## Title
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# The economic value of novel means of ascending high mountain peaks: a travel cost demand model of Pikes Peak cog railway riders, automobile users and hikers

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In addition to hiking trails, some peaks have alternative transportation routes such as cog railways, trams or roads to reach the summit. The authors use a count data travel cost model to estimate the recreational demand for traditional and novel means of ascending Pikes Peak in Colorado. Their analysis shows statistically significant differences in the demand curve slopes and in the net willingness to pay (consumer surplus) for three categories of recreationists who take alternative means to ascend the mountain. The more exotic or unique the means of ascent, the higher the visitor benefits are. Cog railway and automobile users and those ascending by hiking receive consumer surpluses of US$98, US$54 and US$31, respectively, per day trip.

*Keywords*: mountain recreation; travel cost model; hiking; trams; motorized recreation; Pikes Peak

Most high mountain peaks throughout the world are accessible only by hardy hikers and/or when guided by skilled mountaineers. Occasionally, some peaks are accessible simultaneously by mechanized means such as cabled trams or special railcars, as well as by hiking/climbing. For example, peaks in resort areas may be accessed by chairlifts or trams in conjunction with alpine ski areas such as Jackson Hole, Wyoming. The summit of Mount San Jacinto outside of Palm Springs, California, can be accessed either through hiking or by a ride to the top in an aerial tram. Only rarely do the terrain and road infrastructure allow for automobile access to these high peaks, while maintaining the natural

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character sought by hikers and traditional outdoors recreationists. However, there are a few such peaks – Sandia Peak in New Mexico and Pikes Peak and Mount Evans in Colorado – that can be accessed by hiking or by motor vehicle. Furthermore, in addition to motorized vehicle and hiking access, the summits to both Sandia Peak and Pikes Peak can be reached via a mechanized means such as a tram and cog railway, respectively.

Our study has two purposes. First, we quantify the economic values of these novel means of ascent, as they have not been studied previously. While there have been several past studies that have examined disparate recreational uses, much of this literature has focused on recreation carrying capacity (Manning *et al*, 2002, 2003); trade-offs between recreation and natural resource use (Lambert and Shaw, 2000; Tarrant and Cordell, 2002); conflict resolution between multiple recreation uses (Koontz and Hoag, 2005; Newman *et al*, 2006); and multiple use on public lands (Loomis, 2002). Although May (1997) implemented a travel cost model to determine consumer surplus in a multi-use recreational area, she evaluated only the consumer surplus for snowmobiling. We believe that this is the first study that uses a travel cost model to investigate the differences in the values between recreationists using disparate means for high altitude mountain access.

Second, we examine whether the presence of motorized vehicles and cog rail passengers affects hiker consumer surplus and net benefits of climbing high mountain peaks. Valuation of the different recreational modes of ascending Pikes Peak may be confounded by the fact that each Fourteener is considered highly unique in its own right – and the prestige of summiting a peak higher than 14,000 feet is available in only a few places in the USA. Thus, we are valuing novel transportation and its effect on a relatively unusual recreational environment. In contrast, other studies that have looked at the economics behind disparate forms of recreation (Keith, 1980; Rosenthal and Walsh, 1986) have concentrated on activities that could, arguably, take place in many other nearby natural settings. The existing literature suggests that the potential interaction among dissimilar modes of travel raises the possibility of negative interactions, reducing the benefits for one group or another (Newman *et al*, 2006). For example, conflicts are common between visitors engaging in different recreation activities (for example, hikers and mountain bikers; hikers and horses) at areas where multiple activities are allowed (Manning, 1985). These conflicts are exacerbated when one set of visitors is motorized and the other is non-motorized (Shelby, 1980; Jackson and Wong, 1982; Manning, 1985). Furthermore, there is also a question of the relationship between crowding (regardless of whether it arises from a disparate recreational activity) and natural resource quality (Vaske *et al*, 1980).

There is also heightened management relevance to this latter issue, as increased recreational demand has exerted pressure on national parks and other public lands during the past several decades. Conflicts abound with regard to the continuum of experiences that public recreational areas should provide. This continuum may range from maintaining a purely natural environment at one end of the spectrum, to a highly developed resort area capable of providing accessibility to many potential visitors and generating tourism revenues (Loomis, 2002). These issues are exemplified by gateway communities that push for trams or chairlifts up to the top of prominent peaks as a tourist draw, which potentially may conflict with recreationists that are attracted to traditional outdoor recreation opportunities in the area. For example, Estes Park has an aerial tram outside of the Rocky Mountain National Park in Colorado – a popular hiking and camping destination. Moab, Utah, has chairlift rides to the top of sandstone cliffs, in an area that also provides world class mountain biking. Besides the obvious visual effects of such infrastructure, the addition of mechanized transport may reduce benefits to hikers and those seeking a more natural experience. Although discussion has taken place for years about how to manage the land best for multiple recreation interests, this is the first study to estimate the differences in economic benefits associated with different recreational modes on the same mountain peak. Further, we discuss the implications of novel means of ascent, as well as these other issues, later in our paper.

## Hypotheses

In this paper, we compare the economic benefits received by visitors who ascended Pikes Peak in one of three categories: hiking (which also includes a few visitors bicycling); motorized vehicles (automobiles and a few motorcycles); and the cog railway, which is propelled by a locomotive with a cog wheel that connects with a steeply inclined centre track. We hypothesize the more novel the method of ascent, and hence the more unique the experience, the higher the economic benefits received by the visitor. We also evaluate whether the presence of cog railway riders and motorized vehicles on the mountain might reduce what otherwise would be a relatively high hiking value downward to a more modest value. This hypothesis is grounded in the fact that there are more than fifty 14,000-foot peaks in Colorado that can be hiked or climbed. Only two 14,000-foot peaks can be ascended by motorized vehicle, and only the summit of Pikes Peak can be reached via all three modes. Thus, for hikers seeking to summit high peaks, there are many substitutes for Pikes Peak. Therefore, we hypothesize that the benefits to those who hike Pikes Peak may be relatively low, as the presence of automobiles and throngs of cog railway passengers at both the peak and the base may diminish the quality of hikers' recreational experience.

Economic benefits are defined as the user's net willingness to pay (WTP), or WTP in excess of their costs, also referred to as consumer surplus (CS). Thus, our hypothesis can be formalized as:

$$\text{Ho: } CS_{\text{hike}} = CS_{\text{motor}} = CS_{\text{cog railway}}$$

$$\text{Ha: } CS_{\text{hike}} < CS_{\text{motor}} < CS_{\text{cog railway}}.$$

## Count data travel cost models

In order to calculate a visitor's CS, we estimate statistically his or her demand curve for ascending Pikes Peak. The travel cost method (TCM) has been commonly used for decades to estimate a recreation demand curve empirically.

However, since annual trips to a recreation site is a non-negative integer, and if the average number of trips taken per person is small, statistical efficiency can be improved by adopting a count data estimator that accounts for this feature of the dependent variable (Creel and Loomis, 1990; Hellerstein, 1992). A commonly used count data estimator for the annual number of trips consumed by an individual in a year is a Poisson estimator, where the probabilities of an individual taking $y$ trips can be modelled as:

$$Pr(y|X) = \exp(-\lambda)*\lambda^y/y!, \tag{1}$$

where $\lambda$ is the Poisson parameter, which is equal to the expected number of trips. Equation (1) yields a familiar semi-log demand form for trips:

$$\ln \lambda = \beta_0 - \beta_1 TC + \beta_2 X_2 + \ldots \beta n \mathrm{X} n, \tag{2}$$

where $TC$ is travel cost. The $\beta$s and $X$s reflect respective coefficients and other non-price independent variables (such as demographics, for example).

However, a restriction of the Poisson count data model is that it assumes the mean and variance of trips are equal. This may not be the case, resulting in a condition known as overdispersion. The negative binomial form of the count data model is a more general count data model and does not impose the equality of mean and variance of trips. The negative binomial model also allows one to test for overdispersion (see Haab and McConnell, 2002, for more details). Thus, we test for overdispersion using the negative binomial model.

Using either the Poisson or negative binomial count data model, the CS per trip is:

$$CS \text{ per trip} = 1/\beta_1. \tag{3}$$

Following Englin and Shonkwiler (1995), it is not necessary to use a simulation method or bootstrapping in order to estimate confidence intervals for CS per trip calculated from a negative binomial or Poisson TCM. Englin and Shonkwiler provide a simple Taylor series approximation for the confidence interval around the CS per trip that involves the standard errors on the TC coefficient.

A single TCM demand function can be used to calculate separate estimates of CS for each of the three trip types – for example, hiking, motorized vehicle and cog railway. This is an especially attractive feature when there are small sample sizes, since separate models for each group cannot be estimated. To make this feature more explicit, we combine a stylized version of our model in (2) with the distinguishing feature of the interaction of travel mode with the travel cost variable to allow for testing for differences in CS by mode:

$$\begin{aligned} \ln \lambda &= \beta_0 - \beta_1 TravelCost + \beta_2(Car*TravelCost) \\ &+ \beta_3\ (CogRailway*TravelCost) + \beta_4 TravelTime + \beta_5 Income + \beta_6 Income^2 \\ &+ \beta_7(No\ of\ Other\ Rec\ Trips), \end{aligned} \tag{4}$$

where *TravelCost* is the round trip fuel costs reported by visitors. Using just the fuel costs in the model ensures that we have incorporated only the exogenous variable trip costs (Ward, 1984). However, a road toll for automobiles and cog railway tickets are necessary and exogenous expenses for these two types of visitors, so they are added to their travel costs.

*Car* and *CogRailway* are dummy variables for whether the individual drives a motorized vehicle or rides the cog railway to the top of Pikes Peak, respectively.

*TravelTime* is the round trip travel time from home to the base of Pikes Peak (see Feather and Shaw, 1999, for more details on incorporating travel time as a separate variable). Failure to control separately for visitor travel time can result in omitted variable bias on the travel cost coefficient, and hence biased CS estimates (Cesario and Knetsch, 1970). *Income* is annual household income.

*No of Other Rec Trips* is the response to the question 'About how many non-Fourteener related outdoor recreation trips have you taken during the past 12 months?' The number of recreation trips to other areas has been suggested by Smith (1993) as a proxy for the substitute price to all other substitute recreation sites. Essentially, the greater the number of trips to all other sites, the lower the travel cost is to these substitute sites.

## Hypothesis testing methods

Statistical significance on the differential price slope coefficient, $\beta_2$ or $\beta_3$, would indicate that the price slope for the various trip modes of ascent are different and, therefore, the CS of the three sample groups also may be different. Thus, our first hypothesis tests the similarity of hikers, motorized vehicle visitors and cog railway users to determine whether or not the price interaction coefficients are statistically significant. Thus, equal demand curve slopes indicate that there is no difference in value between those who ascend Pikes Peak on foot or via motorized vehicle or cog railway. In this case:

$$\text{Ho: } \beta_2 = 0 \tag{5}$$

$$\text{Ho: } \beta_3 = 0. \tag{6}$$

The CS for the omitted category, hikers, is $|1/\beta_1|$, while the counterpart for motorized vehicle ascents and cog railway rides to the top of Pikes Peak are given in Equations (7) and (8), respectively:

$$CS_{\text{motor}} = |1/(\beta_1 + \beta_2)|. \tag{7}$$

$$CS_{\text{cog railway}} = |1/(\beta_1 + \beta_3)|. \tag{8}$$

Equality of CS is our main interest and would be tested by:

$$\text{Ho: } CS_{\text{motor}} = CS_{\text{hikers}} \tag{9}$$

$$\text{Ho: } CS_{\text{cog railway}} = CS_{\text{hikers}}. \tag{10}$$

This is tested by whether the confidence intervals on the respective CS estimates overlap (Creel and Loomis, 1991).

## Data

From July 2006 through November 2006, 206 mail-back surveys were distributed over five separate non-holiday weekends, once a month during the late morning. The surveys were distributed both at the base of the mountain and at the summit. Base distribution took place at the trailhead for hikers/bikers, the cog railway station and at the entrance gate for motorized vehicles. Summit surveys were distributed to recreationists at the rest stop/restaurant/gift shop hut at the top of the peak.

Sample size (both in general and for specific travel modes) was influenced greatly by weather, the logistics of cog railway operation and difficulty in distinguishing between visitors who had arrived at the summit by car versus cog railway. Inclement weather during the 2006 hiking season affected the survey distribution efforts significantly, resulting in a smaller sample size than originally desired. Prime Fourteener hiking takes place between the months of June and September, after much of the winter snow has melted at this altitude. Weekend storms, coupled with severe afternoon weather (not unusual at high altitude, but relatively intense in 2006 compared to other years) reduced the potential survey days, requiring that we extend the distribution into November. Severe weather also shortened the length of time researchers spent at the summit and trailhead and we believe that it may have reduced the number of visitors (particularly hikers). Although total recreational visitor use is often difficult to quantify (English *et al*, 2002), we believe that the effect of weather on reduced Pikes Peak Fourteener recreation was validated by eight respondents who independently answered 'weather' to the survey question: 'Please tell us what activities and natural resources influence how you select what Colorado Fourteeners to hike during a given year.'

The logistics of the cog railway operation also affected survey distribution. Although the cog railway publishes an annual schedule, the number of trips up the mountain varies according to the weekend, as well as the number of reservations. For example, on some autumn weekends, only one cog trip was actually planned and the percentage of cog railway riders was proportionately smaller than the rest of the visitors at the top of the peak. Once at the Pikes Peak summit, visitors have a maximum of 20–30 minutes to enjoy the views before they must return to the cog. The strict departure policy (http://www.cograilway.com/alongroute.htm) limited the number of visitors that surveyors could approach about the study on a given day, particularly since it was often difficult to distinguish cog riders from car visitors after the initial unloading on the summit. Although no study refusals were noted, cog railway riders generally appeared to be less attentive to the surveyor, presumably because of limited control over their departure schedule and less time to enjoy the summit as an 'end destination'. Efforts were made to increase the number of observations of cog railway riders as the study continued, although survey distribution was still higher for motorists, the group that constituted the largest proportion of recreational visitors. Non-response rates were slightly higher for cog railway visitors and motorists compared to hikers, although the response rate for all recreational categories was 55%.

The mail-back surveys were designed along the lines of Dillman's Tailored Design Method (Dillman, 2000) and included an attractive cover and an

Table 1. Count data travel cost demand model for Pikes Peak, Colorado.

| Variable | Coefficient | Std error | *z*-Statistic | Probability |
|---|---|---|---|---|
| Constant | 4.86422 | 0.10679 | 45.546 | 0.0000 |
| Travel cost | –0.03244 | 0.00367 | –8.825 | 0.0000 |
| Travel time | –0.00231 | 0.00045 | –5.059 | 0.0000 |
| Car*Travel cost | 0.01377 | 0.00377 | 3.652 | 0.0003 |
| Cog*Travel cost | 0.02224 | 0.00391 | 5.678 | 0.0000 |
| Income | –2.62E–05 | 1.61E–06 | –16.244 | 0.0000 |
| Income squared | 2.50E–11 | 2.23E–12 | 11.209 | 0.0000 |
| No of other rec trips | –0.03327 | 0.00653 | –5.089 | 0.0000 |
| $R^2$ | 0.4523 | Mean dependent var | | 5.4719 |
| Adjusted $R^2$ | 0.4050 | LR index (Pseudo–$R^2$) | | 0.506 |
| Log likelihood | –490.160 | LR statistic (7 df) | | –1005.372 |
| Restr log likelihood | –992.846 | Probability (LR stat) | | 0.0000 |

*Note*: Dependent variable: annual trips. Observations: 89.

easy-to-follow survey booklet. The surveys were distributed by a university student. A script was devised for the student to approach the survey respondents and the student was provided a script for Frequently Asked Questions, which made it clear that the university was retaining and analysing the data. After providing the visitors with the survey and a postage-paid return envelope, the student collected follow-up contact information for the second round of survey distribution to follow Dillman's (2000) repeat mailing recommendation. Of the 190 mail-back surveys handed out, 105 surveys were returned, giving a response rate of 55%. Our returned surveys showed that 50% of the visitors sampled drove a motorized vehicle up Pikes Peak, while 35% hiked and 15% took the cog railway to the top.

## Statistical results

Table 1 presents the Poisson count data TCM equation. This form of the count data model was acceptable as the overdispersion parameter in the negative binomial model was insignificant ($p$ = 0.41). Due to item non-response on several questions (particularly income and travel time), the net sample for the TCM is 89, with 43 car drivers, 34 hikers and 12 cog railway riders. Nonetheless, all of the coefficients are of the theoretically correct sign and are significant at the 1% level. In particular, travel cost and travel time are negative. Overall, the likelihood ratio statistic suggests all the coefficients collectively are significantly different from zero at the 1% level. The pseudo $R^2$ is 51% and the adjusted $R^2$ of 41% is respectable for individual cross-section data.

In terms of our first hypothesis test of whether auto and cog railway users have different price slopes than hikers, we reject equality of price slopes. In particular, *Car*TravelCost* and *Cog*TravelCost* coefficients are statistically significant at the 1% level. The positive coefficients suggest that motorized vehicle and cog railway user demands are more price inelastic than hikers.

Table 2. Mean consumer surplus per Pikes Peak trip with confidence intervals (CIs).

| Activity | Mean (US$) | Lower 90% CI (US$) | Upper 90% CI (US$) |
|---|---|---|---|
| Hiking | 31 | 26 | 38 |
| Motorized vehicle | 54 | 47 | 63 |
| Cog railway | 98 | 77 | 135 |

## Comparison of benefit estimates

Table 2 presents the CS or net WTP per trip of Pikes Peak hikers, motorized vehicle users and cog railway riders, respectively. The hiker CS at US$31 per trip is about two-thirds that of automobile users (US$54), which is about half that of cog railway riders (US$98). None of the 90% confidence intervals overlap, suggesting that the CS per trip is statistically different between activities.

To interpret the data in terms of our hypothesis, the rarest opportunity (cog railway) has a substantially higher CS per day trip, and thus overall value to railway riders than the motorized vehicle and the hiking options. There is no other 14,000-foot peak in Colorado where one can take a novel conveyance like a cog railway to the top; clearly, the cog has a very large value to the people riding it. In fact, the US$98 per day trip value is about four times greater than the average sightseeing value in the intermountain western US (Loomis, 2005). With respect to motorized vehicles, there is only one other 14,000-foot peak that can be driven and that is Mount Evans, about 100 miles from Pikes Peak. Thus, the automobile users also have a relatively high value, due in part to limited equivalent substitutes. In contrast, all of the other 54 Fourteeners in Colorado can be hiked or climbed on foot. Further, 52 of these other peaks do not have automobiles or cog railway tourists at the top after one hikes the long distance to the summit. Thus, there are many substitutes for Pikes Peak for hikers and these substitutes are without roads, automobiles and large groups of visitors at the top. This Pikes Peak hiking value is somewhat less than the average value of US$39 for hiking in the intermountain west (Loomis, 2005). The Pikes Peak hiking value contrasts with an average value of US$300 per trip for hiking other Fourteeners that do not have motorized access to the summit (Keske and Loomis, 2007). Thus, in some respects, the presence of dozens of automobiles and hundreds of cog railway passengers at the summit transforms what is elsewhere in Colorado a very valuable peak-bagging experience (that is, climbing a 14,000-foot peak) into a hike of below-average value.

Despite the small sample size, we believe that the benefit estimates reflect the multi-modal recreational issues of crowding and potential for displacement of non-motorized users by motorized users that are present on Pikes Peak and similar multi-use areas. Support for our conclusions is provided, in part, by qualitative comments written by recreationists in the survey comment section. For example, several Pikes Peak hikers indicated a willingness to substitute to less crowded areas. One hiker/runner stated, 'I ran to the peak and chose Pikes for its good trail. The population on that mountain surprised and overwhelmed me. I think I will stick to hiking other Fourteeners to stay away from crowds.'

Another hiker noted the impact of multiple modes of recreation on Pikes Peak on crowding and suggested that paved roads should be kept to a minimum, 'Pikes Peak and Mt Evans should remain the ONLY (with emphasis) peaks that can be driven to the summit.' This particular hiker also suggested implementing a hiking fee to reduce trail crowding. However, hikers were not the only recreationists to mention crowds. Motorists noted that crowding increased when the cog railway arrived, and for a short time this affected the quality of their experience at the summit.

In contrast, both motorists and cog railway riders seemed to acknowledge the higher expenditures involved with their experiences, consistent with their higher CS. For example, one motorist remarked, 'The cost to drive up Pikes Peak is a little steep – US$35 for four people – but it is worth the price for the awesome experience, especially because of the steep roads, narrow places, huge cliffs and sheer, dangerous drops. Keeps us humble.' Another motorists stated 'price is of no relevance' to driving to the top of Pikes Peak.

The higher values generated by the cog railway are also consistent with the concept of novelty, or scarcity. As a cog rider articulated, 'Pike's Peak cog railway was one of the several aims, despite costs.' In summary, although the sample sizes were smaller than desired, we believe that the written comments corroborate the relative ranking of the empirical CS estimates of the three groups.

## Conclusion

Using a series of price interaction variables, we adapted a count data travel cost model successfully to test for differential price slope effects and different CS estimates for three modes of ascending Pikes Peak in Colorado. A novel mechanized means of ascending high peaks, particularly by cog railway, has a very high net economic value to visitors. The high value may arise from the uniqueness of the ride to the top of a high peak. When we broaden the means of ascent to include automobiles, the high value may also arise because it is one of only two opportunities some of these visitors have to 'summit' and take in the views from the top of an alpine peak. For those not able or willing to engage in the long hike, the cog railway or automobile provide a rare opportunity to gaze down from the top of a high peak (14,000 feet in our case). Given the limited substitute opportunities to do this in the USA, the novel means of ascent generate high net economic values for participants. However, hikers climbing these same peaks obtain relatively lower values than cog railway users and automobile visitors. Based on written comments on the back of the visitor surveys, the presence of automobiles and hundreds of cog railway riders at the summit reduces the sense of accomplishment of climbing a 14,000-foot peak into just another long hike.

We believe that one of the important implications from this study is that 'novel' forms of recreation like cog railways have the potential to affect the motorized (as well as non-motorized) recreation, due to crowding. Furthermore, hiker CS (supported by qualitative data) indicates that hikers are willing to shift their recreation to other less crowded Fourteeners. What appears to be a 'novelty' for many motorists and cog railway riders may make the experience more 'pedestrian' for a hiker seeking solitude on a high mountain peak.

In summary, cog railway visitors, motorized users (cars and motorcyclists) and those ascending by non-motorized means (hiking and biking) accrue CSs of US$98, US$54 and US$31 per day trip, respectively. This suggests that rare and unique means of ascent (cog railway) yield relatively high values compared to more traditional means of mountain recreation. Thus, land managers should be aware that while novel mountain transportation modes may present high CS, there may also be a negative reaction from traditional recreationists towards proposals to add trams or roads that provide access to the tops of high mountain peaks. Thus, from a policy perspective, land managers must consider carefully the trade-offs from catering to groups that may have different levels of benefits. Measurement of the direct and indirect costs that may be imposed on the environment from these mechanized means of ascent and the effect on other recreationists should also be considered in future research and policy decisions.

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