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

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A R T I C L E I N F O

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A B S T R A C T

Individuals often recreate with others, but models of recreation-site choice (which ski area, climbing route, golf course, or bike trail) ignore the social aspect—a trait they share with most choice models. Site-choice models seek to explain site choice as a function of only the cost of visiting each site, the physical characteristics of the sites, income, and other characteristics of the individual. They ignore the influence of others on site choice. We find, using choice experiments, that having a companion and the companion's relative ability are critical determinants of site choice—what social psychology would predict. 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, importantly, how one values the physical characteristics of sites depends on whether one has a companion. The magnitudes of our estimated companion effects suggest recreation-demand models that ignore them, all do, omit a critical endogenous variable. An implication is that observed trip patterns can be generated by social-interaction game playing ("where I go depends on where you go and …"), not utility maximization in isolation. This paper does not model the game; it estimates a recreator's utility/reaction function with companion effects, showing the importance of the social component.

## 1. Introduction

This research is motivated by the conjecture that where you recreate often depends on where friends 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 estimate the magnitudes of such *companion effects*. If the magnitudes are large, observed recreation-site choices are likely the outcome of a game or bargaining among individuals, rather than individual utility-maximizing behavior in social isolation.[1,2] 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*

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[1] Whether 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. Since we are not modeling these specifics, 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 other individuals.

[2] While companion effects make a game likely, they are not sufficient. Consider an individual whose potential companions are constrained to recreate at certain places; he is not playing a game with them because where they recreate is exogenous from his perspective and his site choice has no influence on where they recreate. For example, your potential skiing companion, but not you, purchases a season ski pass effectively constraining himself to a specific ski area. You then choose given this constraint.

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*effects*, first step in understanding choice in this social context. This utility function determines the individual's *reaction* to the behavior of potential companions.

Existing recreation site-choice models, with a few exceptions, ignore the social aspect of recreation: with whom you personally recreate, and their ability, is assumed immaterial to where you recreate, and assumed immaterial to how site characteristics are valued.[3] The implications of this omission are significant and will be discussed.

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. And, the cost of staying together 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. Competition – never mentioned in the literature in recreational site choice – 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.[4] 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, while not mentioning 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 careful elicitation of persons' subjective perceptions on the interactions in which they participate.” By “subjective perceptions” he means, we believe, stated preferences. Motivated by these criticisms, we estimate the effect of companion on utility with a survey 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 that 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 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.

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).[5]

The choice experiment approach allows us to 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 revealed-preference (RP)

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[3] There is minimal recreation-demand literature on choice of companion and the influence of companion on site choice. Kaoru (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 that party size influences entry point and choice of trails. While noting party formation, they do not model party formation.

Chapman and Hanemann (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 can be 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.

[4] Social 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.

[5] Of course, coordinating freetime can also have congestion and agglomeration effects.

data that is the result of a game; one typically cannot identify the reaction function by observing only the equilibrium of the game—an "untieable" Gordian knot. Manski (2000) emphasizes this point.[6]

In contrast to our choice experiments, quasi-experimental data is sometimes found or created that can be used to avoid the reflection problem.[7] Another approach to solving the reflection problem is to instrument the choices of the other player or players (e.g. Borjas, 1992; Gaviria and Raphael, 1999; Timmins and Murdock, 2007). The choice-experiment approach cuts the game-theoretic Gordian knot of social interactions, so avoids the reflection problem.[8]

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.[9] Mountain biking was chosen for a number of reasons. (1) It does not require a companion. (2) 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 (3) we have done the previous research on the choice of mountain-bike trails (Morey et al., 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, unlike 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, three important simplifying assumptions have been made. (1) 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. (2) 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. (3) And participation (number of trips) is not modeled.

The model for our data is a simple discrete-choice random-utility model: sophisticated choice models are not required to make the empirical point.[10] We assume that 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 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. And, to estimate how the presence of a companion affects the value of site characteristics.

The magnitudes of our estimated companion effects suggest that recreation-demand models that are estimated with RP data and that ignore companion effects – all do – omit a critical endogenous variable. If companion effects are important, modeling and estimating site choices for the purpose of estimating WTP for site characteristics is difficult. One needs to model the social interaction, simultaneously modeling both site and companion choice. Valuation becomes difficult, and difficult to interpret if potential recreators are playing site/companion games. If, for example, the goal is to estimate an individual's WTP for an improvement in Site A, one should estimate the individual's *WTP to play the game* with Site A improved, not their *WTP* for that improvement in social isolation – the individual does not live in social isolation.

### 1.1. Organization

Section 2 continues the discussion on social interaction and choice, reviewing the literature. Section 3 discusses the survey and its design, including the choice experiment; Section 4 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, and take as given the behavior of the companion. *WTP* estimates for a change in the ability of one's companion are also reported.

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

[7] Sacerdote (2001) uses the fact that Dartmouth freshman-year roommates are not chosen but 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.

[8] Akin 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, so observed site choices are the equilibrium of a sorting game. Boxall et al. (2003), like us here, use choice experiments to avoid the endogeneity problem, varying congestion levels independently of the other site characteristics.

[9] The choice of climbing site has been studied by Jakus and Shaw (1996), Shaw and Jakus (1996), and Grijalva et al. (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 cannot, or cannot ski where you want to ski, detracts from the experience. These studies do not take this into account.

[10] That said, in future work we hope to formally investigate heterogeneity in the preferences for a companion.

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 are thoughts for those using choice data with potential companion effects.

## 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.[11] 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.[12] 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.[13]

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.[14] 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 et al., 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 Bulman, 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 et al., 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). Some individuals, to protect their egos, purposively handicap their ability (Jones and Berglas, 1978) by, for example, riding hard 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 that you are not one of them.

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

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

While we are not modeling the social interaction, our results suggest social interaction, so we briefly discuss the social interaction literature, pointing out the issues and difficulties associated with estimating companion effects and modeling a site/companion game.

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

[12] 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.

[13] How sexual desire affects choices is a subject ripe for economic research.

[14] Motives for the drive include self-enhancement, perceptions of relative standing, maintaining a positive self image, and closure (Suls et al., 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).

Potential biking companions interact driven by *network effects/network externalities*: they coordinate and either form a network (ride together), or not.[15]

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 (e.g. go to the same party). 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 site/companion 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). A game with some similarities is which neighborhood to live in and then how to behave when there (Bala and Goya, 2000). Game-theoretic literature where one simultaneously chooses an alternative and a partner includes Jackson and Watts (2002) and 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 large-group discrete-choice random-utility model. They assume that the utility an individual gets from an alternative depends on his characteristics, characteristics of his group (e.g. ethnic mix, average income), and his 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.

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 that 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), an appropriate assumption for recreation. See, for example Sacerdote (2001) and Duflo and Saez (2003). Data that is the outcome of many simultaneous games, each by a small number of endogenous players are more complicated than population games where everyone is playing the game together and this is 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

Surveying mountain bikers, preference data was collected in two forms: answers to attitudinal questions, and responses to choice pairs.[16] Fig. 1 (in color) is a snapshot of a choice-pair question 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 footnote 16. 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 primarily 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'."

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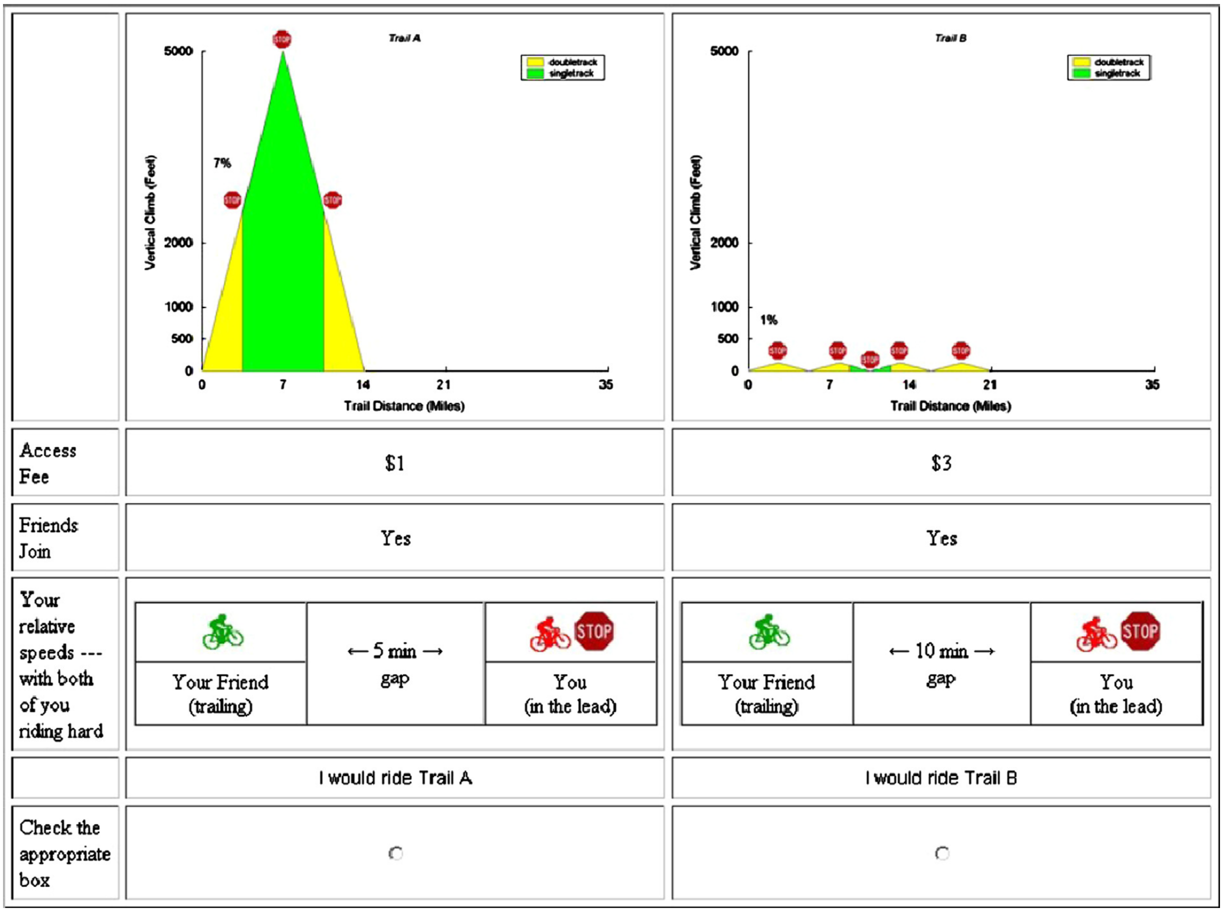
[15] Much of the literature on network effects has to do with which good to adopt. For example, the benefits I get from having unlimited text messaging on my cell phone depends on how many of my friends and associates use text messaging: we jointly create, or do not, a network of text messagers. Farrell and Klemperer (2007) is an excellent review article on network effects from the perspective of industrial organization.

[16] One can see the survey as the respondents saw it by typing in your browser http://www.colorado.edu/economics/morey/respondentview/bikefinal.htm.



| | | |
|---|---|---|
| Access Fee | $1 | $3 |
| Friends Join | Yes | Yes |
| Your relative speeds --- with both of you riding hard | Your Friend (trailing)<br>← 5 min → gap<br>You (in the lead) | Your Friend (trailing)<br>← 10 min → gap<br>You (in the lead) |
| | I would ride Trail A | I would ride Trail B |
| Check the appropriate box | ○ | ○ |

**Fig. 1.** A choice pair from the survey. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

### 3.1. Characterizing mountain-bike trails

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

Morey et al. (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.[17]

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 ft. of climbing and descending (the grade is always either plus or minus 35%).

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).

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[17] 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 a forest fire, or the special geographic and weather characteristics of a unique trail-system (Moab, Utah). See Fix and Loomis (1997), Loomis et al. (2001, 2003), and Hesseln et al. (2004).

**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 (min) | solo, −10, −5, −2<br>0 (same ability), +2, +5 and +10 |

### *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 and endogenous aspect 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 example, you play no game, but the others likely played a 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 did not, 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 2 min if both riders rode at their typical pace. This does not mean the gap would always be 2 min, 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 unknown proportion of the individuals who received our e-mail 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 true 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.[18] Our sample took approximately 28,000 rides in the last 30 days, a large proportion of these rides included at least one companion. Most respondents do some biking alone: 22% report they usually ride alone, while another 39% report they often do.

The mean age of respondents is 37; 86% 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.

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 30 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, do not 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 positively 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.

### 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%). The presence of a companion is more important than the access fees (the “price”) in the fee range asked ($1 to $20).

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

## 6. A simple Companion-Interaction Model of ride choice

### 6.1. Ride choice

Assume that the utility to individual $i$ if they do 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[19]

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

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 fraction. A grade of over .1 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 min 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 min 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 min 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 min 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 min 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 min 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

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

with the restriction $climbs_j = 0 \iff grade_j = 0$. Some square-root and interaction terms are included because non-linearities and interactions among the site attributes were expected.[20]

The first line of Eq. (3), the term $(\beta_{el}D_{li} + \beta_{em}D_{mi} + B_{eh}D_{hi})(expend_i - fee_j)$, 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 $\beta_{el}$ 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 step-income effects, a simple way to incorporate the common observation that willingness-to-pay is a function of available income.

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[19] The stochastic specification could be complicated in numerous ways (e.g. random parameters). Doing some will not change the basic finding that there are companion effects. Estimating with more complicated stochastic specifications is not the point of the paper.

[20] Note that Eq. (3) is not a complete second-order approximation: a number of nonlinear and interaction terms are omitted. These omissions were imposed in the interests of simplicity and because our objective was to estimate the influence of a companion and her ability, not to precisely estimate how all of the site attributes interact. Looking ahead, our primary results are maintained through a number of different specification of Eq. (3).

The next 11 terms represent 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 remaining terms, 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

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

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

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

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 alone $V_{solo_j} < 0$.

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

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

The ln likelihood function for the sample is

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

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

Based on a likelihood-ratio test, 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 that being alone is evaluated differently if one is on a short trail. 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

$$\begin{aligned} V_{ij}^{(*)} = {} & (.1130D_{li} + .0910D_{mi} + .0773D_{hi})(expend_i - fee_j) + .6001(single_j)^{0.5} - .0686(trail_j) + .8297(trail_j)^{0.5} - .2182(climbs_j) \\ & + 1.8553(climbs_j)^{0.5} - .0016(grade_j) - .06418(climbs_j trail_j)^{0.5} - .0177(climbs_j grade_j)^{0.5} + .0077(trail_j grade_j)^{0.5} \\ & - 1.1656(solo_j) - .4366(single_j)(solo_j) + .6858(solo_j)D_{t7} + .2104(climbs_j)(solo_j) - .0012(grade_j)(solo_j) \\ & - .8488(back10_j) - .6287(back5_j) - .3858(back2_j) - .4746(front2_j) - .5688(front5_j) - .8229(front10_j) \end{aligned} \tag{8}$$

Table 2 lists these estimated parameters and their $t$-statistics.

The parameter estimates are discussed in the next 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-choice 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.[21] 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 ($B_{b10} = B_{b5} = B_{b2} = B_{f2} = B_{f5} = B_{f10} = 0$). Comparing the Companion-Interaction Model and the Ability

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

**Table 2**
Companion-Interaction Model: param. estim.

| Parameter | Estim. | *t*-Value |
|---|---|---|
| *Income-effects parameters* | | |
| $\beta_{el}$ | .1130 | 22.31 |
| $\beta_{em}$ | .0910 | 29.41 |
| $\beta_{eh}$ | .0773 | 16.86 |
| *Trail-attribute parameter (exclud. interactions with solo)* | | |
| $\beta_{ss}$ | .6001 | 7.13 |
| $\beta_{t}$ | −.0686 | −4.04 |
| $\beta_{tt}$ | .8297 | 5.63 |
| $\beta_{c}$ | −.2182 | −4.69 |
| $\beta_{cc}$ | 1.8553 | 16.52 |
| $\beta_{g}$ | −.0016 | −3.30 |
| $\beta_{ct}$ | −.06418 | −2.79 |
| $\beta_{cg}$ | −.0177 | −2.73 |
| $\beta_{tg}$ | .0077 | 3.54 |
| *Solo parameters* | | |
| $\beta_{solo}$ | −1.1656 | −14.33 |
| $\beta_{ssolo}$ | −.4366 | −7.10 |
| $\beta_{t7solo}$ | .6558 | 6.31 |
| $\beta_{csolo}$ | .2104 | 5.69 |
| $\beta_{gsolo}$ | −.0012 | 3.32 |
| *Time-gap parameters* | | |
| $\beta_{b10}$ | −.8488 | −20.31 |
| $\beta_{b5}$ | −.6287 | −14.96 |
| $\beta_{b2}$ | −.3858 | −9.13 |
| $\beta_{f2}$ | −.4746 | −11.39 |
| $\beta_{f5}$ | −.5688 | −13.87 |
| $\beta_{f10}$ | −.8299 | −18.98 |

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 the parameter estimates

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

$$V^*_{solo_j} = -1.1656 - .4366(single_j) + .6858D_{t7} + .2104(climbs_j) - 0.0012(grade_j). \tag{9}$$

The negative constant, −1.1656, indicates that, Ceteris Paribus, being alone decreases utility. The estimate of $\beta_{ssolo}$ (−.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 4 reports estimated *WTP* for having a companion on this trail; it is negative.[22]

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 $\beta_{fx}$). Fig. 2 shows how estimated utility varies as a function of the time gap between the rider and companion.[23] Shorter gaps are preferred to longer gaps, and riders, are, on average, close to indifferent between being behind and being in front.

While the above are the estimated companion effects for our particular specification of the indirect utility function, we investigated a number of different specifications of Eq. (3). The influence on choice of the presence of a companion and the companion's ability were always significant. So was the influence of companion on the value of trail attributes.

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[22] 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.

[23] On the basis of a likelihood ratio test, the null hypothesis that one is indifferent to the magnitude of the time gap is rejected.

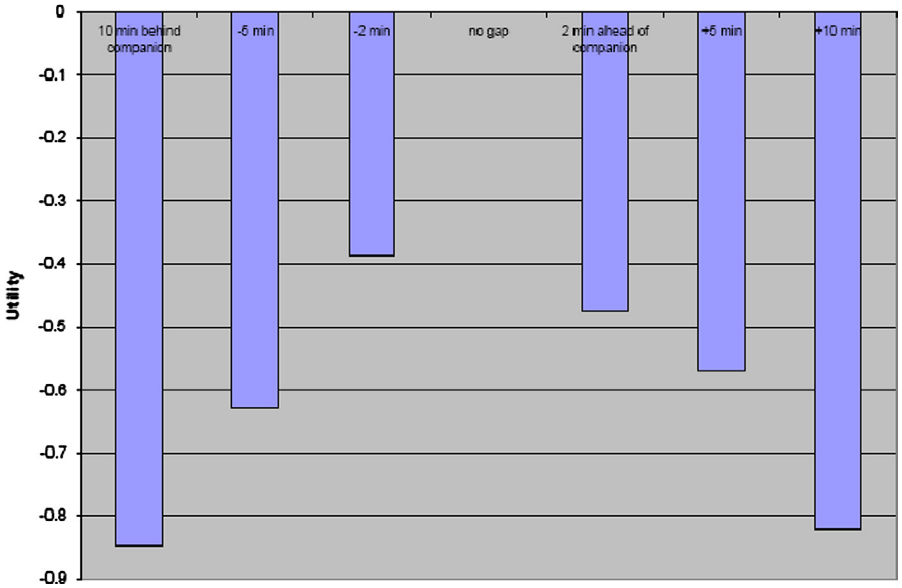

**Fig. 2.** Utility as a function of the gap.

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% 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.[24]

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 increases utility. On a 35 mile trail, increasing the number of climbs decreases utility.[25]

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*

Eq. (9) can be used to derive *WTP* measures. One can think of these as cardinal measures of how much the individual cares about a companion or a site characteristic, a way to present the message of the parameter estimates, and to assess the importance of companion effects relative to trail attributes. One can calculate an individual's estimated *WTP* to have a companion of a particular ability on a particular trail. One can also determine an individual's *WTP* to increase the amount of single-track at Trail 3, conditional, for example, on him being alone at all of the trails, or conditional on him having a slow companion at Trail 3 and a fast companion at all the other sites. *WTP* estimates such as these, while informative, need to be carefully interpreted; they are *not* estimates of *WTP* to play a site/companion game, so not the measures one would use to value policies if site/companion choice is determined by game playing. They are the *WTP* measures one would use for policy valuation if what others do is not influenced by the individual's behavior.

With these cautions in mind, *WTP* estimates for increasing the proportion of singletrack are driven by the following terms in Eq. (9):

$$V^*_{single_j} = -.4366(solo_j)(single_j) + .6001(single_j)^{0.5} \tag{10}$$

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[24] 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 do not become a bad until about the 25th mile—these estimates are less plausible than the Companion-Interaction Model estimates.

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

**Table 3**
Per-ride *WTP* estimates for increasing the proportion of singletrack from 0 to 100%.

| **Models ↓** | **Weekly entertainment expend.** | | |
|---|---|---|---|
| | ≤25 | \$26–\$100 | > 100 |
| CI* Model: alone | \$1.45 | \$1.80 | \$2.11 |
| CI 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 |

* Companion-Interaction.

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 3 reports these per-ride *WTP* estimates for going from no singletrack to 100% singletrack; they are based on the restrictive assumption that where others ride is not influenced by where you ride. For three reasons, they are reported: (1) so their magnitude can be compared to the comparable *WTP* estimates for having a companion and compared to 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; and (3) to indicate the extent to which omitting exogenous companion effects (the Asocial Model) might affect the parameter estimates on the trail characteristics.

Singletrack, for example, 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).

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

A final caution about the estimates in Table 3: if companion effects are important, one should not compare the *WTP* estimates in Table 3 to determine how biased the parameter on singletrack (or any trail attribute) would be if one estimates a discrete-choice RUM with RP data that includes site attributes but excludes companion effects. Table 3 informs on what will happen when one estimates with SP data purged of the social interaction, and one forgets to include companion attributes in the indirect utility function. In this restricted SP world, excluding companion effects is an omitted variables problem, an omitted *exogenous* variable. With RP data that is the outcome of multiple games, one cannot solve the interaction problem and use the RP data to value site attributes unless one explicitly models the game(s), or instruments the *endogenous* companion variable.

### 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 4. 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.[26]

### 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 10 min or behind

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[26] 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.

**Table 4**
*WTP* estimates for no companion to a companion of one's ability.

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

**Table 5**
Per-ride *WTP* estimates for going from a companion of one's ability to one slower or faster.

| **Relativeability ↓** | **Weekly entertainment expend.** | | |
|---|---|---|---|
| | ≤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 |

10 min, but marginally prefer to be behind if the gap is 2 min (a result consistent with the social-psychology literature on competition)—see Table 5 and Fig. 2.

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

Consider now 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 and no companion on *A*, if one makes the companion on *B* 5 min 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 RP choice data with potential companion effects

1. We found, using choice experiments, that whether one has a companion, and the companion's relative ability are important determinants of recreation-site choice. Our estimates indicate that 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. Our application was mountain biking but companion effects are likely for most types of site-specific recreation, and many other activities as well.
2. Those like us, researchers who have estimated site-choice models with RP data while ignoring companion effects, might argue that the estimated values of the site characteristics are asymptotically unbiased: the effects of companions and

social interactions somehow averaging out. Maybe, but we are not convinced: there is an important omitted, *endogenous* variable. 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—the *reflection problem*.

3. Whether companion effects and social interactions “come out in the wash” is an empirical question, actually two empirical questions: how important are companions in a particular application, and the extent to which the resulting social-interaction games distort the RP choice patterns observed from what they would have been in the absence of social interaction. The paper indicates that companion is important in mountain biking, but does estimate or indicate how much any observed pattern of RP site choices might be influenced by social-interaction effects.
4. The value of a site characteristic will differ across sites if the value of that characteristic depends on whether one has a companion. In which case, the propensity to have a companion differs across the sites.[27]
5. The cost of ignoring the companion effect is lessened if presence of a companion does not influence how one values the site characteristics (if the Simple-Companion Model is correct).
6. Ignoring companion effects is more problematic than omitting an *exogenous* variable like the weather.
7. Being alone does not imply that one did not play a site/companion game.
8. Instead of a choice-experiment like ours, one might 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, 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 Borjas (1992) and Gaviria and Raphael (1999) on instrumenting the choices of the other player or players. One would need 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.
9. Aggregate trip patterns are likely often the equilibrium of many simultaneous site/companion games; that is, the set of all potential recreators consists of many subsets of potential companions.
10. One could use choice-experiments with exogenous companion effects, such as ours, to estimate a utility/reaction function with companion effects, as we do. One could then identify a small potential-companion set and use each player's estimated utility function to identify the game equilibrium for that group of potential companions, hopefully unique.[28] One could then change some of the site characteristics and find the new game equilibrium. Then one could possibly back out each player's *WTP* to play the game with the new, rather than initial, site characteristics.
11. One could model the social interaction (game/bargaining) and then assume one's site-choice data was generated by that social-interaction process.[29] One could then use the site-choice data to estimate the parameters, hopefully unique, in your social-interaction econometric model. One could then try to back out each individual's *WTP* to socially interact with some new set of site characteristics.
12. We estimate the importance of others for choice; we do not model how choices are made when what I do depends on what you do and what you do depends on what I do—we identify a problem but do not solve it.

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[27] Our estimates, for example, indicate that one is more likely to ride alone on short trails with lots of climbs.

[28] For example, one might assume three riders and two trails, specifying the characteristics of each trail, and the expenditure category of each rider. One could then, assuming our estimated utility function with companion effects (Eq. (9)), identify Nash equilibria. Examples are available from the authors.

[29] There 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 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,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 that 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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