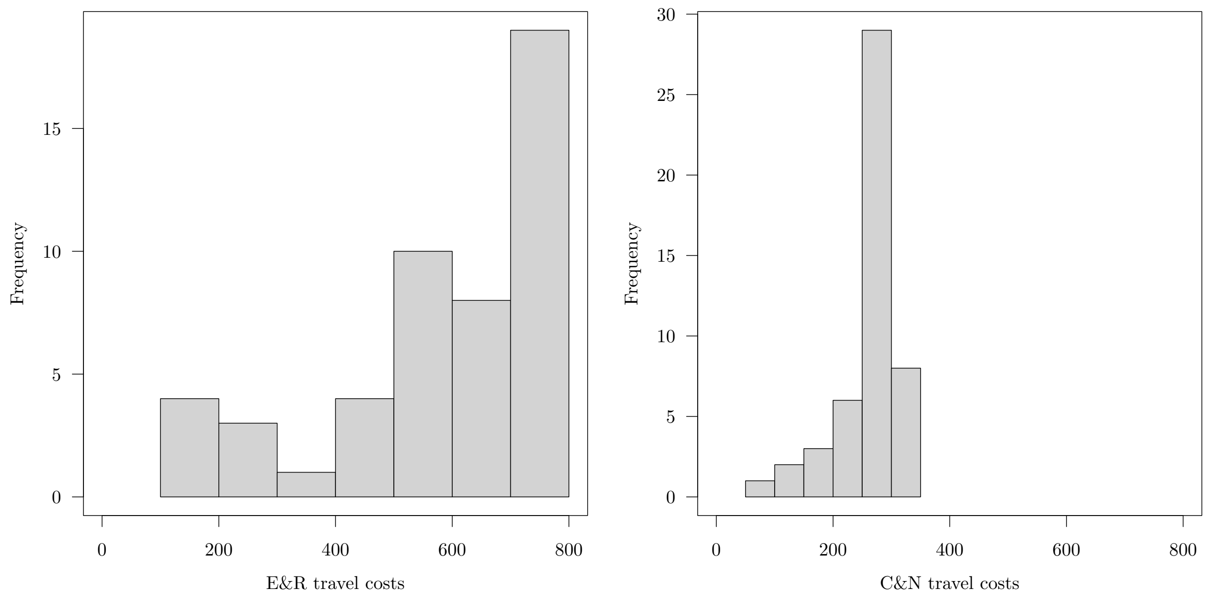

Figure 2. Histograms of E&R (left panel) and C&N (right panel) travel cost estimates.

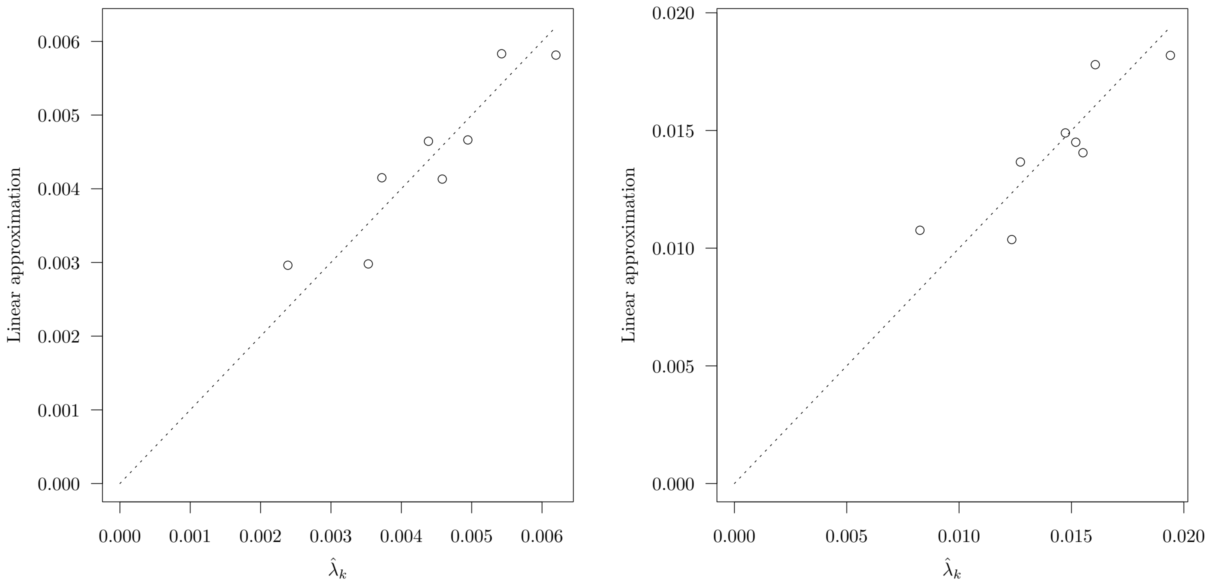

Figure 3. Predicted values from auxiliary regressions of the primary segment-specific travel cost coefficients, $\hat{\lambda}_k$, on a constant and dummy variables for the three dimensions that define the demographic segments: ≥\$75K, White, and ≥40y.o. using the Enriquez and Richardson travel cost estimates (left panel) and the Carr and Newbold travel cost estimates (right panel).

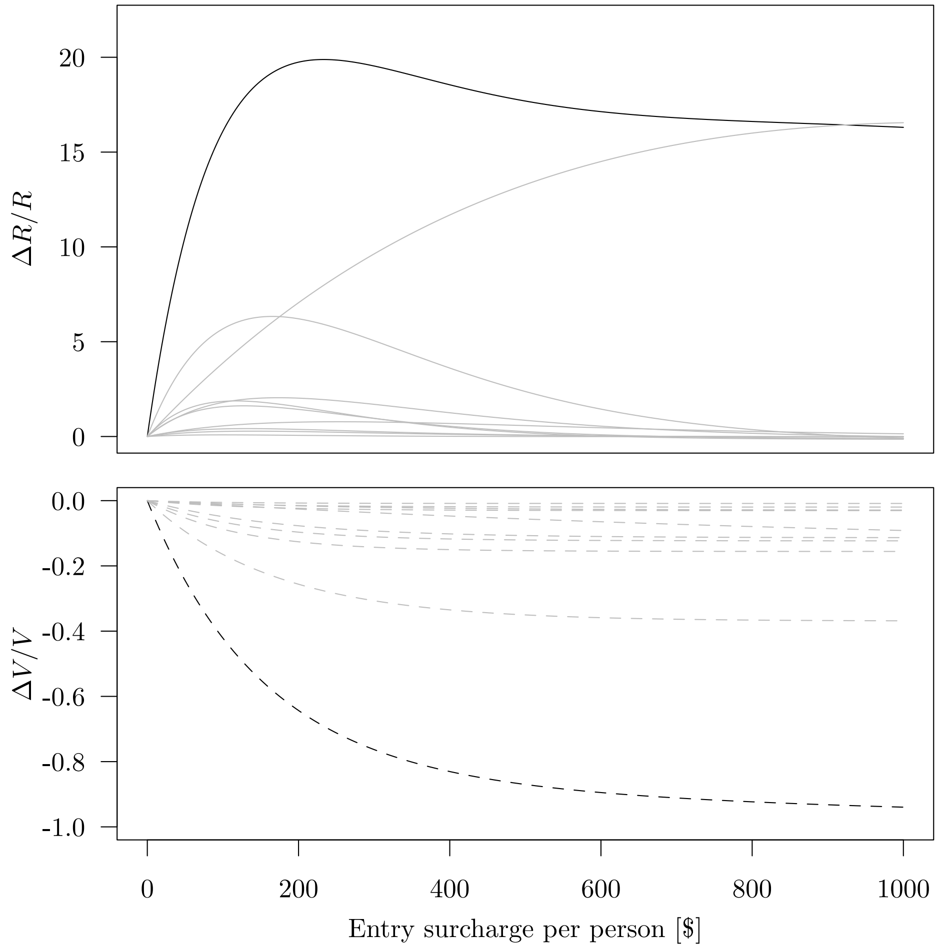

Figure 4. Predicted relative changes in fee revenues, $\Delta R/R$ (top), and park visits, $\Delta V/V$ (bottom), versus the entrance surcharge per person to Yellowstone National Park based on the average of the two sets of travel cost estimates developed by (1) Enriquez and Richardson and (2) Carr and Newbold. The gray lines are curves for the individual demographic segments, which add up to the black curves that show the total effects.

Table 1. Parameter estimates, standard errors, and t-statistics based on travel cost estimates developed by Enriquez and Richardson (left table) and by Carr and Newbold (right table).

Parm.	Est.	s.e.	t-stat
θ_1	-3.63294	0.09643	-37.67
θ_2	-3.62665	0.10540	-34.41
θ_3	-3.02839	0.10201	-29.69
θ_4	-2.87912	0.10679	-26.96
θ_5	-3.02398	0.10375	-29.15
θ_6	-3.14281	0.10637	-29.55
γ_2	-1.15588	0.18312	-6.31
γ_3	-0.32600	0.38678	-0.84
γ_4	-1.85786	0.44143	-4.21
γ_5	-0.17707	0.14834	-1.19
γ_6	-0.40442	0.15888	-2.55
γ_7	-1.15024	0.58565	-1.96
γ_8	-1.63506	0.42952	-3.81
λ_1	0.00372	0.00015	24.18
λ_2	0.00353	0.00027	13.21
λ_3	0.00458	0.00063	7.31
λ_4	0.00239	0.00069	3.48
λ_5	0.00543	0.00021	25.41
λ_6	0.00495	0.00024	20.67
λ_7	0.00620	0.00101	6.11
λ_8	0.00439	0.00070	6.24
pR^2	0.34457		

Parm.	Est.	s.e.	t-stat
θ_1	-2.29857	0.14015	-16.40
θ_2	-2.29165	0.14651	-15.64
θ_3	-1.69236	0.14425	-11.73
θ_4	-1.54284	0.14772	-10.44
θ_5	-1.68817	0.14550	-11.60
θ_6	-1.80823	0.14725	-12.28
γ_2	-1.14610	0.27598	-4.15
γ_3	0.01522	0.63860	0.02
γ_4	-2.27958	0.83629	-2.73
γ_5	-0.21558	0.20847	-1.03
γ_6	-0.39622	0.22650	-1.75
γ_7	-0.68805	0.79200	-0.87
γ_8	-1.43199	0.62379	-2.30
λ_1	0.01273	0.00051	25.03
λ_2	0.01234	0.00089	13.81
λ_3	0.01551	0.00224	6.92
λ_4	0.00826	0.00291	2.84
λ_5	0.01606	0.00062	26.11
λ_6	0.01519	0.00071	21.44
λ_7	0.01940	0.00293	6.62
λ_8	0.01473	0.00223	6.60
pR^2	0.35248		

Table 2. Auxiliary regressions of the estimated travel cost coefficients for the demographic segments on a constant and demographic dummy variables, based on travel cost estimates developed by Enriquez and Richardson (E&R), Carr and Newbold (C&N), and the average of the two.

	$\hat{\beta}$	s.e.	t-stat
E&R			
Constant	0.00464	0.00043	10.8
≥$70K	-0.00168	0.00043	-3.92
White	0.00002	0.00043	0.0422
≥40y	0.00117	0.00043	2.72
R^2	0.850		
C&N			
Constant	0.0149	0.00151	9.89
≥$70K	-0.00414	0.00151	-2.75
White	-0.000395	0.00151	-0.262
≥40y	0.00329	0.00151	2.19
R^2	0.756		
Average			
Constant	0.00735	0.000690	10.7
≥$70K	-0.00247	0.000690	-3.58
White	-0.000115	0.000690	-0.167
≥40y	0.00179	0.000690	2.59
R^2	0.830		

Table 3. Estimates of consumer surplus per visit [$] and the price elasticity of demand for trips to Yellowstone National Park based on travel cost estimates developed by Enriquez and Richardson (E&R), Carr and Newbold (C&N), and the average of the two.

					E&R			*C&N*			*Average*		
k	≥$75K	White	≥40y	Share	CS	Price elas.	Fee elas.	CS	Price elas.	Fee elas.	CS	Price elas.	Fee elas.
1	1	1	1	0.369	268.6	1.98	0.01294	78.6	3.32	0.04417	168.3	2.36	0.02064
2	1	1	0	0.114	283.2	1.86	0.01233	81.0	3.21	0.04307	176.7	2.23	0.01975
3	1	0	1	0.030	218.3	2.50	0.01598	64.5	4.24	0.05409	135.5	3.02	0.02575
4	1	0	0	0.029	418.8	1.38	0.00834	121.1	2.32	0.02885	256.7	1.67	0.01361
5	0	1	1	0.156	184.3	2.57	0.01890	62.3	3.89	0.05586	120.2	2.98	0.02898
6	0	1	0	0.123	202.2	2.33	0.01723	65.8	3.68	0.05287	130.5	2.73	0.02670
7	0	0	1	0.009	161.4	3.16	0.02167	51.5	4.99	0.06778	102.6	3.74	0.03408
8	0	0	0	0.020	228.0	2.36	0.01533	67.9	3.92	0.05148	142.5	2.82	0.02454
9				0.150	1,261.0	1.98	0.00277	752.2	3.32	0.00911	1,060.0	2.36	0.00330
Overall						2.12	0.01288		3.47	0.04121		2.51	0.02012

Table 4. Six entry fee scenarios evaluated using parameter estimates based on three travel cost datasets, by Enriquez and Richardson (E&R), Carr and Newbold (C&N), and the average of the two. Fee changes are per person surcharges. Columns are predicted changes in total visits and total entry fee revenues relative to their baseline levels.

Scenario	$\Delta V/V$	$\Delta R/R$
E&R		
1: +$5 all	-0.018	1.38
2: +$10 others, locals free	-0.033	2.52
3: +$20 intl	-0.002	0.84
4: +$10 others, +$20 intl, locals free	-0.034	2.93
5: +$50 intl	-0.006	2.05
6: +$100 intl	-0.011	3.94
C&N		
1: +$5 all	-0.057	1.29
2: +$10 others, locals free	-0.093	2.12
3: +$20 intl	-0.004	0.83
4: +$10 others, +$20 intl, locals free	-0.095	2.53
5: +$50 intl	-0.010	1.99
6: +$100 intl	-0.019	3.72
Average		
1: +$5 all	-0.028	1.36
2: +$10 others, locals free	-0.050	2.41
3: +$20 intl	-0.003	0.84
4: +$10 others, +$20 intl, locals free	-0.051	2.82
5: +$50 intl	-0.007	2.03
6: +$100 intl	-0.013	3.88

Author biography

Stephen C. Newbold is an associate professor in the Department of Economics at the University of Wyoming. His research and teaching interests include environmental and natural resource economics, bio-economic modeling, applied econometrics, and quantitative policy analysis including applications to climate change, water quality, and human health impacts.