

It's not where you do it, it's who you do it with?*

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Abstract: Models of recreation-site choice (which ski area, climbing route, golf course, or bike trail) lack social context—a trait they share with most choice models. Site-choice models seek to explain number of trips and destination choices as a function of only the cost of visiting each site, the physical characteristics of the sites, income, and other characteristics of the individual; whether one has a companion, and their ability, is assumed immaterial. We find, using choice experiments, that having a companion and the companion's relative ability are important determinants of site choice. One will often choose a site less preferred in terms of its costs and characteristics if one has a companion of one's ability at the lesser site but not at the better site. Companions of comparable ability are preferred over companions that are better or worse, and how one values the physical characteristics of sites depends on whether one is alone. These findings suggest that site-choice data can be the equilibrium of a game or of bargaining, rather than the result of each individual maximizing their utility in social isolation. To date, recreation-site-choice models do not model the game or otherwise address this endogeneity issue. We cogitate on whether those who estimate the values of site characteristics can, comfortably, ignore companion effects.

1 Introduction

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This research is motivated by the conjecture that where you recreate depends on where friends, family members, competitors and associates want to recreate, and where they want to recreate depends on where you want to recreate—a *reflection* problem (Manski (1993)). The objective is to assess the magnitudes of such *companion effects*. If the magnitudes are large, observed recreation-site choices can be the outcome of a game or bargaining among individuals, rather than individual utility-maximizing behavior in social isolation.¹ This paper does not model the social interaction; rather it investigates the importance of a companion in site choice—our product is the estimation of the recreator’s *utility function* with companion effects, a first step to understanding choice in this social context. This utility function determines the individual’s *reaction* to the behavior of potential companions.

Existing recreation-demand models, with a few exceptions, lack social context (individuals interacting on a personal level): with whom you personally recreate, and their ability, is assumed immaterial to where you recreate, and assumed immaterial to how site characteristics are valued.² The implications of this omission are significant and will be discussed in detail.

The presence of a companion and their ability can directly affect utility for a number of reasons: (1) Participating in a site-specific recreational activity is an opportunity to socialize, or to be alone. The cost of socializing, which

¹Whether the recreational choices of a group of individuals is best described as the equilibrium of a *game* or *bargaining*, or the outcome of a *group-decision process* depends on the specifics of how the individuals interact. It also depends on how one defines games and bargaining. Since we are not modeling the specifics of the interaction, we will use the term *game* to describe the social interaction, defining a game as a situation where each individual has a choice to make, each individual has an objective, and the choice of each individual affects the other individuals. Bargaining can be viewed as a type of game.

²See Phaneuf and Smith (2005) for a recent review of recreation-demand modeling. There

is minimal recreation-demand literature on choice of companion and the influence of companion on site choice. Karou (1995) investigates one of our empirical questions showing that site choice varies as a function of one’s companions (family groups choose closer sites than groups of friends or business associates). Karou does not investigate, as we do, the choice of companion (party composition is given), or estimate the effect of companion on the value of site characteristics. Shechter and Lucas (1978) use simulations to model use patterns in trail networks assuming party size influences entry point and choice of trails. While noting party formation, they do not model party formation.

Hanneman and Chapman (2000) note the presence of surfers can make a beach more attractive to others: surfers as site characteristics, not people with whom one personally interacts; these are not companion effects.

Timmins and Murdock (2007) tackle the influences of congestion and agglomeration (the more crowded the better) on site choice. Congestion/agglomeration effects and companion effects are different: the individual takes crowd level as given but chooses whether to have a companion. Congestion is modeled as impersonal crowding (other people are simply taking up space); personal interaction is not considered. However, there are similarities between companion effects and congestion/agglomeration effects: with both the equilibrium allocation across sites is the outcome of a game, and if crowding is a good (agglomeration)- not typically assumed in recreation demand models - crowding has a social aspect: a site is more attractive because everyone else wants to be there. McConnell (1977) considered this in beach use: a lot of teenagers at a beach make it more attractive to other teenagers and less attractive to other demographics. Such network effects are discussed in more detail in Section 2.2.

requires remaining with the companion, increases the more abilities differ. (2) Safety could be a factor: one feels safer, or less adventurous, with a companion because the companion is there to help if one is injured, lost, or one has an equipment problem. Mountain biking, for example, is often done on remote and difficult trails with potential for injury or losing one's way. Climbing, skiing, and hiking can be similar in this regard. Or, having a companion can decrease safety: climbing with an inexperienced climber, being prodded to ski or bike above your level. (3) Companions create the potential for competition, a critical aspect of many recreational activities. Competing can influence utility in multiple ways: the process is enjoyed, or not; the outcome of the contest is enjoyed, or not, and there is learning—companions provide an opportunity to learn about one's skill and fitness level, and this can increase or decrease utility.

With notable exceptions (e.g. Veblen (1899), Duesenberry (1949), Leibenstein (1950), Pollak (1976)), studying how choice is directly influenced by other people was for a long time the domain of social psychology—the study of the individual in a social context.³ As Manski notes in his 2000 *Journal of Economic Perspectives* article, "Economic Analysis of Social Interactions," this has changed; economists now study game theory, the evolution of social norms, and the behavior of families. Manski (2000) is quite critical of the empirical work in economics on social interactions, arguing that it (1) tosses around jargon from social psychology without precisely defining terms and with little connection to economic theory, and (2) draws inferences about what interactive process generated the observed joint behavior, eliding that an observation can often be generated by many different processes. Manski sees a "compelling need to enrich our data," that economic theorists need to know what "social interactions are prevalent in the real world" so they know what to model, and that "Empirical analysis of social interactions would particularly benefit from performance of well-designed experiments in controlled environments and from carefully elicitation of persons' subjective perceptions on the interactions in which they participate." By "subjective perceptions" he means, we believe, stated preferences. Responding to these criticisms, we present an explicit and utility-theoretic theory of choice where social interactions matter and estimate preferences with a survey carefully crafted to elicit how companion effects and site characteristics interact in the determination of site choice.

Specifically, we investigate, using choice experiments we designed for the purpose, whether having a companion and the companion's relative ability are important determinants of site choice. Looking ahead, our estimates indicate they are as important determinants as the costs and physical characteristics of the sites. Simply put, one will often choose a less-preferred site in terms of its costs and characteristics over a more-preferred site if one has a companion of one's ability at the lesser site but not at the better site. Companions also influence how one values site characteristics. In addition, companions of com-

³Social psychology focuses on the individual and investigates how thoughts, feelings, and behaviors are influenced by other people. Sociologists in the field focus on the behavior of the group. In this paper the focus is on the individual. Social psychology has not studied recreation-site choice.

parable ability are preferred over companions significantly better or worse at the activity. These findings should not surprise skiers, rock climbers, bikers, or social psychologists.

Economists who study recreation demand and want to determine how to increase welfare typically think in terms of enhancing site characteristics. Our finding that a companion of one's ability will often increase utility as much as an improvement in site characteristics, suggests benefits to making it easier to coordinate with those in your potential-companion set. For example, if "It's not where you do it, it's who you do it with" is true for many activities, policies to coordinate free-time might significantly improve welfare (Krugman (2005)).⁴ National holidays are, for example, blocks of common free-time. Maybe it is not folly when most of the E.U. is on vacation in August: Pierre and Ricardo are likely to each find an ideal recreation companion.

The choice experiment approach allows us estimate the influence of a companion on choice without modeling the social interaction: in our choice experiments what others do is exogenous. This exogeneity does not exist in behavioral data that is the result of a game; one typically cannot identify the reaction function by observing only the equilibrium of the game—Manski (2000) emphasizes this point.⁵ In contrast to our choice experiments, quasi-experimental data is sometimes found or created that can be used to avoid the reflection problem.⁶ Another approach to solving the reflection problem is to instrument the choices of the other player or players (e.g. Borgas (1992), Gaviria and Raphael (1999), and Timmins and Murdock (2007)). Starting with a choice-experiment, we naively assumed the basic issues of how to use behavioral data to identify and estimate social interaction effects had been solved, but this is not the case. The choice-experiment approach cuts the game-theoretic Gordian knot of social interactions, so avoids the problem.⁷

The activity chosen for the choice experiment is mountain biking, but one would expect our findings apply to many other site-specific recreational activities: climbing (technical and mountain), hiking, road-biking (choice of route), skiing (downhill and cross country), and golf.⁸ Mountain biking was chosen for

⁴Of course, coordinating freetime can also have congestion and agglomeration effects.

⁵The identification and endogeneity difficulties are echoed in Sacerdote (2001), Duflo and Saez (2003), earlier papers by Manski ((1993) and (1995)), and Evans et al. (1992).

⁶Sacerdote (2001) uses the fact that Dartmouth freshman-year roommates are randomly assigned to study how one's roommate affects one's study effort and membership in social organizations. Duflo and Saez (2003) use a quasi-experiment to study how saving decisions are affected by the decisions of others. Bertrand et al. (2000) estimate peer-group effects on participation in welfare programs, relying on individuals in a neighborhood interacting mostly with those who speak the same language. Munshi and Myauz (2006) estimate the effect of religious group on adoption of contraceptives, relying on religious group being exogenous, and adoption of contraceptives being independent across religious groups.

⁷Akin to companion effects in recreation-demand models is the problem of congestion (Cesario ((1980)): congestion is a site characteristic but one that is endogenously determined by choice, so observed site choices are the equilibrium of a sorting game. Boxall, Rollins and Englin (2003), like us here, use choice experiments to avoid the endogeneity problem, varying congestions levels independently of the other site characteristics.

⁸The choice of climbing site has been studied by Jakus and Shaw (1996), Shaw and Jakus (1996), and Grijalva, Berrens, Bohara, Jakus, and Shaw (2002). Applications to skiing include

a number of reasons: it does not require a companion. If one has a companion, you only bike together if you bike at the same speed. The companion's relative ability determines whether one is waiting or chasing. And, finally, we have done previous research on the choice of mountain-bike trails (Morey, Buchanan and Waldman (2002)). Consider other activities: tennis requires a companion and their ability is of critical importance, but all of the sites (tennis courts with the same surface) are the same. With fly fishing on rivers, site characteristics are of critical importance and whether one has a companion might be important, but the ability of the companion is not critical; each angler fishes a different stretch of the stream, so how much one catches does not depend on the other's ability. In technical climbing, a companion is typically necessary, and their ability a matter of life and death. Golf, like tennis, is an activity where a companion is not necessary and a companion's ability is important, but, unlike tennis, site characteristics vary widely.

In the model and choice experiment, two important simplifying assumptions have been made. Mountain-bike rides have either no companion or one companion. Allowing for multiple companions of varying abilities would be more difficult to analyze and model. The companion is restricted to be of one's own gender and not a member of one's family. Family dynamics and choice is a complicated endeavor, as is the influence of sexual attraction on choice.

The modeling framework is a discrete-choice random-utility model. We assume the utility one gets from a mountain-bike ride depends on the cost of the trip, the characteristics of the site (trail length, type of trail, amount of climbing, number of climbs), whether one has a companion (yes or no) and, if so, how far back or ahead the companion will be between stopping points if both parties are riding hard, but not at the limits of their abilities. The model is standard except for inclusion of the companion characteristics. From the two rides available in each choice pair, the individual chooses the one he or she most prefers. The goal is to model, identify, and estimate the significance of companion effects, and their importance relative to prices and the physical characteristics of the sites.

Our choice experiment was constructed so there is no game or bargaining. However, if there are companion effects in choice data, and one wants to use the behavioral data to estimate preferences, one sometimes must model the game. Current recreation-site-choice models never model the game.

1.1 Organization

Section 2 continues the discussion on social interaction and choice. Section 3 discusses the survey and its design, including the choice experiment; Section 4

Morey (1981, 1984, 1985) In each of these sports, what one experiences depends on the characteristics of the site, who you are with, and their skill and fitness level at that sport. For example, skiing with someone who is much faster or slower, who wants to ski where you can't, or can't ski where you want to ski, detracts from the experience. These studies do not take this into account.

describes the sampling plan. Section 5 looks at the data and describes what it says, in broad strokes, about social context in mountain biking. Section 6 specifies a *Companion-Interaction Model* of ride choice. It reports and discusses the parameter estimates, presents willingness-to-pay, *WTP*, estimates for going from no companion to one of one's ability—these depend on the characteristics of the trail. *WTP* estimates for a change in the ability of one's companion are also reported. For comparison, *WTP* estimates are reported for increasing the proportion of singletrack, a trail type. These *WTP* for trail type also show how *WTP* for site characteristics can depend on whether one has a companion. Section 7 is an illustration. Section 8 cogitates on whether those who use behavioral data to estimate the values of site characteristics can, comfortably, ignore companion effects. Section 9 uses the estimated utility/reaction function to simulate a game of who will ride with whom, and where. Section 10 summarizes, notes problems, and reports how one might extend our model to consider preference heterogeneity for a companion.

2 The literature on social interaction and choice

2.1 Why do other people matter?

Social psychology asserts a native desire to seek the company of others—it is the premise of the field.⁹ Social psychologists offer numerous reasons for wanting companions. Here we discuss a few that likely influence whether you ride alone or with others. First, and foremost, people get utility from friendship and human contact.¹⁰ This category includes the feelings of security provided by a companion, and also the joy of interacting with others, including games and competitive situations. Second is sexual desire. We have tried to eliminate sexual desire as a factor in our choice experiment.¹¹

Third, having company during an activity allows one to gauge one's own ability levels: we use other people to gather information about ourselves—*social comparison* (Festinger (1954)),

There exists in the human organism, a drive to evaluate his opinions and abilities

...people evaluate their opinions and abilities by comparison respectively with the opinions and abilities of others.

The tendency to compare oneself with some other specific person decreases as the difference between his opinion or ability and one's own increases.

⁹ Asch (1952) and Brown (1965) are two of the early texts in social psychology.

¹⁰ We interact with others because it increases our utility: either directly or because interacting gets one more utility-producing goods; here we are considering the direct effect. Economists more often model the indirect effect of other people.

¹¹ How sexual desire affects choices is a subject ripe for economic research.

Comparison is part of our quest to make ourselves feel better.¹² Riding with better riders and keeping up allows one to identify with those better riders, riding with lesser riders and beating them confirms you are not one them—you have drawn a contrast/distinction between them and you. Both processes can be self-enhancing. The drive to compare is not limited to humans (Gilbert, Price, and Allan (1995)), so likely has a genetic component.

In mountain biking the comparisons can be on technical skill, strength, and endurance: one needs a technical ride to assess a companion's skill level, and only one short, steep climb to assess strength, but a long hard ride to assess endurance. Looking ahead, we find having a companion is valued less highly if the ride is short. We also find that the value of a companion declines as the difference between his and your ability increases.

Social Comparison theory has evolved since 1954 but its basic tenets remain. In January 2007, the journal *Organizational Behavior and Human Decision Processes* produced a special issue on *social comparison processes*.

Empirical studies indicate we generally prefer to compare ourselves to those who are slightly better, but there are costs to doing so (Buunk and Gibbons (2007), Brickman and Bullman (1977)). Ignoring the costs, the implication for mountain biking is you would choose a slightly better rider over a slightly worse rider. Studies have found individuals who compare themselves to those better at a task think comparing upward is the way to improve, and, in fact, improve at the task faster than those who compare themselves to equals or lessers (e.g. Blanton, Buunk, Gibbons, and Kuyper (1999)).

However, participating in an activity with those better can be threatening. One can eliminate this threat by riding alone or by choosing a riding companion "out of one's league"—termed "self-handicapping" ((Shepperd and Taylor (1999)). You can also show up at the ride with a list of your "self-reported" handicaps for the day. Some individuals, to protect their egos, purposively handicap their ability (Jones and Berglas (1978)) by, for example, riding to exhaustion the day before.

There is evidence that some individuals compare downward - *downward social comparison theory* (Wills 1981). As noted above, one way to improve self-esteem, if it is low, is to ride with lesser riders and demonstrate you are not one of them.

Alternatively, one might not ride with others because one has no need to compare: for some finding out whether they are better or worse is immaterial to their utility.

¹²Motives for the drive include self-enhancement, perceptions of relative standing, maintaining a positive self image, and closure (Suls, Martin and Wheeler 2002). Studies indicate that the inclination to socially compare is positively correlated with (1) low self-esteem and neuroticism, (2) a strong interest in others and what they feel, and (3) having a "high chronic activation of the self" (Buunk and Gibbons (2007))

2.2 The game, social interaction, bargaining, and networking literature, briefly mentioned

Potential biking companions interact driven by *network effects/network externalities*: they coordinate and either form a network (ride together), or not.¹³

The social coordination literature typically assumes choosing alternative j makes the other choosers of j better off—one coordinates so many do the same thing (go to the same party, communicate using the same text-messaging service, etc.). This is an appropriate assumption for many applications, but not for mountain biking. Having a companion mountain biking can be a good or a bad, so coordinating might mean not riding together.

The mountain-bike interaction has three components: which trail to ride, who to play with, or not, on that trail, and how to play: adjust one's speed, or not, to the speed of one's partner (slow down if leading, push harder if following). A game with some similarities is which neighborhood to live in and then how to behave when there (Bala and Goyal (2000)), but in that game players do not bargain with respect to who will live where. Game-theoretic literature where one simultaneously chooses an alternative and a partner includes Jackson and Watts (2002), Goyal and Vega-Redondo (2005) who develop "a simple model to examine the interaction between partner choice and individual behavior in games of coordination," and Hojman and Szeidl (2006) who study "a social game where agents choose their partners as well as their actions." None of these papers are empirical.

In a series of papers, Brock and Durlauf (2001a, 2002) and Durlauf (2001) model social interaction in the context of a discrete-choice random-utility model, like we do here, but the interactions are different. They assume the utility individual i gets from an alternative in a choice set depends on characteristics of the individual, characteristics of the individual's group (e.g. ethnic mix, average income), and individual i 's beliefs about which alternative everyone else in the group will choose. Beliefs are expressed as subjective probabilities; for example, the individual associates some probability with everyone choosing alternative k . Group size is large and exogenous; in contrast, in mountain biking, group sizes are small and fluid. Their equilibrium is the set of choices that both maximizes everyone's utility and makes everyone's beliefs correct; the social interaction is impersonal, and without bargaining. Mountain biking choices are sometimes based on everyone's beliefs about who will show up at which trail head, and no prior arrangements, but more often who is riding with whom and where is determined in advance with calls, texts and e-mails.

¹³Much of the literature on network effects has to do with which good to adopt. For example, the benefits I get from having unlimited text messaging on my cell phone depends on how many of my friends and associates use text messaging: we jointly create, or don't, a network of text messagers. Farrell and Klemperer (2006) is an excellent review article on network effects from the perspective of industrial organization.

Brock and Durlauf 2002 specify a multinomial logit model of choice where the utility individual i get from choosing alternative k is increasing in his expectation of the percentage of the group that will choose alternative k —this assumption pushes the equilibrium in the direction of many members choosing the same alternative. Assuming identical beliefs and knowledge of which alternative was chosen by each member of a sample, the likelihood function for the utility parameters is derived. The econometric modeling and estimation of social-interactions is surveyed in Brock and Durlauf (2001b).

Instead of assuming individual choice is being influenced by the choice of everyone else in the population, another strain of research assumes "each individual is influenced only by a small (finite) subset of the population (Krauth (2006)). See, for example Sacerdote (2001) and Duflo and Saez (2002). Mountain-bike groups are small. Games where the number of players is small are typically more complicated than population games because the subsets of co-players are endogenous.

Section 9 of the paper discusses more of the game literature.

3 The survey and the choice-experiment design

The goal was to collect from mountain bikers six types of data: preference, demographic, health, fitness, exercise, and psychological.¹⁴ Preference data was collected in two forms: answers to attitudinal questions, and responses to choice pairs. Figure 1 is a snapshot of a choice-pair question from the survey.

¹⁴One can see the survey as the respondents say it at <http://www.colorado.edu/economics/morey/respondentview/bikefinal.htm>

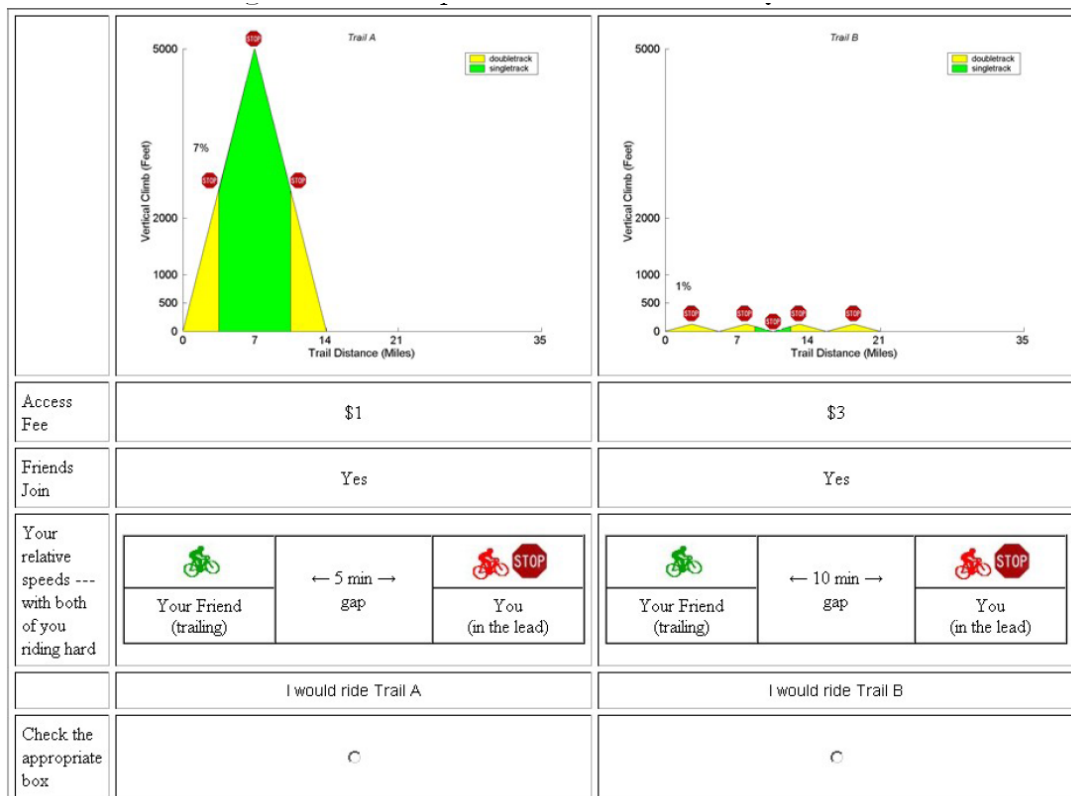


Figure 1: A choice pair from the survey

The ride characteristics and their levels will be described below in more detail. Preferences are estimated with the data from the stated-preference choice pairs.

Most of the attitudinal questions in the survey are Likert-scale questions that ask the respondent's level of agreement with different statements about mountain biking and mountain-biking trails. One can see all of the attitudinal questions using the link in the last footnote. Question 35 asks, for example, "To what extent do you agree with the statement: "Singletrack is the only kind of trail I want to ride.""

The attitudinal questions are used to independently assess the importance riders place on a companion, the degree to which it depends on the companion's relative ability, why riders might care about a companion, and how important is having a companion relative to the physical characteristics of the trail.

Questions were asked to measure psychological characteristics that might influence where and with whom one would want to mountain bike: how the respondents feel about competition, risk, and socializing in the context of recreation. These go to issues such as risk taking, whether mountain biking is pri-

marily a social or competitive activity, and whether riders want to challenge or be challenged by their companion, or ride alone. For example, "To what extent do you agree with the statement, "Competition destroys friendships".

3.1 Characterizing mountain-bike trails

Mountain-bike trails vary in terms of six characteristics: trail length, proportion of trail that is singletrack versus doubletrack, total vertical feet of climbing, number of climbs, access fee, and speed of a companion rider relative to your speed; no companion is a possibility. Single-track is a trail, double-track is, or once was, a two-track dirt road.

Morey, Buchanan and Waldman (2002) found the first five to be significant and important determinants of site choice using choices between pairs of generic mountain-bike trails—they did not consider companion. The importance of these five characteristics for trail choice is consistent with our personal experiences, interviews with many individual mountain-bikers, focus groups and pretests.¹⁵

Table 1 reports the characteristic levels in the design. Some combinations of trail characteristics are infeasible or impossible, so excluded: for example, miles of singletrack cannot be greater than miles of trail, and no climbs and no climbing are equivalent. And, no one could ride a seven-mile trail with 5000 feet of climbing and descending (the grade is always either plus or minus 35%).

Table 1: Characteristic levels

Characteristic	Levels
Trail length (miles)	7 14, 21 and 35
Miles of singletrack	0, 3.5, 7, 14, 21, and 35
Vertical ft. of climbing	0, 500, 1000, 2000 and 5000
Number of climbs	0, 1, 2 and 4
Access fee	\$1, \$3, \$5, \$8 and \$20
Time gap (minutes)	solo, -10, -5, - 2 0 (same ability), +2, +5 and +10

The intent was to include a broad range of trail types: \$20 is a high access fee given that most trails are currently free; 35 miles corresponds to a ride of at least four hours; 5000 ft. is a lot of climbing. All of the trails in the choice-pairs are feasible mountain-bike trails.

The survey specified that all of the trails were loops, all started at the same elevation, were closed to motorized vehicles, contained specific sections of singletrack and/or double-track, and close at hand (so travel costs were small and the same for all sites). Respondents were asked to assume vegetation did not vary across the alternatives.

¹⁵There are a few travel-cost models of the demand for specific and branded mountain-bike sites, but these provide no guidance for characterizing generic sites. These studies focus on either the aesthetic effect of a forest fire, or the special geographic and weather characteristics of a unique trail-system (Moab, Utah). See Fix and Loomis (1997), Loomis, González-Cabàn and Englin (2001), Loomis, González-Cabàn and Alexander (2003), and Hesselh, Loomis, and González-Cabàn (2004).

3.1.1 Speed of a companion rider relative to your speed

When one rides a trail alone one can choose, within one’s physical limits, how fast to ride, where to stop, and even whether to stop—any competitiveness comes from within, but there is no companionship, camaraderie, or socializing. If hurt or lost, one is alone. All this is different if one rides with a companion, and, how it differs depends on your relative abilities and the inclinations of both parties. One might have to struggle greatly to maintain contact with a riding companion, or conversely spend much of the ride waiting for him to catch up. Riding companions can be evenly matched, sometimes competing, and sometimes socializing.

To simplify and avoid the interactive aspects of choice, we present the respondent with choices of trails where the presence (or absence) of a companion and their relative ability is another exogenous aspect of the ride: in the experiment, companion cannot be unbundled from the other characteristics of the alternative. Riders have some experience with companion constraints: Don calls to say he is riding the Guber trail, and Bob calls to say he and Marc are riding the Gomer trail, and you choose one of these two rides, or ride alone on some third trail. When one makes the choice of with whom to ride, one takes into account the abilities of the other riders and their inclinations towards competitiveness and socialization, along with the physical characteristics of both trails, and in this case, you play no game.

When one rides with a companion, the lead rider typically stops at a number of points along the trail to wait for his companion to catch up: if the leader didn’t, one would be riding alone; social pressure says stop and wait. We made the number of stopping points an increasing function of the trail length, locating them at typical stopping points along a trail, for example, at the top of climbs, or half way down long descents. Stopping is only required if one has a following companion.

Trails are specified in terms of whether a companion is on the ride, and, if so, his expected arrival time at each stopping point relative to the other rider if both are riding at a hard pace. Table 1 reports the range of time gaps. Consider a gap of two minutes if both rider rode at their typical pace. This does not mean the gap would always be 2 minutes, but indicates the second rider would have to work to stay with the lead rider. Depending on their temperaments, for each rider this gap might generate more or less utility than no gap.

An efficient choice-pair design was generated (details on request) consisting of fifteen versions of the survey, each with five choice pairs (“Would you prefer to ride Trail A or Trail B?”). Except for the choice pairs, the fifteen versions were identical. Respondents were randomly assigned to a version.

4 An internet survey with e-mail solicitation

Our population of interest is those individuals who take most of the mountain-bike rides—an imprecisely defined group—what we would call *serious mountain bikers*. The vast majority of mountain-bike rides are taken by serious riders—there are many more individuals who occasionally ride a mountain bike off-road, but these individuals take only a small proportion of all mountain-bike rides.

Solicitation e-mails were sent to possible mountain bikers asking them to complete our online survey and to forward our e-mail to other potential mountain bikers. Our expectation was occasional mountain bikers would be less likely to take the time to complete our survey, so the vast majority of our respondents would be individuals serious about mountain biking.

Nine-hundred and thirty-seven identical solicitation e-mails were sent out, many to lists of individuals. We estimate somewhere in the neighborhood of seven thousand people were contacted in this initial e-mailing. Some proportion of the individuals who received our e-mail, probably large, were not active mountain bikers. Our initial e-mailing went to bikers we know, mountain-bike clubs, road-bike clubs, racing teams (both mountain and road), mountain-bike touring companies, mountain-bike advocacy groups, road and mountain-bike race organizers, mountain-bike race officials, sports magazine editors, lists of individuals who applied for entrance to races and organized rides, and similar organizations for other sports such as road-riding, running and triathlons. Women's sports organizations were specifically targeted. Large mountain-biking organizations were also contacted by phone or in person, and asked to distribute the solicitation to their members. We do not know how many times our e-mails were forwarded to other mountain bikers.

No claim is made that the result of this process is a random sample of serious mountain bikers. That said, the preferences of the respondents likely reasonably approximates the preferences of those who take most of the rides.

5 The data and what it says about social context in mountain biking

The survey resulted in usable responses from 4605 mountain bikers. While 87% of the respondents are residents of the U.S.; residents of 49 countries completed the survey.¹⁶

The mean age of respondents is 37; eighty-six percent are male; 80% make \$40K or higher, and 32% make \$100K or greater. Sixty-five percent report spending between \$26 and \$100 dollars on fun stuff per week. Most respondents live with a significant other, and live in a household with more than one wage-earner. Respondents average .6 kids.

¹⁶A static version of the survey with summary statistics can be found at <http://www.colorado.edu/economics/morey/static/index.html>

Most respondents are serious mountain-bikers. This is illustrated by their gear, the extent of their mountain biking, and their skill levels. On average, they went mountain biking slightly more than six days in the previous thirty days, and three and a half hours in the previous week; they mountain bike more than road bike. Fifty-nine percent have participated in at least one organized mountain-bike race.

Sixty-eight percent consider their bike to be "top end" or better. Based on their answers to skill questions, each respondent was placed in one of five Skill levels. Skill level 5, the highest level, are experts, Skill level 1 has the lowest skills. The average skill level in the sample is 3.2, indicating very skilled.

We discuss next those questions that inform about the importance of a companion, why a companion might be important, and the significance of the companion's relative ability.

5.1 Likert-scale data on companion and their ability

5.1.1 Social and competitive

Summarizing the Likert-scale data, friends are important both to socialize with and to compete with, and mountain bike rides accomplish both. Fifty-one percent of respondents agreed with the statement "Mountain bike rides are an opportunity to be with and enjoy my friends." To the question, "How often do

you socialize with riding companions" 32% answered "on average once a week."

One reason for a companion is to determine how good one is relative to others, not everyone else, but one's friends and fellow riders. Forty-two percent *definitely* or *somewhat* agreed mountain-bike rides "are an opportunity to compete with others." And, 72% of respondents *definitely* or *somewhat* agreed with the statement "I enjoy competing with others." Note that 38% raced in the last year. For racers, a ride can be a respite from competition or an opportunity for less-structured competition.

Of significance, only 9% of respondents *definitely* or *somewhat agreed* with the statement "Competition destroys friendships"—few seem to think beating their friend will cause them to lose their friend.

5.1.2 Companion and safety

Many of the respondents worry about injuries and breakdowns. To the question "When you ride alone, do you worry about an accident or mechanical problem that could leave you stranded on the trail" 51% responded either *sometimes* or *often*. These worries, however, don't seem to make riding alone rise to the level of "frightening," only 16% of respondents *definitely* or *somewhat* agree with the

statement "Riding alone frightens me." The responses to the injury, mechanical, and fear questions are positive correlated, but the correlations are low. We did not ask about worries of human or animal attacks, but should have; a number of riders, the majority female, noted this concern in their written comments.

5.1.3 Importance of relative ability

A number of questions were asked that go to the issue of the relative ability of a companion rider. To the question, "Is friend's speed important?" 63% answered *very* or *somewhat important*.

Twenty-one percent dislike "stopping and waiting for slower riders"; 23% dislike "trying to keep up" with faster riders. Informal discussions in online mountain-biking forums suggest a distaste for trying to keep up is more likely to cause one to ride alone than is having to stop and wait for slower riders—competing and winning is better than competing and losing. Most respondents do some biking alone: 22% report they usually ride alone, while another 39% report they often do.

5.2 How important is companion and ability relative to the physical characteristics of the trail?

After the respondent answered five choice pairs: would you ride Trail *A* or Trail *B*, they were asked "When you were making your choices between trails *A* and *B* in questions 41 – 45, how important was each of the ride attributes?"

The most important characteristics in determining choice are miles of singletrack and total trail length: 80% and 79% report them *somewhat* or *very important*. Next are the number of peaks and amount of climbing (77%), followed by the presence of a companion (65%), access fee (55%), and companion's relative ability (48%). Presence of a companion is more important than the access fees in the fee range asked (\$1 to \$20).

6 A Companion-Interaction Model of ride choice

6.1 Ride choice

The utility to individual i if they choose ride j is

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

where ε_{ij} is a draw from an Extreme Value distribution. The term *ride* denotes a trail/companion combination. The probability of individual i choosing

alternative A given the choice pair A, B is, therefore¹⁷

$$P_{iA} = \frac{e^{V_{iA}}}{e^{V_{iA}} + e^{V_{iB}}} \quad (2)$$

The deterministic component of utility, V_{ij} , is assumed a function of the following trail and companion characteristics:

$trail_j \equiv$ the number of miles of trail on ride j

$single_j \equiv$ the fraction of the trail on ride j that is singletrack

$grade_j \equiv$ the average grade on the climbs, expressed as a %. A grade of over 10% is steep.

$climbs_j \equiv$ the number of climbs on ride j

$expend_i \equiv$ weekly expenditures by individual i on entertainment (in \$)

$fee_j \equiv$ the fee charged for ride j (in \$)

$D_{li} \equiv$ 1 if individual i spends on himself for entertainment less than \$25 a week, and zero otherwise

$D_{mi} \equiv$ 1 if individual i spends on himself for entertainment between \$25 and \$100 a week, and zero otherwise

$D_{hi} \equiv$ 1 if individual i spends on himself for entertainment more than \$100 a week, and zero otherwise

$solo_j \equiv$ 1 if individual i is alone on ride j , and zero otherwise

$back10_j \equiv$ 1, if there is a companion on the ride, and at normal effort levels individual i would be 10 minutes behind the companion at each wait point

$back5_j \equiv$ 1, if there is a companion on the ride, and at normal effort levels individual i would be 5 minutes behind the companion at each wait point

$back2_j \equiv$ 1, if there is a companion on the ride, and at normal effort levels individual i would be 2 minutes behind the companion at each wait point

$front10_j \equiv$ 1, if there is a companion on the ride, and at normal effort levels individual i would be 10 minutes ahead of the companion at each wait point

$front5_j \equiv$ 1, if there is a companion on the ride, and at normal effort levels individual i would be 5 minutes ahead of the companion at each wait point

¹⁷One could allow, for example, choices for an individual to be correlated across the choice pairs by estimating a random-parameters model. Doing so will not change the basic finding that there are companion effects.

$front2_j \equiv 1$, if there is a companion on the ride, and at normal effort levels individual i would be 2 minutes ahead of the companion at each wait point

The intent is to estimate the preferences of the representative individual in the class of serious mountain bikers. Specifically assume

$$\begin{aligned}
V_{ij} = & (\beta_{el}D_{li} + \beta_{em}D_{mi} + \beta_{eh}D_{mi})(expend_i - fee_j) \\
& + B_s(single_j) + B_{ss}(single_j)^{0.5} \\
& + B_t(trail_j) + B_{tt}(trail_j)^{0.5} \\
& + B_c(climbs_j) + B_{cc}(climbs_j)^{0.5} \\
& + B_g(grade_j) + B_{gg}(grade_j)^{0.5} \\
& + B_{ct}(climbs_j trail_j)^{0.5} + B_{cg}(climbs_j grade_j)^{0.5} + B_{tg}(trail_j grade_j)^{0.5} \\
& + B_{solo}(solo_j) + \beta_{tsolo}(trail_j)(solo_j) + \beta_{ssolo}(single_j)(solo_j) \\
& + \beta_{csolo}(climbs_j)(solo_j) + \beta_{gsolo}(grade_j)(solo_j) \\
& + B_{b10}(back10_j) + B_{b5}(back5_j) + B_{b2}(back2_j) \\
& + B_{f2}(front2_j) + B_{f5}(front5_j) + B_{f10}(front10_j)
\end{aligned} \tag{3}$$

with the restriction $climbs_j = 0 \iff grade_j = 0$.

The first line of Equation 3, the term $(\beta_{el}D_{li} + \beta_{em}D_{mi} + \beta_{eh}D_{hi})(expend_i - fee_j)$, is the utility individual i gets from other entertainment. It depends on his budget for entertainment, $expend_i$, the fee for ride j , fee_j , and the individual's marginal utility from expenditures on entertainment, where β_{el} is the marginal utility of expenditures for those who spend less than \$25 a week, β_{em} is the marginal utility of expenditures for those who spend between \$25 and \$100 a week, and β_{eh} is the marginal utility of expenditures for those who spend more than \$100 a week. The probability of individual i choosing a particular ride is a function of the fee and his expenditure category: there are income effects.

The next group of eleven terms, lines 2 – 6, represents the baseline utility one gets from the site's characteristics, independent of whether one is riding solo or one has a companion. Note that nonlinear and interaction effects are allowed. For example, the marginal utility of trail length is a function of all the site characteristics, so increased trail length could be a good or bad depending on grade, number of climbs and current trail length.

The last four lines, line 7 – 11 determine how the utility of the ride is affected by the presence of a companion and the companion's ability. If one is riding alone ($solo_j = 1$ and $frontX_j = backX_j = 0 \forall X$) the expected utility from the ride shifts from the baseline by

$$\begin{aligned}
V_{solo_j} = & B_{solo} + \beta_{tsolo}(trail_j) + \beta_{ssolo}(single_j) \\
& + \beta_{csolo}(climbs_j) + \beta_{gsolo}(grade_j)
\end{aligned} \tag{4}$$

If one has a companion ($solo_j = 0$), utility shifts from the baseline by

$$V_{companion_j} = B_{b10}(back10_j) + B_{b5}(back5_j) + B_{b2}(back2_j) + B_{f2}(front2_j) + B_{f5}(front5_j) + B_{f10}(front10_j) \quad (5)$$

This expression is zero if the companion is of your ability ($frontX_j = backX_j = 0 \forall X$), the default. So, if a companion of one's ability is preferred to a companion of a different ability, $V_{companion_j} < 0$, and if a companion of one's ability is preferred to riding along $V_{solo_j} < 0$.

These expressions determine expected WTP for a companion; WTP will depend on the ability of the companion, the characteristics of the trail, and the individual's expenditure category.

Note how the utility from the site characteristics depends on whether one is riding alone. For example,

$$V_{trail_j} = B_t(trail_j) + B_{tt}(trail_j)^{0.5} + B_{ct}(climbs_j trail_j)^{0.5} + B_{tg}(trail_j grade_j)^{0.5} + \beta_{tsolo}(trail_j)(solo_j) \quad (6)$$

The ln likelihood function for the sample is

$$\ln L = \sum_{i=1}^{4583} \sum_{k=1}^{m_i} [c_{iA_k}(\ln P_{iA_k}) + (1 - c_{iA_k})(1 - \ln P_{iA_k})] \quad (7)$$

where m_i is the number of choice pairs answered by individual i ($m_i \leq 5$), and $c_{iA_k} = 1$ if individual i choose alternative A in pair k and zero otherwise. 22,685 choice pairs were answered.

The estimated B_{gg} and β_s (the nonlinear term on grade and the linear term on singletrack) were not significantly different from zero, so were set to zero. The parameter β_{tsolo} was also found to be insignificant, so the term $\beta_{tsolo}(trail_j)(solo_j)$ was deleted and replaced with $\beta_{t7solo}(solo_j)D_{t7}$ where $D_{t7} = 1$ if the trail is 7 miles or less, and zero otherwise. In explanation, 7 miles is a short trail, so $\beta_{7solo} \neq 0$ would indicate a companion of one's ability is important if the trail is short. Comments from mountain-bike riders suggest $\beta_{7solo} > 0$: the disutility from riding alone is lessened if one is on a short ride.

The Companion-Interaction Model estimated expected-utility to individual i from ride j is

$$\begin{aligned}
V_{ij}^* = & (.1130D_{li} + .0910D_{mi} + .0773D_{hi})(expend_i - fee_j) \\
& + .6001(single_j)^{0.5} - .0686(trail_j) + .8297(trail_j)^{0.5} \\
& - .2182(climbs_j) + 1.8553(climbs_j)^{0.5} \\
& - .0016(grade_j) - .6418(climbs_j trail_j)^{0.5} \\
& - .0177(climbs_j grade_j)^{0.5} + .0077(trail_j grade_j)^{0.5} \\
& - 1.1656(solo_j) - .4366(single_j)(solo_j) \\
& + .6858(solo_j)D_{t7} + .2104(climbs_j)(solo_j) - .0012(grade_j)(solo_j) \\
& - .8488(back10_j) - .6287(back5_j) - .3858(back2_j) \\
& - .4746(front2_j) - .5688(front5_j) - .8229(front10_j)
\end{aligned} \tag{8}$$

The estimated t -statistics vary, in absolute value, from 2.73 to 29.41. The parameter estimates are discussed in the next section subsection.

Three special cases of the Companion-Interaction Model are of interest: an *Asocial Model*, a *Simple-Companion Model*, and an *Ability Doesn't Matter Model*. In the Asocial Model, all of the parameters that influence utility from a companion are set to zero ($B_{solo} = \beta_{ssolo} = \beta_{t7solo} = \beta_{csolo} = \beta_{gsolo} = B_{b10} = B_{b5} = B_{b2} = B_{f2} = B_{f5} = B_{f10} = 0$). The Asocial Model is the benchmark because recreation-demand models, to date, have not included companion—they are asocial. A likelihood ratio test rejects the Asocial Model: the Companion-Interaction Model fits the data significantly better. As one sees from the parameter estimates and the *WTP* estimates reported below, companion is as important to ride choice as many of the trail characteristics.

The Simple-Companion Model is the Companion-Interaction Model with the interaction terms between $solo_j$ and the trail characteristics fixed at zero ($\beta_{ssolo} = \beta_{t7solo} = \beta_{csolo} = \beta_{gsolo} = 0$). We call this the Simple-Companion Model because one gets utility (or disutility) from a companion, and it depends on the companion's relative ability, but the influence of companion does not depend on what kind of trail you are on (the trail attributes): in the Simple-Companion Model, the utility one gets from a trail characteristic is restricted to not depend on whether one has a companion.

Comparing the Simple-Companion Model and the Companion-Interaction Model, one rejects the null hypothesis that utility from companion is independent of trail type.¹⁸ With our data, or similar bundled choice-pair data, excluding companion will cause an omitted variables problem because having a companion affects the relative utility one gets from the different trail characteristics—the parameter estimates on the trail characteristics will be biased.

The Ability Doesn't Matter Model is the Companion-Interaction Model with companion included but the influence of their ability expunged ($B_{b10} = B_{b5} =$

¹⁸A likelihood ratio test comparing the Asocial Model and the Simple-Companion Model also rejects the null hypothesis that companion is irrelevant.

$B_{b2} = B_{f2} = B_{f5} = B_{f10} = 0$). Comparing the Companion-Interaction Model and the Ability Doesn't Matter Model, one rejects the null hypothesis that the ability of one's companion is irrelevant—including relative ability significantly improves the explanatory power of the model.

6.2 Interpreting our parameter estimates

Remember the sample is not necessarily representative of all serious mountain bikers—so no claim is made the estimated parameters and estimates of WTP are best estimates for the population. The intent is to determine whether companion is important, and, if it is important for our sample, it is likely important for the population of serious mountain bikers—whether it is a little more, or less, important, is, for our purpose, immaterial.

For the Companion-Interaction Model, the estimated expected utility from being alone is

$$\begin{aligned} V_{solo_j}^* = & -1.1656 - .4366(single_j) \\ & +.6858D_{t7} + .2104(climbs_j) \\ & -0.0012(grade_j). \end{aligned} \tag{9}$$

The constant, -1.1656 , indicates that, *Ceteris Paribus*, being alone decreases utility. The negative sign of the estimate of β_{ssolo} ($-.4366$) indicates being alone is worse when one is on singletrack, possibly because being on singletrack makes one feel remote, or there is greater chance of injury; both make one feel vulnerable. Being alone is more attractive when the trail is short ($D_{t7} = 1$): based on survey comments, one gets the sense short rides are more likely to be taken alone. The more climbs, the more attractive is being alone ($\beta_{csolo} = .2104$): groups tend to break up on climbs and descents—it is where differences in skill and fitness levels have the biggest effect—steepness amplifies this effect.

On most trails, being alone is bad, but it can be a good. For example, being alone increases utility if the trail is seven miles, has no singletrack, and has four climbs; if one is on such a trail, having a companion makes one worse off. Looking ahead, Table 3 reports estimated *WTP* for having a companion on this trail; it is negative.¹⁹

Riding with someone faster or slower is worse than riding with someone of one's own ability (see the parameter estimates for the β_{bx} and the β_{fx}). Figure 2 shows how estimated utility varies as a function of the time gap between the rider and companion. Shorter gaps are preferred to longer gaps, and riders, are, on average, close to indifferent between being behind and being in front.

¹⁹The influence of companion is much simpler in the restrictive and rejected Simple-Companion Model: being alone is always a bad, and, by assumption, independent of the type of trail and the ability of one's companion.

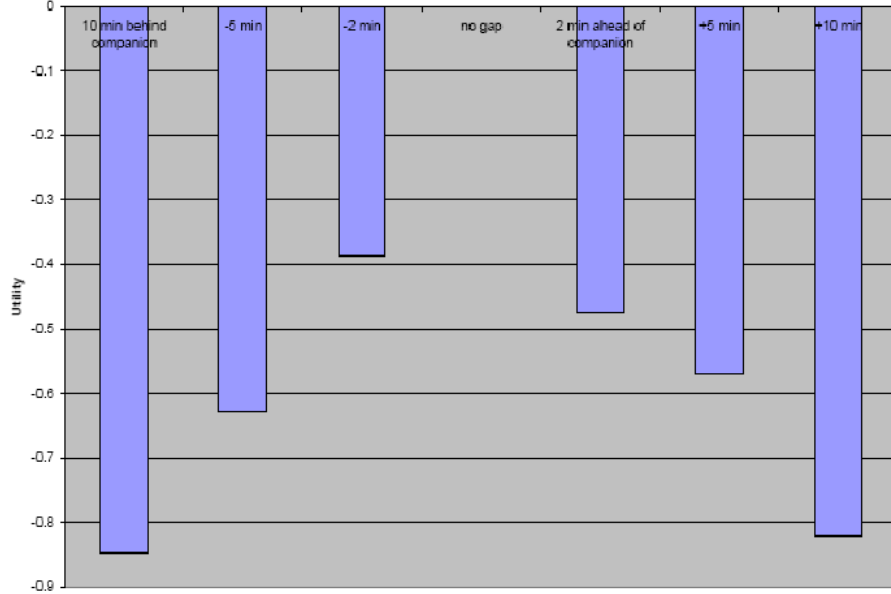


Figure 2: Utility as a function of the gap

As expected, the fee has a negative impact on utility but this impact lessens the higher the expenditure category for personal entertainment: the marginal-utility of money is declining, step-wise, in expenditure level, causing *WTP* for changes in ride characteristics to vary by expenditure category.

The impact of trail length ($trail_j$) is, as expected, complicated, and this is reflected in the Companion-Interaction Model estimates. Consider first rides where one has a companion. For a flat trail, utility increases with trail length but at a decreasing rate, asymptoting out at around 35 miles: even flat, 35 miles is a very long trail—most riders would require three to five non-stop hours. At the other extreme, more miles is a bad if the trail has four steep climbs and descents—most riders do not have the strength to repeatedly climb a 13.5 percent grade, and descending a trail this steep requires great skill, and the right temperament. The more climbs and the more grade, the more quickly increased miles go from a good to a bad. Things are a bit more complicated when one is alone ($solo_j = 1$): there is a utility gain to being alone if one is on a short trail, but this advantage disappears when the trail exceeds seven miles.²⁰

The impact of climbs is also complicated. Climbs are more attractive when

²⁰In contrast to the Companion-Interaction Model estimates, for the Simple-Companion Model the effect of more miles is restrictively simple: more miles are almost always preferred, an exception is a trail with four very steep (13.5%) climbs and descents, and even on such a trail, increased miles don't become a bad until about the twenty-fifth mile - these estimates are less plausible than the Companion-Interaction Model estimates.

one is alone. On a short trail, increasing the number of climbs from one to four increases utility. On a 35 mile trail, increasing the number of climbs decreases utility.²¹

Put simply, the story with $trail_j$, $climbs_j$ and $grade_j$ is more of one can be a good or a bad depending on its current level and on the levels of the other two—this is reasonable.

6.3 WTP estimates for increasing the proportion of singletrack

WTP estimates for increasing the proportion of singletrack are driven by the following terms in Equation 3:

$$V_{single_j}^* = -.4366(solo_j)(single_j) + .6001(single_j)^{0.5} \quad (10)$$

so depend on whether one has a companion. If one has a companion ($solo_j = 0$), increasing the proportion of singletrack always increases utility, but at a decreasing rate. In contrast, if one is alone, increasing the proportion of singletrack is good up to approximately 50% singletrack, but after that increasing the proportion makes the rider worse off. Reflecting: a trail with both single and double-track is more varied, and double-track is often easier than singletrack, so double-track adds stretches where one can relax, riders might appreciate this, particularly when alone. Looking at related data, before the choice questions were asked, respondents were asked, "To what extent do you agree with the statement "singletrack is the only kind of trail I want to ride." Fifty-four percent *definitely* or *somewhat* agreed.

Table 2 reports per-ride WTP estimates for going from no singletrack to 100% singletrack. For three reasons, they are reported: so they can be compared to the WTP estimates for having a companion and the WTP estimates for a change in your companion's ability, (2) to indicate the extent to which the value of a trail characteristics can be affected by the presence of a companion, (3) and to indicate the extent to which ignoring companion effects (the Asocial Model) might affect the parameter estimates on the trail characteristics.

Singletrack is valued much more if one has a companion (\$6.60 with the companion vs. \$1.80 without him, for those in the middle expenditure group).

Table 2: per-ride WTP estimates for increasing the proportion of singletrack from zero to 100%

Models ↓	weekly entertainment expend.		
	≤ \$25	\$26 – \$100	> \$100
Companion-Interaction Model: alone	\$1.45	\$1.80	\$2.11
Companion-Interaction Model: with companion	\$5.31	\$6.60	\$7.76
rejected Simple-Companion Model	\$8.93	\$11.07	\$12.97
rejected Asocial Model	\$9.53	\$12.41	\$14.54

²¹ Again the Simple-Companion Model estimates are restrictively simple: in the range zero to four, more climbs are always preferred.

In contrast, the Asocial Model, which completely ignores companion, generates much larger *WTP* estimates for an increase in this trail attribute.

6.4 *WTP* estimates for going from no companion to one of one’s ability

Consider next some per-ride *WTP* estimates for going from no companion to a companion of one’s ability, holding constant all of the trail characteristics: Table 3. Most of these *WTP* estimates are positive. Estimates are reported for three trail types (first–flat and all singletrack; third–steep, lots of climbs and no singletrack; and second–an intermediate case) and two trail lengths: 7 miles and more than 7 miles.

WTP for a companion of one’s ability varies substantially by trail type and length. The value of a companion of one’s ability is always less when the trail is short–compare, for example, \$1.49 with \$7.56. *WTP* for a companion increases with the proportion of singletrack, and decreases as the number of climbs increases. Consider the extreme case, estimated *WTP* for a companion of one’s ability is negative for a 7 mile trail with no singletrack and many climbs.²²

Table 3: *WTP* estimates for no companion to a companion of one’s ability

	weekly entertainment expend.		
	≤ \$25	\$26 – \$100	> \$100
No climbs, all singletrack			
Companion-Interaction Model: 7-mile trail	\$8.11	\$10.07	\$11.85
Companion-Interaction Model: > 7 miles	\$14.18	\$17.61	\$20.72
2 climbs, 5.4% grade, 25% singletrack			
Companion-Interaction Model: 7-mile trail	\$1.49	\$1.85	\$2.17
Companion-Interaction Model: > 7 miles	\$7.56	\$9.39	\$11.04
4 climbs, 10.8% grade, no singletrack			
Companion-Interaction Model: 7-mile trail	–\$3.20	–\$3.98	–4.68
Companion-Interaction Model: > 7 miles	\$2.87	\$3.56	\$4.19

6.5 *WTP* estimates for a change in the ability of one’s companion

Next consider per-ride *WTP* estimates for a change in the relative ability of one’s companion: specifically, going from a companion of one’s ability to a companion faster or slower. Summarizing, these estimates are all negative and increase in absolute value as the gap increases. Individuals, on average, are close to indifferent between being ahead ten minutes or behind ten minutes, but prefer to be behind if the gap is two minutes–See Table 4 and Figure 2.

²²In comparison, the rejected Simple-Companion Model restricts this *WTP* to be independent of the trails characteristics; they are, by expenditure category, always \$9.85, \$12.20 and \$14.31.

Table 4: per-ride *WTP* estimates for going from a companion of one’s ability to one slower or faster

relative ability ↓	weekly entertainment expenditures		
	≤ \$25	\$26 – \$100	> \$100
Two minutes faster than comp.	−\$4.20	−\$5.22	−\$6.14
Two minutes slower than comp.	−\$3.41	−\$4.23	−\$4.99
Ten minutes faster than comp.	−\$7.28	−\$9.04	−\$10.65
Ten minutes slower than comp.	−\$7.51	−\$9.33	−\$10.98

7 An illustration comparing the Asocial, Simple-Companion, and Companion-Interaction models

Consider how the estimated probability of choosing one trail over another differs between the Asocial Model, the Simple-Companion Model, and the Companion-Interaction Model. Consider a seven-mile trail, all singletrack, an average climbing grade of 10.8%, four climbs, and a trail access fee of \$5. Let *RideA* be this trail with no companion, and let *RideB* be this trail with a companion of the same ability.

Because the Asocial Model cannot distinguish between *A* and *B*, under the Asocial Model, the estimated probability of choosing *B* over *A* is 50%. With the estimated Simple-Companion Model, the probability of choosing *B* is 75%: having a companion of one’s ability improves the ride. However, with the estimated Companion-Interaction Model, the probability of choosing *B* is only 52% because for this more general model, on a short ride of seven miles, a companion is less important.

For the same physical trail, if one makes the companion five minutes faster, the Asocial Model again predicts the probability of choosing *B* is 50%. However now the Simple-Companion and Companion-Interaction Models disagree as to whether having this companion is a good or a bad. With the estimated Simple-Companion Model, the probability of choosing *B* is 63%: the companion is valuable, just not as valuable as they would be if they were the same ability. But for the Companion-Interaction Model, the preferred model, the probability of choosing *B* is 38% – the companion is a bad.

8 Thoughts for those using choice data with potential companion effects

All of the logit models we estimated, including the standard Asocial Model, are strictly "incorrect" for choice data where the outcome is something more than each individual maximizing their utility independent of everyone else. Our choice data avoids this problem, by construction.

Those, like us, who many times have estimated choice of activity ignoring companion effects and done so with RP-choice data, might argue the resulting estimated values of the characteristics are asymptotically unbiased: the effects of companions and social interactions averaging out. Maybe, but we have not been convinced. The problem, put simply, is that companion is a characteristic of each alternative that interacts with the alternative's other characteristics; if one ignores companion effects one has, at a minimum, an omitted variables problem, and if one includes companion one has an endogeneity problem—choices determine whether one has a companion. Additionally, if how one values the characteristic of an activity depends on whether one has a companion, and if the likelihood of having a companion varies by activity, the average value of each characteristic will vary across activities.

In recreation demand, even if the estimated average values of the site characteristics over the X sites are unbiased, this is typically not the WTP estimate of policy interest. Typically the goal is to estimate WTP for a change in the characteristic levels at a specific site, for example an injured site in the case of a Natural Resource Damage Assessment. If companion effects are ignored, the values of site characteristics assumed constant across sites, and their estimated values are derived from the variation in characteristic levels across sites, the damage estimate will be biased if the injured site is not average in terms of companion intensity (e.g., if most people fish alone at sites A and B , but typically have a companions at site C , the injured site).²³

If the issue is simply companion effects cause the parameters on the characteristics to vary across alternative – we don't think it's that simple – one could proceed by ignoring the characteristics and simply estimate a separate quality constant for each alternative, an approach which accommodates varying parameters on site characteristics, but precludes valuing the separate characteristics, making it impossible to value changes in the alternatives.

If when one collects RP-site-choice data, one also collects data on whether one has a companion in the chosen activity, and their ability, one could see whether and how companion profiles vary by activity; data on "party size" is sometimes collected. If there is no pattern, our comfort level associated with ignoring companion effects would increase.

If there are direct companion effects, but no indication a companion affects the value of the characteristics, we would be more comfortable ignoring companion effects than if there were such indications. In our application, companions do affect the value of site characteristics, and we suspect they will in many applications.

If one has data on whether the individual has a companion in his chosen activity, one still does not have data on whether he would have had a companion

²³For example, Hagler Bailly (1995) for litigation for the State of Montana, estimated annual damages of \$1.4 million (in 1992 dollars) from mining injuries to the Clark Fork River. Injuries were reduced catch rates. Damages were estimated using a multi-site travel-cost model estimating a cost parameter and a common catch-rate parameter (Morey et al. (2002)). The unanswered question is whether uninvestigated companion effects were significant and, if so, whether anglers were more or less likely to have a companion at the Clark Fork River.

in each alternative activity. So, even with companion data one could not simply include companion as a site characteristics, like we include trail length – the attribute is only observed for the chosen site. Note that one would likely not want to do this even if one somehow had this data: biased parameter estimates would likely result.

One could instrument companion to get an unbiased estimates of how a companion directly and indirectly (through site characteristics) affects site choice. This is how Timmins and Murdock (2007) estimated a recreation-demand model using observed choice data that found a significant congestion effect, "Ignoring congestion leads to an understatement of a lake's value by more than 50%." Put simply they used aggregate quality at the other sites as an instrument for congestion at site j , arguing that it is correlated with congestion but not a direct determinant of the utility of site j . See also Borgas (1992) and Gaviria and Raphael (1999) on instrumenting the choices of the other player or players. To implement this approach one obviously needs a good instrument for companion: a random variable that does not directly influence the site chosen but is highly correlated with whether one has a companion at that site, e.g., a companion tax/subsidy that varies by site (at some recreation sites one gets a discount for bringing a friend).

It is important to conceptually distinguish between companion as a characteristic of each alternative and preference heterogeneity with respect to companion. In a standard choice model one can always interact a characteristic of the alternatives with a characteristic of the individual which is a determinant of whether the individual prefers a certain type of companion (e.g. a covariate such as whether the individual races, or the extent he worries about being injured).²⁴ Doing so will cause the values of activity characteristics to vary across individuals in terms of their preference for a companion, but it does not address the possibility that companion is an endogenous attribute, and does not allow the value of characteristics to vary across activities.

8.1 A reader of a previous version asked, "Can people get utility from having a companion without a game being in play?"

The answer is yes. For example, if recreators live in a world where who you recreate with on a given choice occasion is exogenously determined by custom or social obligation, there is no gaming or bargaining, and one could estimate a site-choice model with parameters on site characteristics interacted with dummies for one's companion constraint, and one would have estimates of how the value of site characteristics vary with companion. Note the restriction that on a given choice occasion, one has a companion, or not, no matter which site is chosen.

Or, one could imagine a world where one's potential companions are con-

²⁴Or, one could incorporate preference heterogeneity by estimating a latent-class model that ignores companion effects but makes the class-membership probabilities a function of covariates that influence preference for a companion.

strained to recreate at certain places, while those in one's sample choose their site taking as given where their potential companions will be. Potential companions are known and your companion set differs from mine (we know different riders). Again there is no game, and with site-choice data one can estimate conditional-indirect utility functions with companion effects. Note that this is the constrained world we created with our choice experiment, so we could estimate companion effects.²⁵

Again, we are not game theorists and are not trying to model the gaming or bargaining, but it seems to us that site choices are often, but maybe not always, the result of a game. That said, the cost of ignoring companion effects, with or without a game, is difficult to ferret out.

9 A simple simulation of who will ride with whom and where: given our estimated utility functions with companion effects, one can identify possible game equilibria

But, from an observed equilibrium one typically cannot retrieve the estimated utility functions.

Assume, for expositional simplicity, three riders (Rocky, Bullwinkle and Boris) and two trails (the Guber and the Gomer).²⁶ It is Saturday morning and each will ride. Who will ride where and with whom? It depends on the characteristics of the two trails, the relative abilities of Rocky, Bullwinkle and Boris, their expenditure categories, and how equilibrium is defined and achieved.

Assume the boys have identical preferences, the one's estimated above; Rocky and Boris are of the same ability but Bullwinkle is five minutes slower (his heavy horns slow him down). Bullwinkle and Boris are in the high-expenditure category, Rocky in the low one.

Assume the Gomer trail is 7 miles of singletrack with a 5% grade and two climbs, The Guber trail is 14 flat miles of double-track. The fee for for Gomer trail is \$10 and the fee for the Guber Trail is \$2. With this information, one can calculate each boy's expected utility for each feasible trail/rider allocation.

Consider first what each would do if the other two guys did not exist. Expectationally, Bullwinkle and Boris will ride the Gomer trail, the trail with

²⁵Such constraints can mimic the real world. For example, in Colorado people living on the Front Range (Colorado Springs north through Denver to Fort Collins) have a choice set of approximately ten down-hill ski areas, but many people effectively constraint themselves to a specific site by purchasing a season pass for that site. Skiers without season passes then choose where to ski taking as constraints where their friends have season passes, so do not play a game, at least not with those friends.

²⁶For details on Rocky, Bullwinkle, Boris and Natasha go to http://en.wikipedia.org/wiki/The_Rocky_and_Bullwinkle_Show

the better physical characteristics, but Rocky will choose the Guber trail, the five-fold cheaper trail. On average, this is what we would observe in a random sample of these users if there were no companion effects.

But there are estimated social interactions. Given the estimated parameters and ignoring the random components in the three utility functions, three possible equilibria are each individual riding alone on the Gomer trail.²⁷ That is, the possible equilibria are identified given the estimated utility function with companion effects.

In contrast to our choice-experiment, consider collecting choice data for the season and estimating a site-specific recreational demand model, with, or without, companion effects. As noted earlier, there are potential problems. This data on Boris's, Bullwinkle's and Rocky's trips is likely generated by repeated social interactions (repeated games, repeated bargaining). One can possibly estimate preference parameters by modeling the interactions. If one models the game, it is still not clear one will be able back out estimates of the preference parameters for site characteristics and companion effects: different sets of preference parameters could generate the same equilibrium vector of site choices. Things are even more complicated, as in our simulation, if there are multiple equilibria.²⁸ We avoided these problems with our choice data by designing a choice experiment that made what others do exogenous. We also abstract from modeling who is in the group—why isn't Boris's friend Natasha included?

10 Summary, problems, and extensions

²⁷Karauth (2006) shows that in the Brock-Durlauf- type group models, when the group size is small, there will be multiple equilibria whenever group behavior exerts any influence.

²⁸There is a growing literature on estimation when the data is generated by a game. For example, Sowtevent and Kooreman (2007) develop and estimate a model where the group is small and the choice variables are discrete. The application is the choices made by high-school students and simulation methods are used to estimate the model. Tamer (2003) analyzes a bivariate discrete response model which is a stochastic representation of a two-person game with multiple equilibrium, and identifies conditions for identification. In 2003 the *Journal of Applied Econometrics* devoted a whole edition to the estimation of social interactions. In the introduction to the issue, the editors state, "The papers in this special issue reflect efforts by a set of leading economists to grapple with the difficult identification and estimation issues that arise in trying to estimate the magnitudes and consequences of social interactions" (Durlauf and Moffitt (2003)).

Chiappori and Ekeland (2006a and b) take a different and more general approach to estimating individual preferences and the intragroup decision process. In our context, they ask the following: if one observes how a small group of individuals aggregately allocates trips across a set of sites subject to the group's aggregate budget, can one identify, in theory, the utility functions of the group members and the intragroup decision process? They ask this question assuming the allocation is Pareto efficient. Their results apply to the outcome of social-coordination games if the number of players is small and the equilibrium is efficient. In general, the answer to their question is no, as expected, but they identify necessary and sufficient conditions for identifying the utility function and the process. These are more general than one would expect, and could hold for a small-group site-choice game with companion effects, particularly if some individual behavior is also observed.

We investigate, using choice experiments, whether having a companion and the companion's relative ability are important determinants of recreation-site choice. Our estimates indicate they are as important as the costs and physical characteristics of the sites. Companions of comparable ability are preferred over companions substantially better or worse at the activity. And, how one values the physical characteristics of site depends on whether one is alone or with a companion. Companion effects have not previously been included in a site-specific recreational demand model.

If there are companion effects, site-choice data is likely the equilibrium of a game. If one's intent is to estimate the preferences over the determinants of site choice with such data, one should either explicitly model the game, or find some other way to address the fact that the characteristic *companion* is endogenously determined, or convince oneself that companion effects wash out in the wash. We avoided this problem by constructing our choice experiment so the companion effects could be estimated with no game between respondents. Our type of choice experiment could be used to investigate social interaction affects in other choice contexts (e.g. choice of neighborhood, choice of peer group, and who dates, and with whom).

Above, we cogitate on whether those who use site-choice data to estimate the values of site characteristics can, comfortably, ignore companion effects. One might, for example, imagine our results being used in NRDA litigation to argue that damage estimates from a model that does not include companion effects are highly biased. Or, use our estimates to argue that one simply cannot estimate WTP for a change in the characteristics of a site until one explicitly models social interactions: without specifying how people interact, one cannot predict how choice will change, or estimate values.

Or, one might more optimistically argue that when hypothetical choice experiments (would you rather fish the site under characteristic levels A or B) are used to value the characteristics of a specific site, the respondent will consider who they will be with in each alternative when making their choice, even if companion affects are unmentioned. So, if respondents correctly predict what the social-interaction equilibrium will be under each alternative, one will end up with unbiased estimates of the site characteristics, at that site. For example, the NRDA of the PCB damages to the bay of Green Bay where preference data was collected by asking anglers whether they would prefer to fish Green Bay under conditions A or B (Morey et al. (1999) and Breffle et al. (2006)), arguing that the damage estimate was not biased by the fact that companion effects were not considered, even though anglers are more likely to have a companion when fishing the open waters of Green Bay than when fishing a smaller, inland substitute lake.

The responses to the attitudinal questions in our survey indicate that whether a companion is a good or a bad likely varies across individuals. The same for relative ability: some prefer to lead, some prefer to chase, and others say they don't care. But, the model presented assumes homogenous preferences. A next step is to model preference heterogeneity for companion, likely using a latent-class model. The survey included psychological questions about friendship, competi-

tiveness, assertiveness and preferences for risk. We hope the responses to these questions can help to explain preference heterogeneity over companion.

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