

# 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 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 at the activity, and how one values the physical characteristics of sites depends on whether one is alone. These findings suggest that behavioral site-choice data is often the equilibrium of a social coordination game, not the result of the individual maximizing his utility in social isolation. To date, recreation-site-choice models do not model the game.

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)). If the conjecture is correct, observed recreation-site-choices are the outcome of a social-coordination game. This paper does not model the game; 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

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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 (interacting with others 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.<sup>1</sup> The implications of this omission is 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 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 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.<sup>2</sup> As Manski notes in his 2000 *Journal of Eco-*

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<sup>1</sup>See 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) first 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 model, 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 in influence of congestion on site choice. Congestion and companion effects are different: the individual takes congestion levels as given but chooses whether to have a companion, and congestion is modeled as impersonal crowding (other people are simply taking up space); personal interaction is not considered. There are similarities: with congestion the equilibrium allocation across sites is the outcome of a game, and if congestion is a good - 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.

<sup>2</sup>Social psychology focuses on the individual and investigates how thoughts, feelings, and

*nomie 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. In addition, companions of comparable ability are preferred over companions significantly better or worse at the activity. These findings should not surprise skiers, rock climbers, bikers, or social psychologists.

The choice experiment approach allows us estimate the influence of a companion on choice without modeling a social-coordination game: 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.<sup>3</sup> In contrast to our choice experiments, quasi-experimental data is sometimes found or created that can be used to avoid the reflection problem.<sup>4</sup>

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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.

<sup>3</sup>The identification and endogeneity difficulties are echoed in Sacerdote (2001), Dufo and Saez (2003), earlier papers by Manski ((1993) and (1995)), and Evans et al. (1992).

<sup>4</sup>Sacerdote (2001) uses the fact Dartmouth freshman-year roommates are randomly assigned to study how one's roommate affects one's study effort and membership in social organizations. Dufo 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.

Another approach to solving the reflection problem is to instrument the choices of the other player or players (e.g. Borgas (1992) and Gaviria and Raphael (1999)). 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.

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.<sup>5</sup> Mountain biking was chosen for 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, 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. Golf, like tennis, is an activity where a companion is not necessary, 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. In addition, the choices are hypothetical.<sup>6</sup>

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

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<sup>5</sup>The 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 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.

<sup>6</sup>At great expense, individuals recruited for a mountain bike trip could be presented with two actual trail/companion options, and then transported, with their companion, to the chosen alternative. Potential companions would need to be recruited - for example, a better skilled friend for ride A and a friend of equal skill for ride B. With specific people, it would be difficult to hold the degree of friendship constant and difficult to accurately assess how a respondent assesses a friend's skill.

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 was no game. However, if there are companion effects in behavioral data, and one wants to use the behavioral data to estimate preferences, one must model the game. Current recreation-site-choice models do not model the game.

## 0.1 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 is 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. These also show how *WTP* for a site characteristics depends on whether one has a companion. Section 7 is an illustration. Section 8 uses the estimated utility/reaction function to simulate a game of who will ride with whom, and where. Section 9 summarizes, returns to the issue of site-choice behavioral data being the outcome of a game, and reports how we would like to extend our model to consider heterogeneity.

## 0.2 The literature on social interaction and choice

### 0.2.1 Why do other people matter?

Social psychology asserts a native desire to seek the company of others - it is the premise of the field.<sup>7</sup> 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.<sup>8</sup> This category includes the feelings of security provided by a companion, and also the joy of interacting with others, including games

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<sup>7</sup> Asch (1952) and Brown (1965) are two of the early texts in social psychology.

<sup>8</sup> We interact with others because it increases our utility: either directly or because interacting gets one more utility-producing stuff, here we are considering the direct effect. Economists more often model the indirect effect of other people.

and competitive situations. Second is sexual desire. We have tried to eliminate sexual desire as a factor in our choice experiment.<sup>9</sup>

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.

Comparison is part of our quest to make ourselves feel better.<sup>10</sup> 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. Social comparison theory predicts if one rides with others to assess one's own abilities, the others' abilities need to be commensurate with yours: the value of a companion declines as the difference between his and your ability increases - something we find.

The 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 at the activity can be threatening. One can eliminate this threat by riding alone or by choosing a

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<sup>9</sup>How sexual desire affects choices is a subject ripe for economic research.

<sup>10</sup>Motives 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))

riding companion "out of one's league" - termed "self-handicapping" ((Shepperd and Taylor (1999)).

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: finding out whether one is better or worse is immaterial to one's utility.

## 0.2.2 The game-theory, social interaction, and networking literature briefly mentioned

Potential biking companions play a *social-coordination game* driven by *network effects/network externalities*: they coordinate and either form a network (ride together), or not.<sup>11</sup> There is, to our knowledge, no social coordination game literature on recreational participation and site choice.

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 game 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 similar game is which neighborhood to live in and then how to behave when there (Bala and Goyal (2000)). 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. 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. An equilibrium is the set of choices that both maximizes everyone's utility and makes everyone's beliefs correct. Mountain biking choices are sometimes based on everyone's beliefs about who will show up at which trail head, but more often who is riding with whom and where is determined in advance.

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

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<sup>11</sup>Much 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.

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. Social coordination 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 literature on social-coordination games.

## 1 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.<sup>12</sup> 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.

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<sup>12</sup>One can see the survey as the respondents say it at <http://www.colorado.edu/economics/morey/respondentview/bikefinal.htm>

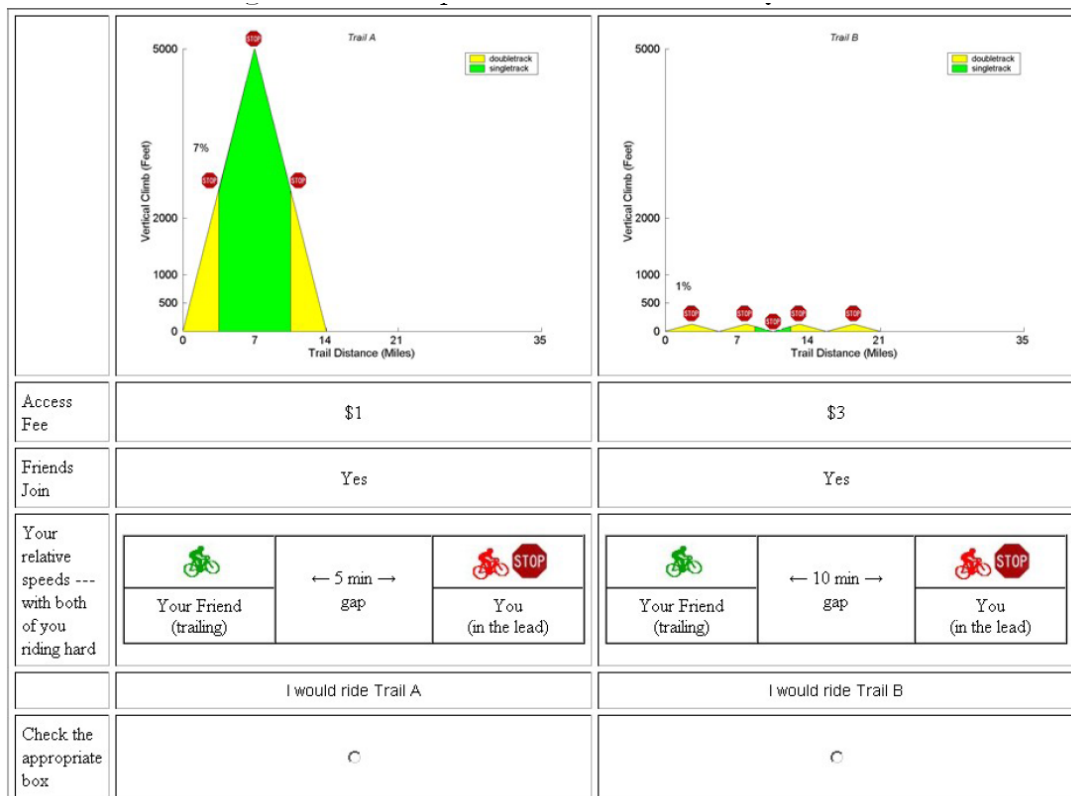


Figure 1: A choice pair from the survey

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".

## 1.1 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.

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.<sup>13</sup>

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 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 were an easy 15-minute bike ride from the respondent's home (so travel costs were small and the same for all sites). Respondents were asked to assume scenery did not vary across the alternatives.

<sup>13</sup>There 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 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 Hesseln, Loomis, and González-Cabàn (2004).

### 1.1.1 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 game-theoretic 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 experience with this type of social bundling: Don calls to say he is riding the Guber trail, and Bob calls to say he and Marc are riding the Gomer trail, and one chooses one of these two rides, or rides alone on some third trail. When one makes the choice of 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.

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 a function of the trail length (one on a seven-mile trail, three on a fourteen-mile trail, five for a twenty-one-mile trail, and nine for a thirty-five-mile trail), 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 hard 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.

## 2 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 occasional 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 solicitation e-mails were sent out, many to multiple parties. 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.

## 3 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.<sup>14</sup>

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.

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<sup>14</sup>A 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.

### **3.1 Likert-scale data on companion and their ability**

#### **3.1.1 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.

#### **3.1.2 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.

### 3.1.3 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.

## 3.2 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).

## 4 A Companion-Interaction Model of ride choice

### 4.1 Ride choice

The utility to individual *i* if they choose ride *j* is

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

where  $\varepsilon_{ij}$  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, therefore

$$P_{iA} = \frac{e^{V_{iA}}}{e^{V_{iA}} + e^{V_{iB}}} \tag{2}$$

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

$front2_j \equiv$  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

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

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

The first four lines of Equation 3 are a flexible specification of how companion can affect how much one enjoys a ride. The expected utility specific to riding alone (the first four lines with  $solo_j = 1$ ) is

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

It is allowed to depend on the physical characteristics of the trail; one would expect this. For example, a companion might be more, or less, valued when the trail is long and difficult.

Setting  $solo_j = 0$ , the expected utility specific to having a companion depends on the companion's relative ability and is

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

This expression is zero if the companion is of your ability, the default.

The fifth line of Equation 3, the term  $(\beta_{ml}D_{li} + \beta_{mm}D_{mi} + \beta_{mh}D_{hi})(expend_i - fee_j)$ , 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  $\beta_{el}$  is the marginal utility of expenditures for those who spend less than \$25 a week,  $\beta_{em}$  is the marginal utility of expenditures for those who spend between \$25 and \$100 a week, and  $\beta_{eh}$  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 first five lines of Equation 3 determine expected  $WTP$  for a companion; it will depend on the ability of the companion, the characteristics of the trail, and the individual's expenditure category.

Considering directly the utility from the site characteristics, the utility from trail length,  $trail_j$ , is, 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 impact of trail length is allowed to be nonlinear and allowed to depend on other ride characteristics, including whether one is alone. For example, increased trail length could be a good or bad depending on grade and number of climbs.

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  $\beta_s$  (the nonlinear term on grade and the linear term on singletrack) were not significantly different from zero, so were set to zero. The parameter  $\beta_{tsolo}$  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

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

The estimated  $t$ -statistics vary, in absolute value, from 2.73 to 29.41

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 a bench-

mark model 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 ( $\beta_{ssolo} = \beta_{t\tau solo} = \beta_{csolo} = \beta_{gsolo} = 0$ ). 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.<sup>15</sup> With our data, or similar bundled choice-pair data, excluding companion will cause an omitted variables problem if having a companion affect 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 ( $B_{b10} = B_{b5} = B_{b2} = B_{f2} = B_{f5} = B_{f10} = 0$ ). 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.

## 4.2 A warning for those using behavioral data

All of the models estimated, including the standard Asocial Model, are **incorrect** for behavioral data that is the equilibrium of one or more social-coordination games -these models assume no game. Our data avoids this problem, by construction.

## 4.3 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 WTP estimates reported 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 immaterial.

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<sup>15</sup>A likelihood ratio test comparing the Asocial Model and the Simple-Companion Model also rejects the null hypothesis that companion is irrelevant.

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

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

The constant,  $-1.1656$ , indicates that, *Ceteris Paribus*, being alone decreases utility. The negative sign on  $\beta_{solo}$  ( $-.4366$ ) 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 ( $\beta_{solo} = .2104$ ): 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.<sup>16</sup>

Riding with someone faster or slower is worse than riding with someone of one's own ability (see the parameter estimates for the  $\beta_{bx}$  and the  $\beta_{fx}$ ). 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.

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<sup>16</sup>The 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.

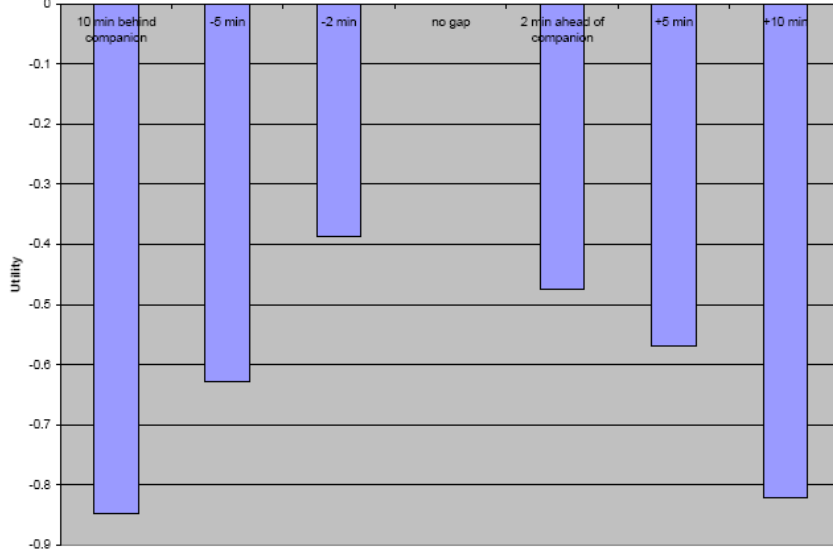


Figure 2: Utility as a function of the gap

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.<sup>17</sup>

The impact of climbs is also complicated. Climbs are more attractive when one is alone. On a short trail, increasing the number of climbs from one to four

<sup>17</sup>In 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.

increases utility. On a 35 mile trail, increasing the number of climbs decreases utility.<sup>18</sup>

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.

#### 4.4 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 estimate 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

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

<sup>18</sup> Again the Simple-Companion Model estimates are restrictively simple: in the range zero to four, more climbs are always preferred.

#### 4.5 *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 7 a mile trail with no singletrack and many climbs.<sup>19</sup>

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

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

#### 4.6 *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.

<sup>19</sup>In 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. For 7 mile trails, *WTP* for a companion of one's ability is always much higher with the rejected Simple-Companion model. For trails of 14, 21, or 35 miles these estimates are sometimes higher, and sometimes lower, than the Companion-Interaction Model estimates. Compare, for example, \$2.87 with \$9.85 and \$14.18 with \$9.85.

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

## 5 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, for example, a trail seven miles long, all single-track, 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.

## 6 A simple simulation of who will ride with whom and where

There are three riders (Rocky, Bullwinkle and Boris) and two trails (the Guber and the Gomer).<sup>20</sup> It is Saturday morning and each will ride, and by assump-

<sup>20</sup>For details on Rocky, Bullwinkle, Boris and Natasha go to [http://en.wikipedia.org/wiki/The\\_Rocky\\_and\\_Bullwinkle\\_Show](http://en.wikipedia.org/wiki/The_Rocky_and_Bullwinkle_Show)

tion, the three riders cannot all ride together. 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 in the previous section; 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 combination.

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 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 social interactions.

But there are estimated social interactions. Given the estimated parameters and ignoring the random components in the three utility functions, there are three possible equilibria: each individual riding alone on the Gomer trail.<sup>21</sup>

Consider collecting behavioral data for the season and estimating a site-specific recreational demand model, with, or without, companion effects. As noted earlier, there are problems. This data on Boris's, Bullwinkle's and Rocky's trips is generated by a repeated stochastic social-coordination game, so one can possibly estimate preference parameters by modeling the game. (Of course, one can eliminate the game by assuming either no companion effects or assuming the three boys were and will always be constrained to bike alone.) If one models the game, it is still not clear one will be able to estimate 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 the game has multiple equilibria.<sup>22</sup> We avoided these problems with our choice data by designing a

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<sup>21</sup>Karauth (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.

<sup>22</sup>There is a growing literature on estimation when the data is generated by a social-coordination 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

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?

## 7 Summary, extensions, and the game problem

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, behavioral site-choice data is the equilibrium of a social-coordination game. If one's intent is to estimate the preferences over the determinants of site choice with such data, one should model the game, current recreation-site-choice models do not. 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 contexts (e.g. choice of neighborhood, choice of peer group, and who dates, and with whom).

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 heterogeneity. The survey included psychological questions about friendship, competitiveness, assertiveness and preferences for risk. We hope the responses to these questions will help to explain the preference heterogeneity over companion.

## 8 References

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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.

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