Transportation Research Part A 45 (2011) 345–361

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

The effect of social comparisons on commute well-being

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ARTICLE INFO

Article history:
Received 28 July 2008
Received in revised form 7 May 2010
Accepted 17 July 2010

Keywords:
Discrete choice analysis
Social comparisons
Comparative happiness
Travel well-being
Commute satisfaction: Travel behavior

ABSTRACT

We study the effect of social comparisons on travel happiness and behavior. Social comparisons arise from exchanges of information among individuals. We postulate that the social gap resulting from comparisons is a determinant of "comparative happiness" (i.e. happiness arising from comparisons), which in turn affects subsequent behavior. We develop a modeling framework based on the Hybrid Choice Model that captures the indirect effect of social comparisons on travel choices through its effect on comparative happiness.

We present an empirical analysis of one component of this framework. Specifically, we study how perceived differences between experienced commute attributes and those communicated by others affect comparative happiness and consequently overall commute satisfaction. We find that greater comparative happiness arising from favorable comparisons of one's commute to that of others (e.g. shorter commute time than others, same mode as others for car commuters, and different mode than others for non-motorized commuters) increases overall commute satisfaction or utility.

The empirical model develops only the link between social comparisons and happiness in the comparisons-happiness-behavior chain. It is anticipated that the theoretical framework that considers the entire chain will enhance the behavioral realism of "black box" models that do not account for happiness in the link between comparisons and behavior.

1. Introduction

Social interactions are an important means of communication and information exchange. They invoke social comparisons which is the process through which individuals compare themselves to others after exchanging information about the attributes of experienced behavior. Social comparisons could affect behavior in at least three ways.

First, information that people obtain from others affects their level of awareness of options and the perception of their attributes, which influence choices. People also judge the attractiveness of different options based on the satisfaction and advice of others, especially in domains where they have little experience. They could use others as exemplars, reducing the cognitive effort associated with making a choice (see, for example, McFadden, 2005, 2010).

Second, people may compare themselves to others for approval and limit their choices through accountability to group norms. This is what is also commonly known as herd behavior, peer influences, conformity, etc. (see, for example, Manski, 1993, 2000).

Third, perceived differences between one's and others' choices may affect one's feelings of well-being and subsequently one's choices. For example, downward comparison (i.e. comparing oneself to others who are doing worse on the item of comparison) may make one feel happier, while upward comparison to others who are better off may make one feel less happy

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doi:10.1016/j.tra.2011.01.011

(Wills, 1981). The relationship between the direction of comparison and affective outcomes has been however debated (Buunk et al., 1990; Suls et al., 2002).

Thus, social comparisons affect behavior through their effect on awareness and perceptions, through accountability and norms, and through their effect on well-being. This paper does not address the first two effects but is concerned with the well-being (or happiness) effect of social comparisons and its impact on preferences. The context of interest in this paper is travel comparisons, well-being, and choices. We start with a brief background of the study of social comparisons in the social psychology and behavioral economics literatures.

1.1. Social interactions and interpersonal comparisons

The importance of sociality and interpersonal (or social) comparisons has long been recognized by sociologists and social psychologists. In his seminal article, Festinger (1954) postulated that people have an intrinsic drive to compare themselves to others and to conform to a group. Subsequently, great interest emerged in studying various dimensions of social comparisons including underlying motives and choice behavior.

As noted earlier, people make comparisons for various reasons including evaluation and validation of actions or opinions, affiliation with a group, self-improvement, and self-esteem (Brickman and Bulman, 1977; Goethals and Darley, 1977; McFadden, 2005). Comparisons made for the purpose of explicit self-enhancement or self-evaluation may affect feelings of well-being (Buunk and Mussweiler, 2001; Taylor and Lobel, 2007). Fox and Kahneman (1992) studied the relationship between well-being judgments and social comparisons. They found that social comparisons may affect well-being in public domains of life where information about others may be more readily available, but in private domains where information about others is scarce, social comparisons may be inferred from satisfaction judgments.

The term "social utility" was coined to refer to the dependence of an individual's utility on his/her outcomes and other people's outcomes (or difference between own and others' outcomes). A number of economists have studied social effects conceptually or experimentally. Manski (1993) discussed conditions under which identification of various social effects is possible. Brock and Durlauf (2001) developed a binary choice model framework where utility is the sum of a private utility, a social utility which reflects the desire of individuals to conform to the average behavior of others in their reference group, and a random error. They studied the equilibrium properties and identification conditions for this model. Behavioral economists have conducted experiments to study the role of interpersonal comparisons in choices and to estimate mathematical functions of social utility. The effects of relationships between people and the context of the situation on the shapes of these functions have been studied (Loewenstein et al., 1989; Messick and Sentis, 1985). These studies have provided further evidence that choices are not purely individualistic but may be motivated by various factors including self-interest, self-sacrifice, altruism, aggression, cooperation, and competition (MacCrimmon and Messick, 1976).

1.2. The travel context

Travel choice behavior has traditionally been modeled using discrete choice methods based on random utility theory. These models are individualistic in the sense that the utility of an action or alternative is a function of attributes of the alternative, which may also be interacted with individual characteristics, but does not depend on the behavior of others. Recognizing the importance of the social dimension in choice behavior, there is now a growing interest among transportation researchers in understanding the patterns of social interactions and their effects on travel decision-making. A number of studies have dealt with data collection aspects and analysis of social interactions (Axhausen, 2008; Carrasco et al., 2008; van den Berg et al., 2009) while some other studies have focused on modeling the effects of others' travel choices on one's travel behavior. Among these modeling efforts, the effect of social influence on travel choice behavior has been studied within the context of residential location choice (Páez and Scott, 2006), the decision to adopt telecommuting (Páez and Scott, 2007), and mode choice (Dugundji and Walker, 2005). In this literature, the most prevalent method of modeling the effect of others' actions on one's own actions is to incorporate others' previous actions as an additional explanatory variable in the utility of one's alternatives. Another method that has been used is to incorporate the interdependencies among decisions as correlations among the error components of the members of the social network.

In this paper, we extend this research stream on the social dimension of travel behavior by opening the "black box" of travel decision-making and explicitly modeling conceptually the behavioral process triggered by social comparisons. We focus only on the well-being effect of social comparisons. We postulate that social comparisons affect travel behavior indirectly through the intervening construct of "comparative happiness" or well-being, defined as the happiness attributed to comparisons. That is, social comparisons generate feelings of happiness or unhappiness, and this "comparative happiness" affects utility and consequently behavior.

1.3. Supporting evidence

Support for the social comparisons-happiness link comes from downward and upward comparison theories (Wills, 1981), as noted earlier. This relationship has been studied for instance in the context of cancer patients who develop coping strategies based on comparisons to other patients with more serious conditions (see, for example, Wood et al., 1985; VanderZee

et al., 1996) and in several other applications (Diener and Fujita, 1997). In the context of travel, dimensions of comparison could include travel time, auto availability, or mode of travel.

Numerous studies have supported the relationship between overall happiness or well-being and behavior, demonstrating that people tend to repeat experiences that they remember as more pleasant or less unpleasant than others. For example, Kahneman and his colleagues demonstrated through a series of laboratory and clinical experiments, involving immersing hands in cold water (Kahneman et al., 1993), listening to aversive sounds (Schreiber and Kahneman, 2000), or undergoing colonoscopy (Redelmeier et al., 2003), that people chose to repeat trials for which they held less negative retrospective affective memories. In a field experiment conducted by Wirtz et al. (2003), students chose to repeat vacations for which they held positive retrospective affective memories. At an aggregate level, recent research by Oswald and Wu (2010) has demonstrated a strong state-by-state correlation between objective measures of quality of life and subjective reported satisfaction levels obtained in a national US survey.

In the context of activities and travel, we have found that activity happiness and travel satisfaction are strongly correlated with activity participation for various types of activities; the greater the activity happiness and the greater the satisfaction with travel to the activity, the higher is the propensity of conducting the activity as measured by weekly activity frequency (Abou-Zeid and Ben-Akiva, 2010a). In the context of travel mode choice, experiments that we conducted in Switzerland and at MIT showed that habitual car drivers were more likely to switch to public transportation for their commute to work if they were satisfied with the service after trying it (Abou-Zeid, 2009; Abou-Zeid et al., 2008). This finding is consistent with evidence in the services marketing literature that relates customer satisfaction to retention and service usage (see, for example, Athanassopoulos, 2000; Rust and Zahorik, 1993; Soderlund, 1998).

Although the above mentioned studies did not examine social comparisons, in contexts where social comparisons are relevant comparative happiness is part of overall happiness or well-being and influences behavior as such. In the context of travel, the level of experienced or perceived satisfaction due to social comparisons could influence travel choices, such as destination, mode, time-of-travel, and route choice.

It should also be noted that a great number of surveys have been conducted worldwide to measure people's satisfaction or happiness with their lives overall, daily activities, and various domains such as work, marriage, income, and health (see, for example, DIW Berlin, German Institute for Economic Research, 2008; The ESRC United Kingdom Longitudinal Studies Centre, 2010; European Commission, 2009; Kahneman et al., 2004; National Opinion Research Center at the University of Chicago, 2010; World Values Survey, 2009). Happiness measures collected in these surveys have advanced the understanding of the causes and correlates of happiness (Andrews and Withey, 1976; Argyle, 1999; Diener, 1984; Kahneman and Krueger, 2006; Schwarz and Strack, 1999; Van Praag and Ferrer-i-Carbonell, 2004; Veenhoven, 1991). However, happiness measures have not been used extensively to model behavior.

1.4. Contributions and organization

Despite the existence of evidence linking social comparisons to happiness, to the best of our knowledge, efforts to model the effect of social comparisons on behavior have not accounted for the intervening construct of comparative happiness. This paper has two main contributions. First, we present a modeling framework for representing the effect of social comparisons on behavior through comparative happiness or well-being. Second, we illustrate empirically the effect of social comparisons on utility or overall satisfaction through the effect on comparative happiness in the context of the commute to work. The empirical model does not estimate the full theoretical framework that includes behavior, but rather focuses on modeling the link between social comparisons and happiness. As satisfaction or happiness is correlated with behavior, a better understanding of the determinants of commute satisfaction sheds light into the behavioral process.

The remainder of this paper is organized as follows. In Section 2, we present a framework for modeling our proposed approach to social comparisons. In Section 3, we present an application that models the effect of social comparisons on commute well-being. Section 4 concludes the paper.

2. Modeling framework

2.1. Framework

A starting point for our proposed approach is the framework described in the existing literature for modeling the effect of social comparisons on behavior which is shown in Fig. 1. The utility U is a direct function of explanatory variables X (attributes of the alternatives and characteristics of the individual) and of the previous actions of others Y. The choice y is a function of this utility. In this figure and all other figures in this paper, we adopt the convention of representing observed variables in rectangles and latent or unobserved variables in ovals. Solid arrows represent causal relationships while dashed arrows represent measurement relationships.

The proposed framework incorporating the intervening construct of comparative happiness is shown in Fig. 2. Here, the previous actions of others do not affect utility directly; rather, they invoke comparisons that affect happiness H (in a comparative sense) which in turn influences utility. The utility of an alternative can be thought of as overall satisfaction with the

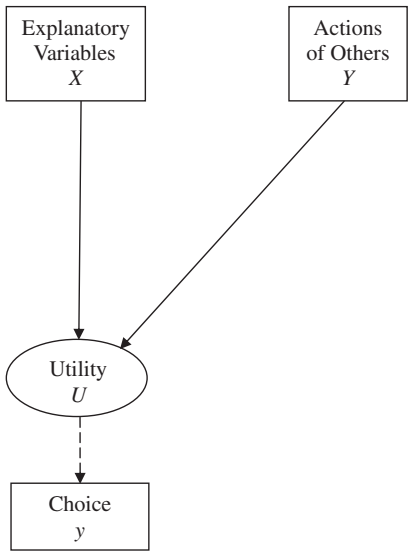

Fig. 1. Existing framework for modeling the effect of social comparisons on choice.

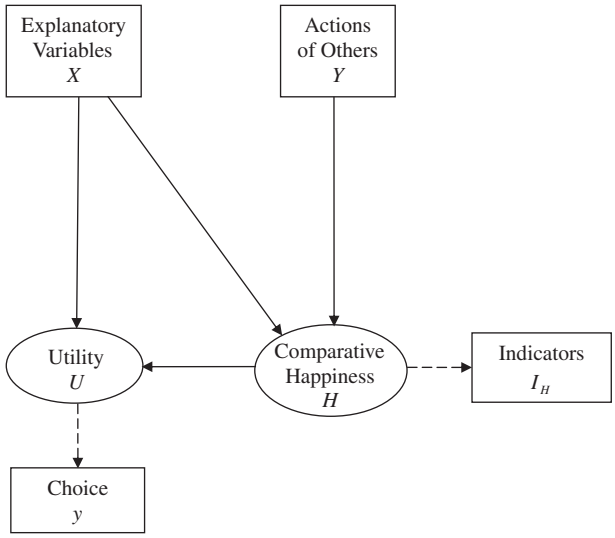

Fig. 2. Proposed framework for modeling the effect of social comparisons on choice.

alternative, and comparative happiness is one part of this utility or overall satisfaction. Measures I_H of comparative happiness for the chosen alternative may be available from surveys.

The framework of Fig. 2 may also be expanded as shown in Fig. 3 to account for the effects of latent or unobserved variables X^* on comparative happiness and on utility. X^* could represent variables such as attitudes, perceptions, personality, etc. Indicators I_{X^*} of latent variables may be available from surveys. Measures h of overall satisfaction with the chosen alternative may also be available and used as indicators of utility. The other components of the framework are as in Fig. 2.

This framework combines a choice model with a latent variable model and can be formulated using the Hybrid Choice Model (HCM) (Ben-Akiva et al., 2002; Walker and Ben-Akiva, 2002). The HCM has been developed to enrich the behavioral realism of discrete choice models by accounting for latent factors such as perceptions, attitudes, and decision protocols or employing more flexible error structures. The role of factors such as attitudes, personality, and lifestyle on choice behavior has been recognized in various transportation contexts including mode choice (Fujii and Kitamura, 2003; Gärling et al., 2001; Johansson et al., 2006; Verplanken et al., 1998), vehicle type choice (Choo and Mokhtarian, 2004), and airline itinerary choice (Theis et al., 2006).

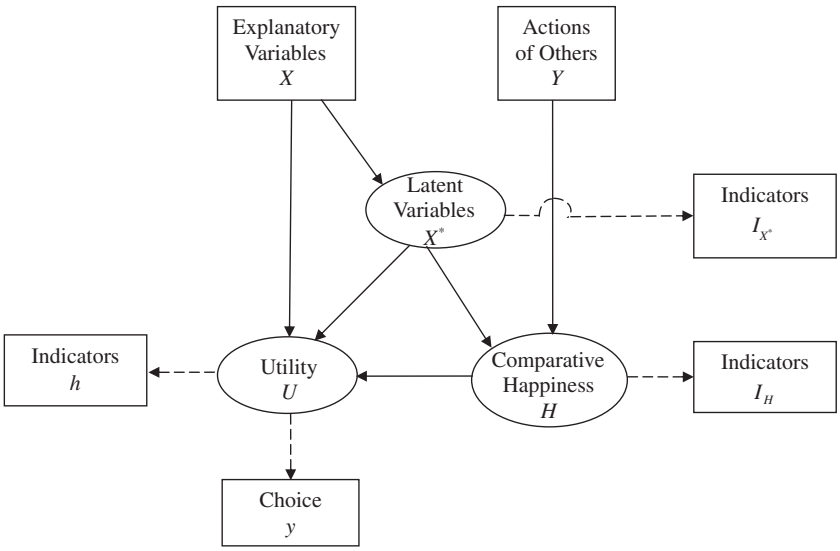

Fig. 3. Extended proposed framework for modeling the effect of social comparisons on choice.

2.2. Formulation

We next present a generic formulation of the model shown in Fig. 3. We assume that all latent variables and their indicators are continuous for simplicity. The model consists of structural and measurement equations. The structural equations express latent variables X^* (Eq. (1)), comparative happiness H (Eq. (2)), and utility U (Eq. (3)) using the causal relationships shown in Fig. 3. Each of these variables is also a function of a random error term. H and U are vectors whose dimensionality is equal to the number of alternatives considered. X^* is a vector of all other endogenous latent variables.

$$X^* = X^*(X, \psi) \tag{1}$$

$$H = H(X^*, Y, \xi) \tag{2}$$

$$U = U(H, X^*, X, \varepsilon) \tag{3}$$

The density functions $f(.)$ of X^*, H, and U, e.g. $f(X^*|X)$, can be derived as the product of the density functions of the corresponding error terms, e.g. $g(\psi)$, evaluated at the inverse transformations, e.g. at $\psi = X^{*-1}(X^*, X)$, and the absolute value of the determinant of the Jacobian of these transformations (Greene, 2002). For the case where X^*, H, and U are linear functions of the corresponding error terms, e.g. $X^* = X^*(X) + \psi$, the density functions $f(.)$ will be equal to the density functions $g(.)$ evaluated at the inverse transformations, e.g. $f(X^*|X) = g(X^* - X^*(X))$.

Let $P(y|U)$ denote the choice probability given the utility ($y_i = 1$ if alternative i is chosen and is 0 otherwise). This conditional probability can be derived from utility maximization. For example, the conditional probability of choosing alternative i can be expressed as follows:

$$P(y_i = 1|U) = \begin{cases} 1 & \text{if } U_i = \max_j U_j \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

The unconditional choice probability $P(y|X, Y)$ (conditional only on observed variables) can be expressed by integrating $P(y|U)$ over the densities of the latent variables, comparative happiness, and utility, as follows:

$$P(y|X, Y) = \int_{X^*} \int_H \int_U P(y|U) f(U|H, X^*, X) f(H|X^*, Y) f(X^*|X) dU dH dX^* \tag{5}$$

where $f(U|H, X^*, X)$ is the conditional density function of utility, $f(H|X^*, Y)$ is the conditional density function of comparative happiness, and $f(X^*|X)$ is the density function of the latent variables X^*.

The availability of indicators I_{X^*} of the latent variables, I_H of comparative happiness, and h of utility (or overall satisfaction) eases the identification of the model and results in more efficient parameter estimates. These indicators can be expressed as a function of the corresponding latent variables and a random error term, as shown in measurement Eqs. (6)–(8). Knowing the distributions of the error terms, the density functions of the indicators can be derived as discussed earlier. A latent variable may have more than one indicator, so I_{X^*}, I_H, and h are vectors. Note that the indicators of comparative happiness and of utility or overall satisfaction are typically indicators for the chosen alternative (i.e. people are asked how

their chosen alternative compares to others' choices, and how happy they are with their chosen alternative). Therefore, Eqs. (7) and (8) include the indicator y of the chosen alternative on the right hand side.

$$I_{X^*} = I_{X^*}(X^*, \eta) \tag{6}$$

$$I_H = I_H(H, y, \omega) \tag{7}$$

$$h = h(U, y, \upsilon) \tag{8}$$

The likelihood of a given observation is the probability of observing the choice and all other indicators. It can be expressed by integrating the product of the conditional choice probability and the conditional density functions of the indicators over the densities of the latent variables, comparative happiness, and utility, as follows:

$$P(y, I_H, I_{X^*}, h|X, Y) = \int_{X^*}\int_{H}\int_{U}\begin{pmatrix} P(y|U)f(I_H|H, y)f(I_{X^*}|X^*)f(h|U, y) \\ f(U|H, X^*, X)f(H|X^*, Y)f(X^*|X)dUdHdX^* \end{pmatrix} \tag{9}$$

where $f(I_{X^*}|X^*)$ is the conditional density function of the indicators of the latent variables, $f(I_H|H, y)$ is the conditional density function of the indicators of comparative happiness for the chosen alternative, and $f(h|U, y)$ is the conditional density function of the indicators of overall satisfaction with the chosen alternative. It is important to note that while endogeneity[2] is an issue in choice models including the behavior of others as an explanatory variable (such as the theoretical model presented above), it is not an issue in the empirical model presented in the next section since we do not model behavior in the empirical model.

The model may be estimated using maximum likelihood or simulated maximum likelihood if the number of indicators is large.

3. Social comparisons and commuting to work

In this section, we present an application that examines the impact of social comparisons on comparative happiness and consequently on overall satisfaction in the context of the daily commute to work. It is hypothesized that overall commute satisfaction is determined, among other things, by how people perceive their commuting situation in comparison to others in their reference group, particularly regarding aspects such as travel time and mode. For instance, a commuter whose travel time is smaller than that of others in his/her reference group is likely to feel happier comparatively and therefore to be more satisfied with his/her commute. A commuter whose mode to work is the same as that of others in his/her reference group is likely to have greater comparative happiness and therefore greater satisfaction with his/her commute due to a lower social gap.

In the remainder of this section, we first describe the causes and correlates of commute satisfaction which guided the design of a survey for measuring well-being and modeling its causes. After describing the survey design, the study sample is described. This is followed by the model specification and estimation results. The empirical model considered represents one component of the theoretical framework described in Section 2 (and shown in Fig. 3); in particular, we model overall satisfaction or utility as a function of comparative happiness, which is affected by social comparisons, explanatory variables, and latent variables, but we do not model the link between overall satisfaction/utility and travel choices. Choices are taken as given in the empirical model, and commute satisfaction is then modeled given these choices.

3.1. Causes and correlates of commute satisfaction

We classify the determinants of commute satisfaction into three main categories: commute attributes, individual characteristics, and comparative happiness.

[2] Suppose Y_i is the proportion of individuals choosing alternative i. If Y_i is included in the utility equation of i, Y_i will be correlated with the error term ε_i of that equation. Intuitively, unobserved variables influencing the utility an individual derives from alternative i will also affect the utility all other individuals derive from i and hence the market share Y_i. If endogeneity is not accounted for, the parameter estimates will be inconsistent. Endogeneity also arises in the theoretical model presented in this paper. Here Y_i affects comparative happiness H_i and consequently utility U_i. Endogeneity arises because Y_i will be correlated with unobserved variables ε affecting utility. Several methods have been developed to correct for endogeneity arising in discrete choice models (see, for example, the discussion, in Train (2009)). A method known as BLP first estimates a choice model where the utility of every alternative contains an alternative-specific constant for every market and other terms that vary over individuals. The constant terms absorb that part of the error that is correlated with Y. The estimated values of the constants are then regressed against variables that do not vary over individuals, including the market shares Y; in this stage, an instrumental variables method is used to account for the endogeneity of Y. A second method is the control-function approach in which the endogenous variable Y is first regressed against some instruments; the fitted residuals from this regression (or some function of them, known as a control function) are then inserted as an additional explanatory variable in the utility. These fitted residuals essentially net out that part of the original error term in the utility that is correlated with Y. Assuming X^*, H, and U are specified as linear functions of the corresponding error terms in Eqs. (1)–(3), then the methods described above can also be applied to handle endogeneity for the theoretical model presented in this paper. For example, using the control-function approach, a fitted or estimated value of Y can first be obtained by estimating a choice model that includes only exogenous attributes (excluding Y) which are by definition not correlated with the error term of the utility equation (see, for example, Timmins and Murdock, 2007). Then Y can be regressed on this fitted value of Y and the residuals can then be included as an additional variable in the comparative happiness Eq. (2).

First, attributes of the commute such as travel time and cost affect commute satisfaction. Certain attributes such as costs are expected to affect the overall evaluation of the commute (i.e. satisfaction) directly, while other attributes may influence the actual experience (i.e. moods and emotions such as stress and enjoyment) which in turn affects overall satisfaction. For example, the degree to which the commute is perceived as stressful affects satisfaction with the commute. Travel stress is caused by long travel or waiting time or distance, traffic congestion, unpredictability and the lack of perceived control, crowding, and other commuting conditions (Evans et al., 2002; Kluger, 1998; Koslowsky et al., 1995, 1996; Novaco et al., 1990; Schaeffer et al., 1988; Singer et al., 1978; Van Rooy, 2006; Wener et al., 2003). It could also be moderated by individual factors, such as the flexibility of the work schedule (Lucas and Heady, 2002) and the use of en-route time to conduct activities as a coping strategy for reducing stress (Lyons and Urry, 2005). Enjoyment of the commute may also affect satisfaction with it. People may enjoy their commute for a number of reasons; they may consider their commute as their private time or as a useful transition between work and home (see, for example, Ory and Mokhtarian, 2005).

Second, individual characteristics such as personality and overall well-being may affect commute satisfaction. Personality has been shown to be a major determinant of overall well-being (DeNeve and Cooper, 1998; Diener and Lucas, 1999), and we hypothesize that it also plays a role in determining commute well-being. For example, individuals with high negative affectivity (e.g. those who get stressed out easily) are likely to get irritated by transportation stressors more quickly than others (Hennessy and Wiesenthal, 1997). Those who plan their activities and are generally on time may be more relaxed and satisfied with their commutes if they have arranged their commuting patterns so that they are less stressful (e.g. plan to arrive on time to work), but they may also be more sensitive to unfavorable traffic conditions that may change their plans or delay their arrival at work. Overall well-being is likely to affect commute well-being in the sense that people who are satisfied with life and its major domains would also tend to be satisfied with their commutes. The personality and overall well-being effects are related to the "top-down approach" to the study of subjective well-being (see, for example, Diener, 1984; Headey et al., 1991), in the sense that stable traits and overall perspective on life affect how people feel about specific life domains. While there might also be an effect from commute well-being on overall well-being (bottom-up approach), we do not study this effect in this paper as we treat overall well-being as an exogenous variable.

Third, people conduct comparisons that affect their comparative happiness and consequently their overall commute satisfaction. In addition to the effect of social or interpersonal comparisons that was discussed earlier, people may conduct intrapersonal comparisons whereby they compare their current situation to previous or anticipated situations (Schwarz and Strack, 1991, 1999). For example, if one's current commute is much shorter than one's previous commute, one may feel more satisfied with the current commute.

The subjective well-being literature also describes the presence of "interdomain transfer effects" where the psychological consequences of conditions in one life domain spill over to another domain. For example, commuting conditions and associated moods may affect job satisfaction, performance at work, residential satisfaction and moods at home (Koslowsky et al., 1995; Novaco et al., 1990, 1991; Wener et al., 2005). In particular, we expect that when people think about their job satisfaction, they factor in their commuting conditions.

The survey described next was based on these hypotheses about the causes and correlates of commute well-being.

3.2. Survey design

We conducted a cross-sectional survey for measuring and modeling commute satisfaction. The survey also measured non-work travel and activity happiness and included a few hypothetical scenarios to assess the impact of well-being on willingness-to-pay for travel options. Commuting cost data were not collected in the survey but have been considered in travel well-being experiments conducted by the authors (Abou-Zeid, 2009; Abou-Zeid et al., 2008; Abou-Zeid and Ben-Akiva, 2010b). The following types of variables were collected in this survey[3]

- Commute satisfaction measure phrased as "*Taking all things together, how satisfied would you say you are with your commute from home to work?*". (5-point semantic scale labeled "Very dissatisfied" to "Very satisfied")
- Commute attributes such as distance, average travel time, travel time variability, predictability, information, travel time use, and other mode-specific attributes (e.g. waiting time for public transportation, safety/type of terrain for non-motorized modes, etc.); and measures of commute stress (stress and anxiety) and enjoyment (enjoyment and perception of the commute as buffer/transition time and as private time) which involved ratings of statements using a 5-point semantic scale labeled "Strongly disagree to "Strongly agree".
- Individual characteristics including personality, overall well-being, and socio-economic and demographic variables. Respondents rated statements about their planning, timeliness, and stress traits, and their level of satisfaction with their life overall and domains including health, work, residence, free time, family life, and social life.
- Commute comparison and comparative happiness variables:
  - *Social comparisons*: Respondents were asked to consider a person in their metropolitan area whose commute was familiar to them. This person is called "comparison other" in what follows. Respondents were asked about their relationship to the comparison other (e.g. friend, colleague, neighbor, relative, family member, or other acquaintance).

[3] The survey questionnaire is available from the authors upon request.

Then they answered three comparison questions. First, they indicated the commute mode of the comparison other. Second, they rated the stress level of their commute relative to that of the comparison other (5-point scale ranging from much more stressful to much less stressful). This rating is a measure of their comparative happiness due to the social comparison. Third, they indicated how much time their commute takes relative to that of the comparison other (5-point scale ranging from much more time to much less time).

- *Intrapersonal comparisons*: Respondents compared the stress level of their current commute to that of a previous commute (5-point scale ranging from much more stressful to much less stressful). This rating is a measure of their comparative happiness due to the intrapersonal comparison.

• Work well-being, including measures of job satisfaction (as mentioned above) and happiness while working, and attributes describing the quality of the work environment such as job type, work schedule flexibility, and income.

3.3. Study sample

A web-based sample of commuters constituted the study sample. Respondents were recruited via emails sent by the authors to friends, colleagues, and anonymous web users. In addition, a few personal interviews were conducted. The sample included respondents from different countries with the largest proportion coming from the United States. The survey covered the following modes of commuting to work: solo car driver, car driver with others in the car, car passenger, bus, subway/train, walk, and bike.

The data used in this paper were collected between June and October 2007. The data were checked for inconsistencies of responses, and observations that were deemed unreliable were removed. After cleaning and accounting for missing values, the sample used in model estimation consists of 594 observations.

The distribution of this sample by commute mode was as follows: 43% car, 25% public transportation, and 32% non-motorized commuters. The majority of the sample was male (66%), young (58% less than 40 years old), and highly educated (56% with a graduate degree and 32% with an undergraduate degree). The average household size was 2.5 and 26% of respondents had kids in the household. Most commuters (89%) had partially or completely flexible work schedules. Of those who reported their job type, the majority (74%) worked in management/professional/technical jobs followed by education/research (17%) and self-employed (3%) jobs. The average annual pre-tax personal income was distributed almost evenly among various categories, possibly due to the fact that different countries are included, with an average value of $69,000.

3.4. Model formulation

In this section, we present a structural equations model formulation of commute satisfaction. For a review of structural equations models, the reader is referred to Bollen (1989) for the case of continuous indicators and to Muthén (1984) for the case of ordered categorical indicators. The model structure corresponding to the hypotheses stated earlier is shown in Fig. 4.

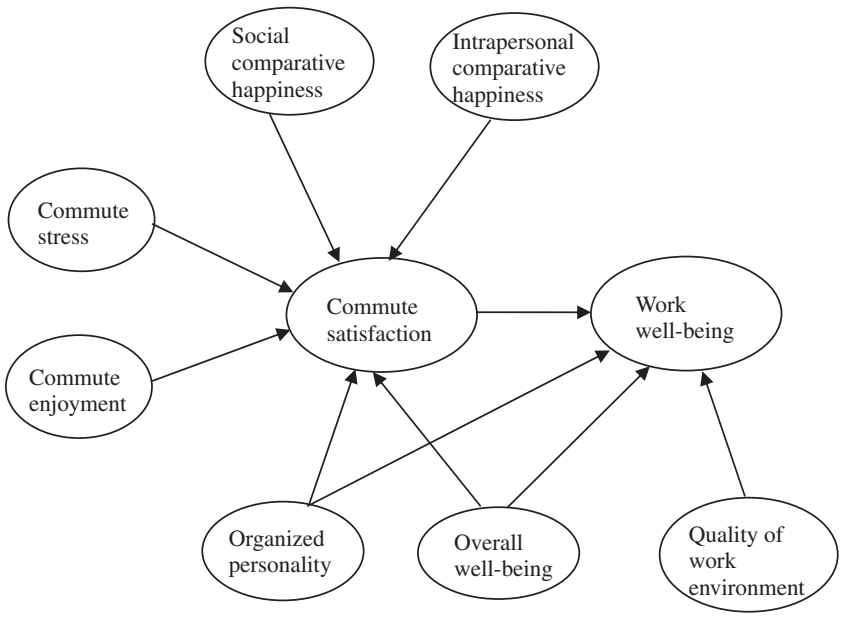

Fig. 4. Model structure for commute satisfaction and work well-being (indicators of all latent variables and causes of variables other than commute satisfaction and work well-being are not shown in the figure).

The causes of the endogenous latent variables (other than commute satisfaction and work well-being) and all indicators are not shown in this figure for simplicity.

The structural part of the model consists of five equations corresponding to latent variables that can be explained by variables available in the survey. As shown in the figure, commute satisfaction, expressed by Eq. (10), is caused by commute stress, commute enjoyment, social comparative happiness, intrapersonal comparative happiness, organized personality, and overall well-being. Work well-being, expressed by Eq. (11), is caused by commute satisfaction, quality of the work environment, organized personality, and overall well-being. Since quality of the work environment has no indicators in the survey, its effect on work well-being is set to 1. Commute stress, expressed by Eq. (12), is hypothesized to be a function of average travel time by mode, time variability for motorized modes (defined as the difference between travel time on a good and a bad day), the occurrence of frequent congestion, and traveling beside traffic for non-motorized modes (dummy variable that takes a value of one if the respondent walks or bikes beside traffic on a highway for most of his/her trip and is zero otherwise). Social comparative happiness, expressed by Eq. (13), depends on travel time and mode comparisons; "Shorter time than others" is a dummy variable indicating that own commute time is smaller or much smaller than the comparison other's commute time, and the different mode combinations refer to "own" mode – "comparison other" mode, where PT denotes public transportation and NM denotes non-motorized. Finally, quality of the work environment, given by Eq. (14), is a function of work time flexibility, job type (with dummy variables included for individuals working in education/research or who are self-employed), and income (with a dummy variable for missing income). The other latent variables in the model, namely commute enjoyment, intrapersonal comparative happiness, organized personality, and overall well-being, are treated as exogenous as they cannot be well explained by data available in the survey. The β's are unknown parameters to be estimated, and ε_1, ξ_1, ψ_1, and ψ_2 are error terms.

In terms of the conceptual model presented in Section 2, commute satisfaction corresponds to the overall utility U (excluding cost); social and intrapersonal comparative happiness constitute two dimensions of the comparative happiness variable H (although intrapersonal comparative happiness is not affected by the previous actions of others); commute stress, commute enjoyment, organized personality, and overall well-being constitute the latent variables X^* affecting happiness. Work well-being and quality of the work environment are additional latent variables not represented in the conceptual framework of Section 2 since it is assumed here that they do not influence commute satisfaction. Note that endogeneity is not an issue in this empirical model since we are not modeling the choice process here.

$$\begin{aligned}\text{Commute satisfaction} = {} & \beta_1 * \text{Commute stress} + \beta_2 * \text{Commute enjoyment} + \beta_3 \\ & * \text{Social comparative happiness} + \beta_4 * \text{Intrapersonal comparative happiness} + \beta_5 \\ & * \text{Organized personality} + \beta_6 * \text{Overall well-being} + \epsilon_1 \end{aligned} \tag{10}$$

$$\begin{aligned}\text{Work well-being} = {} & \beta_7 * \text{Commute satisfaction} + 1 * \text{Quality of work environment} + \beta_8 \\ & * \text{Organized personality} + \beta_9 * \text{Overall well-being} + \psi_1 \end{aligned} \tag{11}$$

$$\begin{aligned}\text{Commute stress} = {} & (\beta_{10} * \text{Car} + \beta_{11} * \text{PT} + \beta_{12} * \text{NM}) * \text{Travel time} + \beta_{13} * \text{Time variability} + \beta_{14} \\ & * \text{Frequent congestion} + \beta_{15} * \text{NM travel beside traffic} + \psi_2 \end{aligned} \tag{12}$$

$$\begin{aligned}\text{Social comparative happiness} = {} & \beta_{16} * \text{Shorter time than others} + \beta_{17} * \text{Car—Car} + \beta_{18} * \text{Car—PT} + \beta_{19} \\ & * \text{Car—NM} + \beta_{20} * \text{PT—Car} + \beta_{21} * \text{PT—PT} + \beta_{22} * \text{PT—NM} + \beta_{23} * \text{NM—Car} \\ & + \beta_{24} * \text{NM—PT} + \xi_1 \end{aligned} \tag{13}$$

$$\begin{aligned}\text{Quality of work environment} = {} & \beta_{25} * \text{Flexible work schedule} + \beta_{26} * \text{Education/research} + \beta_{27} \\ & * \text{Self-employed} + \beta_{28} * \text{Income} + \beta_{29} * \text{Missing income} \end{aligned} \tag{14}$$

The measurement part of the model consists of equations for eight latent variables: commute satisfaction, work well-being, commute stress, commute enjoyment, social comparative happiness, intrapersonal comparative happiness, organized personality, and overall well-being. Each of these variables has one or more ordered categorical indicators obtained from responses to questions with a 5-point semantic scale. Each indicator is associated with a continuous latent response variable that is assumed to underlie the observed categorical response variable. The measurement equations relate the latent variables to the continuous latent response variables. The scale of every latent variable is set by fixing the factor loading for one of its continuous latent response variables to 1. If I denotes an observed indicator, we let I^* denote the corresponding continuous latent response variable. In some cases, a latent variable is set identically equal to its latent response variable for identification purposes.

The measurement model is given by Eqs. (15)–(29). Commute satisfaction is measured by a commute satisfaction indicator. Work well-being is measured by work satisfaction and happiness during the work activity. Commute stress is measured by commute stress and anxiety indicators. Commute enjoyment is measured by commute enjoyment, perception of the commute as buffer or transition time, and perception of the commute as private time. Social comparative happiness

has one indicator, which is comparison of one's commute stress with that of another person. Similarly, intrapersonal comparative happiness has one indicator, which is comparison of one's current commute stress with the stress of a previous commute. Organized personality is measured by planning and timeliness indicators. Finally, overall well-being is measured by life satisfaction, residence satisfaction, and social life satisfaction. Each of commute satisfaction, social comparative happiness, and intrapersonal comparative happiness is set identically equal to the corresponding latent response variable since each of these latent variables has only one indicator. The λ's are unknown parameters to be estimated, and the η's are error terms.

$$\text{Commute satisfaction}^* = 1 * \text{Commute satisfaction} \tag{15}$$

$$\text{Work satisfaction}^* = 1 * \text{Work well-being} + \eta_1 \tag{16}$$

$$\text{Work activity happiness}^* = \lambda_3 * \text{Work well-being} + \eta_2 \tag{17}$$

$$\text{Commute stress}^* = 1 * \text{Commute stress} + \eta_3 \tag{18}$$

$$\text{Commute anxiety}^* = \lambda_5 * \text{Commute stress} + \eta_4 \tag{19}$$

$$\text{Commute enjoyment}^* = 1 * \text{Commute enjoyment} + \eta_5 \tag{20}$$

$$\text{Buffer}^* = \lambda_7 * \text{Commute enjoyment} + \eta_6 \tag{21}$$

$$\text{Privacy}^* = \lambda_8 * \text{Commute enjoyment} + \eta_7 \tag{22}$$

$$\text{Stress less than other}^* = 1 * \text{Social comparative happiness} \tag{23}$$

$$\text{Stress less than before}^* = 1 * \text{Intrapersonal comparative happiness} \tag{24}$$

$$\text{Planner}^* = 1 * \text{Organized personality} + \eta_8 \tag{25}$$

$$\text{On time}^* = \lambda_{12} * \text{Organized personality} + \eta_9 \tag{26}$$

$$\text{Life satisfaction}^* = 1 * \text{Overall well-being} + \eta_{10} \tag{27}$$

$$\text{Residence satisfaction}^* = \lambda_{14} * \text{Overall well-being} + \eta_{11} \tag{28}$$

$$\text{Social life satisfaction}^* = \lambda_{15} * \text{Overall well-being} + \eta_{12} \tag{29}$$

The last component of the model is the threshold model which relates the observed indicators I to their continuous latent response variables I^*. For each of the indicators, the threshold model is given as follows:

$$I = \begin{cases} 1 & \text{if } \tau_0 < I^* \leqslant \tau_1 \\ 2 & \text{if } \tau_1 < I^* \leq \tau_2 \\ \vdots & \\ M & \text{if } \tau_{M-1} < I^* \leq \tau_M \end{cases} \tag{30}$$

where M is the total number of categories of I and the τ parameters are thresholds or cutoff points for I^* that determine the probabilities of observing the different categories of I with $\tau_0 = -\infty$ and $\tau_M = \infty$. For example, the probability that I corresponds to category j can be computed as follows: $P(I = j) = P(\tau_{j-1} < I^* \leqslant \tau_j)$. Assuming that the latent response variables are normally distributed, the corresponding model is probit.

In terms of the conceptual model presented in Section 2, the commute satisfaction indicator is h; the indicators of commute stress, commute enjoyment, organized personality, and overall well-being are the vector I_{X^*}; the indicators of social comparative happiness and intrapersonal comparative happiness are the vector I_H.

3.5. Estimation results

Structural equations models with ordered categorical indicators can be estimated using custom software programs such as the Mplus software (Muthén and Muthén, 1998-2006) or the Integrated Choice and Latent Variable Model software (Bolduc, 2007) or can be programmed and estimated using statistical estimation software such as GAUSS (Aptech Systems, 1995). The model shown in Fig. 4 was estimated using the Mplus software. The estimator used is a limited information robust (mean- and variance-adjusted χ^2 test statistic) method of Weighted Least Squares (WLSMV) (Muthén et al., 1997).

Table 1
Structural model estimation results (PT = public transportation, NM = non-motorized).

Structural equations	Estimate	*t*-Statistic
Commute satisfaction		
Commute stress	−0.486	−13.53
Commute enjoyment	0.744	9.32
Social comparative happiness	0.108	2.81
Intrapersonal comparative happiness	0.0838	1.99
Organized personality	−0.0871	−1.17
Overall well-being	0.0590	1.09
Work well-being		
Commute satisfaction	0.0920	3.38
Quality of work environment	1.00	–
Organized personality	0.170	2.51
Overall well-being	0.484	9.76
Commute stress		
Average travel time (minutes)		
Car	0.0156	5.04
PT	0.00597	1.36
NM	0.00917	1.85
Travel time variability (minutes): car and PT	0.0112	3.53
Frequent congestion dummy: car and bus	0.745	5.42
NM travel beside traffic dummy: NM	0.302	1.39
Social comparative happiness		
Shorter time than others dummy	0.967	9.46
Car – car dummy	0.553	1.65
Car – PT dummy	0.514	1.40
Car – NM dummy	−0.356	−0.85
PT – car dummy	0.268	0.72
PT – PT dummy	0.119	0.31
PT – NM dummy	−0.309	−0.73
NM – car dummy	0.595	2.16
NM – PT dummy	0.505	1.67
NM – NM dummy	0.00 (base)	–
Quality of work environment		
Flexible work schedule dummy	0.168	1.22
Income (in thousands of US dollars)	0.00446	3.15
Missing income dummy	0.253	1.02
Job type		
Education/research dummy	0.410	2.91
Self-employed dummy	0.447	1.68
Missing job type dummy	0.152	0.68

The estimation results shown in Table 1 correspond to the structural parameters of the model. The parameters corresponding to the commute satisfaction and work well-being equations are also shown in Fig. 5 with *t*-statistics in parentheses. The measurement and threshold model parameters, variances, and correlations are presented in Appendix A.

The estimated structural parameters can be interpreted as follows. Supporting the hypotheses on the causes of commute satisfaction, stress decreases satisfaction and the effect is very significant. Longer travel time, higher variability, encountering congestion frequently, and walking or biking beside traffic increase commuting stress. Greater commute enjoyment also increases commute satisfaction, and the effect is very significant.

Greater social comparative happiness increases overall commute satisfaction; the effect is significant but the impact on overall satisfaction is smaller than that of the commute stress and enjoyment variables. Social comparative happiness is mostly determined by travel time comparison; people whose commute is shorter than others' commutes view their situation in a more favorable way (downward comparisons) and feel happier or less stressed. With respect to mode comparisons, car commuters are happiest (in a comparative sense) if the comparison other also commutes by car and least happy if the comparison other commutes by non-motorized modes; non-motorized commuters are happiest if the comparison other commutes by car and least happy if the comparison other commutes by non-motorized modes. The effects for public transportation commuters are not very significant. These findings could be interpreted as non-motorized travelers looking down on car commuters as an indication of personal views held by non-motorized travelers about the stress of driving which they don't experience, and the reverse can be said about car commuters. Greater intrapersonal comparative happiness resulting from comparing one's current commute to one's previous commute also increases current commute satisfaction.

People characterized by an organized personality trait, measured by planning and timeliness indicators, are likely to experience less commute satisfaction perhaps because they may be more sensitive to unfavorable traffic conditions that may change their plans or delay their arrival at work. The effect, however, is not significant. People who have a high level

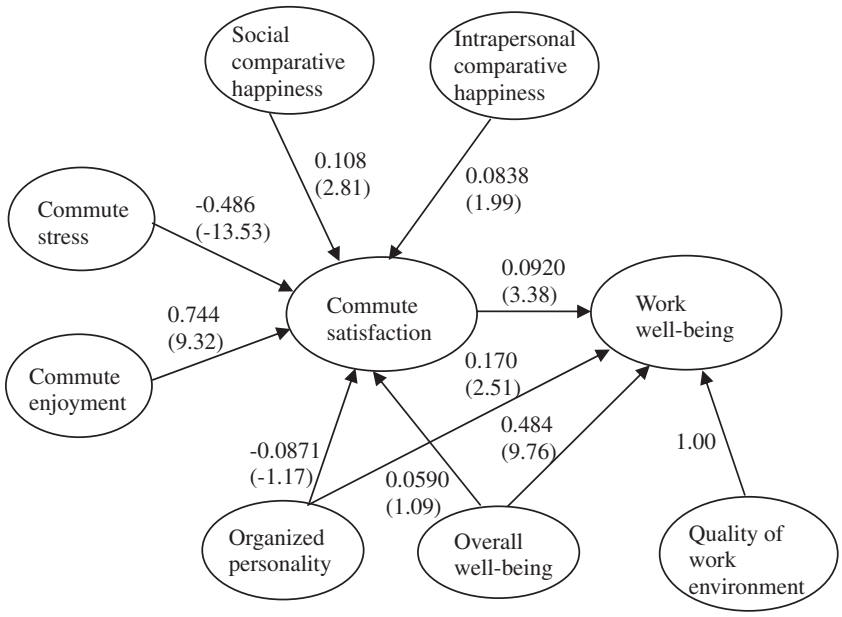

Fig. 5. Structural model parameters for commute satisfaction and work well-being (*t*-statistics are shown in parentheses).

of overall well-being are likely to exhibit this optimistic tendency as well in their evaluation of their commute but again the effect is not significant.

We also find a positive and significant effect of commute satisfaction on work well-being, supporting the spillover hypothesis between these two domains. In addition, people whose work schedules are partially or completely flexible and those with higher incomes, both important attributes defining the quality of the work environment, experience greater work well-being. Job type also affects satisfaction and happiness at work, with those working in education or research or who are self-employed happier than others. Although there are possibly more work environment related variables determining work well-being (see, for example, Warr, 1999), they were not included in the survey to keep it to a manageable length and maintain its primary focus on commute well-being. Work well-being is also positively and significantly affected by the organized personality trait and overall well-being.

There is a positive and significant correlation between commute enjoyment and each of organized personality, overall well-being, and intrapersonal comparative happiness. Moreover, organized personality and overall well-being are positively correlated as might be expected. The correlations of intrapersonal comparative happiness with organized personality and overall well-being are insignificant.

As to the measurement equations of the model, every latent variable's scale is fixed by setting the factor loading for one indicator to 1. As expected, we find that work well-being loads positively on work satisfaction and happiness at work. Commute stress loads positively on the stress and anxiety indicators. Commute enjoyment loads positively on the enjoyment, buffer, and privacy indicators. The organized personality factor loads positively on the planning and timeliness indicators; overall well-being loads positively on life, residence, and social life satisfaction.

The values of the variances and residual variances can be interpreted in terms of the fit of the structural and measurement equations. The estimation software Mplus reports *R*-squared measures for these equations defined as the ratio of estimated explained variance to estimated total variance. All equations had a reasonable fit (smallest *R*-squared = 0.241 for the Buffer measurement equation, and largest *R*-squared = 0.966 for the Commute Stress measurement equation).

Each of the categorical indicators has five categories (ranging from "Strongly disagree" to "Strongly agree" or from "Very dissatisfied" to "Very satisfied"), and therefore four thresholds are estimated for every indicator. The thresholds can be interpreted as scales for the corresponding latent response variables. Their values are different for different latent response variables, but are relatively close for similar latent response variables (see, for example, the thresholds for the planner and on time equations, and those for work satisfaction, life satisfaction, residence satisfaction, and social life satisfaction).

4. Conclusion

We presented new developments to model the impact of social comparisons on travel behavior. We postulated that social comparisons directly affect happiness in a comparative sense (or what we termed "comparative happiness") which in turn

affects behavior through its effect on utility or overall satisfaction. While support for the effect of social comparisons on happiness exists in the literature, to the best of our knowledge, comparative happiness has not been accounted for when modeling social comparisons and behavior. We presented our approach within the framework of the Hybrid Choice Model, which has been proposed to integrate latent variable models with discrete choice methods to enhance their behavioral realism.

We empirically tested the effect of social comparisons on comparative happiness and consequently on overall satisfaction in the context of the daily commute to work. Using a web-based cross-sectional survey conducted with a convenience sample of commuters, we developed a structural equations model for determining the causes of commute satisfaction. The findings indicate that commute stress, commute enjoyment, comparative happiness arising from social comparisons, comparative happiness arising from intrapersonal comparisons, personality, and overall well-being determine commute satisfaction, which in turn affects work well-being. The social comparative happiness effect was significant (but less significant than that of stress and enjoyment) and supported the hypothesis that favorable comparisons to others enhance commute satisfaction. In particular, it was found that social comparative happiness, measured by less perceived stress as compared to others, is determined by having a commute time smaller than that of others and by the gap in travel mode; commuters who travel by car are happier comparatively if comparison others commute by car, while those who commute by non-motorized modes are happier comparatively if comparison others commute by car or public transportation. The mode comparison effects for public transportation commuters were insignificant.

The effect of overall satisfaction on travel behavior was not modeled in the empirical application; that is, commute satisfaction was modeled given the mode choice and the attributes of the chosen alternative. In other research (Abou-Zeid, 2009; Abou-Zeid et al., 2008; Abou-Zeid and Ben-Akiva, 2010b), we measured overall commute satisfaction or utility in a longitudinal context and modeled the relationship between satisfaction and commute mode switching. Future data collection efforts should be designed to enable the estimation of the overall framework presented in Section 2 including social comparisons, comparative happiness, and behavior simultaneously. Moreover, the proposed framework considered only the well-being effect of social comparisons. The framework should be extended to represent other effects of social comparisons and information exchange, including perceptual effects and group accountability.

It should also be noted that the theoretical framework considers utility in a predictive sense (i.e. 'decision utility') while the measures of overall satisfaction and comparative happiness in the theoretical framework as well as in the empirical model are for the chosen alterative only. That is, people are asked about their overall satisfaction with their chosen alternatives, and how their commute with their chosen mode compares to other people's commute. In this sense, the empirical model considers utility or overall satisfaction retrospectively (i.e. 'remembered utility'), and the happiness measures used are indicators of 'remembered utility' which may be thought of as imperfect indicators of 'decision utility' (see Kahneman et al. (1997) and Kahneman (2000), for a discussion of various notions of utility, and Abou-Zeid (2009) for the use of happiness measures as indicators of utility in static and dynamic choice contexts).

A number of extensions should also be considered in future work with respect to the empirical commute satisfaction model. The model was estimated for illustration purposes using a convenience universal sample of highly-educated commuters. While we do not expect the basic relationships in the model to change qualitatively, in future application of this framework, more representative samples should be considered particularly if the choice is modeled together with satisfaction. The model was estimated in a cross-sectional setting which makes it difficult to determine directions of causality. Yet, the results obtained were mostly in accordance with the hypothesized relationships. The social comparisons questions were limited to the selection of one comparison person and to the comparison of travel time, mode, and stress. Broader definitions of comparison groups in the context of the commute to work, other dimensions of comparison, and additional measures of comparative happiness could be examined in future research. The model could also be extended to represent heterogeneity in social comparisons across different personality types, overall well-being levels, or salience of social comparison effects. The extension should also consider the differential effects of social comparisons on well-being through interactions of comparison variables with individual-specific and other relevant variables (such as personality or attitudes).

Appendix A. Model estimation results

	Estimate	*t*-Statistic
Measurement equations		
Commute satisfaction		
Commute satisfaction	1.00	–
Work well-being		
Work satisfaction	1.00	–
Work activity happiness	0.811	14.59
Commute stress		
Commute stress	1.00	–
Commute anxiety	0.824	19.04
Commute enjoyment		
Commute enjoyment	1.00	–

Appendix A (*continued*)

	Estimate	*t*-Statistic
Buffer	0.617	11.70
Privacy	0.707	12.61
Social comparative happiness		
Less stress than other	1.00	–
Intrapersonal comparative happiness		
Less stress than before	1.00	–
Organized personality		
Planner	1.00	–
On time	1.25	6.37
Overall well-being		
Life satisfaction	1.00	–
Residence satisfaction	0.637	12.32
Social life satisfaction	0.672	13.22
Thresholds		
Commute satisfaction		
τ_{11}	−3.12	−10.92
τ_{12}	−2.39	−8.60
τ_{13}	−1.66	−6.03
τ_{14}	−0.182	−0.67
Work satisfaction		
τ_{21}	−1.69	−5.57
τ_{22}	−0.791	−2.80
τ_{23}	−0.0368	−0.13
τ_{24}	1.38	4.91
Work activity happiness		
τ_{31}	−2.34	−7.43
τ_{32}	−1.59	−5.40
τ_{33}	−0.247	−0.86
τ_{34}	1.45	4.96
Commute stress		
τ_{41}	0.178	0.57
τ_{42}	1.42	4.42
τ_{43}	2.00	6.21
τ_{44}	3.45	9.53
Commute anxiety		
τ_{51}	0.0471	0.16
τ_{52}	1.21	3.94
τ_{53}	1.97	6.39
τ_{54}	3.11	9.10
Commute enjoyment		
τ_{61}	−3.48	−10.76
τ_{62}	−2.37	−7.73
τ_{63}	−1.32	−4.44
τ_{64}	0.0696	0.24
Buffer		
τ_{71}	−2.15	−7.20
τ_{72}	−1.32	−4.67
τ_{73}	−0.826	−2.95
τ_{74}	0.647	2.34
Privacy		
τ_{81}	−1.67	−5.86
τ_{82}	−0.676	−2.37
τ_{83}	−0.107	−0.38
τ_{84}	1.04	3.66
Less stress than other		
τ_{91}	−1.07	−3.25
τ_{92}	−0.307	−0.96
τ_{93}	0.625	1.98
τ_{94}	1.36	4.21
Less stress than before		
$\tau_{10\text{-}1}$	−1.68	−5.29
$\tau_{10\text{-}2}$	−0.899	−2.90
$\tau_{10\text{-}3}$	−0.302	−0.99
$\tau_{10\text{-}4}$	0.256	0.84
Planner		
$\tau_{11\text{-}1}$	−2.18	−6.19
$\tau_{11\text{-}2}$	−1.05	−3.41
$\tau_{11\text{-}3}$	−0.417	−1.38
$\tau_{11\text{-}4}$	1.27	4.15

Appendix A (*continued*)

	Estimate	*t*-Statistic
On time		
$\tau_{12\text{-}1}$	−2.19	−5.67
$\tau_{12\text{-}2}$	−1.15	−3.63
$\tau_{12\text{-}3}$	−0.579	−1.85
$\tau_{12\text{-}4}$	1.06	3.35
Life satisfaction		
$\tau_{13\text{-}1}$	−2.27	−6.70
$\tau_{13\text{-}2}$	−1.44	−4.96
$\tau_{13\text{-}3}$	−0.738	−2.54
$\tau_{13\text{-}4}$	1.08	3.74
Residence satisfaction		
$\tau_{14\text{-}1}$	−1.72	−4.62
$\tau_{14\text{-}2}$	−0.980	−2.97
$\tau_{14\text{-}3}$	−0.341	−1.06
$\tau_{14\text{-}4}$	1.19	3.68
Social life satisfaction		
$\tau_{15\text{-}1}$	−1.75	−5.77
$\tau_{15\text{-}2}$	−0.697	−2.46
$\tau_{15\text{-}3}$	−0.0190	−0.07
$\tau_{15\text{-}4}$	1.39	4.92
Variances		
Commute enjoyment	0.633	11.35
Intrapersonal comparative happiness	1.00	–
Organized personality	0.445	5.94
Overall well-being	0.864	13.32
Residual variances		
Commute stress	0.950	18.69
Social comparative happiness	1.00	–
Work well-being	0.639	9.09
Correlations		
Organized personality with commute enjoyment	0.180	5.43
Organized personality with overall well-being	0.184	5.06
Organized personality with intrapersonal comparative happiness	0.0383	1.08
Overall well-being with commute enjoyment	0.202	5.66
Overall well-being with intrapersonal comparative happiness	−0.0148	−0.34
Commute enjoyment with intrapersonal comparative happiness	0.219	5.80

References

Abou-Zeid, M., 2009 Measuring and Modeling Activity and Travel Well-Being. Ph.D. Dissertation, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Abou-Zeid, M., Ben-Akiva, M., 2010a. Well-being and activity-based models. Paper to be Presented at the 12th World Conference on Transport Research, July 11–15, 2010, Lisbon, Portugal.

Abou-Zeid, M., Ben-Akiva, M., 2010b. A model of travel happiness and mode switching. In: Hess, S., Daly, A., (Eds.), Choice Modelling: The State-of-the-Art and the State-of-Practice. Proceedings from the Inaugural International Choice Modelling Conference. Emerald, United Kingdom, pp. 289–305.

Abou-Zeid, M., Ben-Akiva, M., Bierlaire, M., 2008. Happiness and Travel Behavior Modification. Paper Presented at the European Transport Conference, the Netherlands.

Andrews, F.M., Withey, S.B., 1976. Social Indicators of Well-Being. Plenum, New York.

Aptech Systems, 1995. GAUSS Applications: Maximum Likelihood. Maple Valley, Washington.

Argyle, M., 1999. Causes and correlates of happiness. In: Kahneman, D., Diener, E., Schwarz, N. (Eds.), Well-Being: The Foundations of Hedonic Psychology. Russell Sage, New York, pp. 353–373.

Athanassopoulos, A.D., 2000. Customer satisfaction cues to support market segmentation and explain switching behavior. Journal of Business Research 47, 191–207.

Axhausen, K.W., 2008. Social networks, mobility biographies, and travel: survey challenges. Environment and Planning B: Planning and Design 35, 981–996.

Ben-Akiva, M., McFadden, D., Train, K., Walker, J., Bhat, C., Bierlaire, M., Bolduc, D., Boersch-Supan, A., Brownstone, D., Bunch, D.S., Daly, A., de Palma, A., Gopinath, D., Karlstrom, A., Munizaga, M.A., 2002. Hybrid choice models: progress and challenges. Marketing Letters 13 (3), 163–175.

Bolduc, D., 2007. The Integrated Choice and Latent Variable (ICLV) Model: ICLV Estimation Software Version 2.2.

Bollen, A., 1989. Structural Equations with Latent Variables. John Wiley and Sons, New York.

Brickman, P., Bulman, R.J., 1977. Pleasure and pain in social comparison. In: Suls, J., Miller, R.L. (Eds.), Social Comparison Processes: Theoretical and Empirical Perspectives. Hemisphere, Washington, DC.

Brock, W.A., Durlauf, S.N., 2001. Discrete choice with social interactions. The Review of Economic Studies 68 (2), 235–260.

Buunk, B.P., Mussweiler, T., 2001. New directions in social comparison research. European Journal of Social Psychology 31, 467–475.

Buunk, B.P., Taylor, S.E., Collins, R.L., VanYperen, N.W., Dakof, G.A., 1990. The affective consequences of social comparison: either direction has its ups and downs. Journal of Personality and Social Psychology 59 (6), 1238–1249.

Carrasco, J.A., Hogan, B., Wellman, B., Miller, E.J., 2008. Collecting social network data to study social activity-travel behavior: an egocentric approach. Environment and Planning B: Planning and Design 35, 961–980.

Choo, S., Mokhtarian, P.L., 2004. What type of vehicle do people drive? The role of attitude and lifestyle in influencing vehicle type choice. Transportation Research Part A 38 (3), 201–222.
DeNeve, K.M., Cooper, H., 1998. The happy personality: a meta-analysis of 137 personality traits and subjective well-being. Psychological Bulletin 124 (2), 197–229.
Diener, E., 1984. Subjective well-being. Psychological Bulletin 95, 542–575.
Diener, E., Fujita, F., 1997. Social comparisons and subjective well-being. In: Buunk, B., Gibbons, F.X. (Eds.), Health, Coping, and Well-Being: Perspectives from Social Comparison Theory. Erlbaum, Mahwah, New Jersey, pp. 329–357.
Diener, E., Lucas, R.E., 1999. Personality and subjective well-being. In: Kahneman, D., Diener, E., Schwarz, N. (Eds.), Well-Being: The Foundations of Hedonic Psychology. Russell Sage, New York, pp. 213–229.
DIW Berlin, German Institute for Economic Research, 2008. German Socio-Economic Panel Study. <http://www.diw.de/en/diw_01.c.100364.en/about_us/research_departments/german_socio_economic_panel_study/german_socio_economic_panel_study.html>.
Dugundji, E., Walker, J., 2005. Discrete choice with social and spatial network interdependencies: an empirical example using mixed GEV models with field and "panel" effects. Transportation Research Record 1921, 70–78.
European Commission, 2009. Recent standard Eurobarometer. <http://ec.europa.eu/public_opinion/standard_en.htm>.
Evans, G.W., Wener, R.E., Phillips, D., 2002. The morning rush hour: predictability and commuter stress. Environment and Behavior 34 (4), 521–530.
Festinger, L., 1954. A theory of social comparison processes. Human Relations 7 (2), 117–140.
Fox, C.R., Kahneman, D., 1992. Correlations, causes, and heuristics in surveys of life satisfaction. Social Indicators Research 27, 221–234.
Fujii, S., Kitamura, R., 2003. What does a one-month free bus ticket do to habitual drivers? An experimental analysis of habit and attitude change. Transportation 30 (1), 81–95.
Gärling, T., Fujii, S., Boe, O., 2001. Empirical tests of a model of determinants of script-based driving choice. Transportation Research Part F 4 (2), 89–102.
Goethals, G.R., Darley, J., 1977. Social comparison theory: an attributional approach. In: Suls, J., Miller, R.L. (Eds.), Social Comparison Processes: Theoretical and Empirical Perspectives. Hemisphere, Washington, DC, pp. 259–278.
Greene, W.H., 2002. Econometric Analysis, fifth ed. Prentice Hall, Berlin.
Headey, B., Veenhoven, R., Wearing, A., 1991. Top-down versus bottom-up theories of subjective well-being. Social Indicators Research 24, 81–100.
Hennessy, D.A., Wiesenthal, D.L., 1997. The relationship between traffic congestion, driver stress and direct versus indirect coping behaviours. Ergonomics 40 (3), 348–361.
Johansson, M.V., Heldt, T., Johansson, P., 2006. The effects of attitudes and personality traits on mode choice. Transportation Research Part A 40 (6), 507–525.
Kahneman, D., 2000. Experienced utility and objective happiness: a moment-based approach. In: Kahneman, D., Tversky, A. (Eds.), Choices, Values and Frames. Cambridge University Press, New York, pp. 673–692.
Kahneman, D., Krueger, A., 2006. Developments in the measurement of subjective well-being. Journal of Economic Perspectives 20 (1), 3–24.
Kahneman, D., Fredrickson, B., Schreiber, C.M., Redelmeier, D., 1993. When more pain is preferred to less: adding a better end. Psychological Science 4 (6), 401–405.
Kahneman, D., Wakker, P.P., Sarin, R., 1997. Back to Bentham? Explorations of experienced utility. The Quarterly Journal of Economics 112 (2), 375–405.
Kahneman, D., Krueger, A.B., Schkade, D.A., Schwarz, N., Stone, A.A., 2004. A survey method for characterizing daily life experience: the day reconstruction method. Science (December 3), 1776–1780.
Kluger, A.N., 1998. Commute variability and strain. Journal of Organizational Behavior 19 (2), 147–165.
Koslowsky, M., Kluger, A.N., Reich, M., 1995. Commuting Stress: Causes, Effects, and Methods of Coping. Plenum Press, New York.
Koslowsky, M., Aizer, A., Krausz, M., 1996. Stressor and personal variables in the commuting experience. International Journal of Manpower 17 (3), 4–14.
Loewenstein, G.F., Thompson, L., Bazerman, M.H., 1989. Social utility and decision making in interpersonal contexts. Journal of Personality and Social Psychology 57 (3), 426–441.
Lucas, J.L., Heady, R.B., 2002. Flextime commuters and their driver stress, feelings of time urgency, and commute satisfaction. Journal of Business and Psychology 16 (4), 565–571.
Lyons, G., Urry, J., 2005. Travel time use in the information age. Transportation Research Part A 39, 257–276.
MacCrimmon, K.R., Messick, D.M., 1976. A framework for social motives. Behavioral Science 21, 86–100.
Manski, C.F., 1993. Identification of endogenous social effects: the reflection problem. Review of Economic Studies 60, 531–542.
Manski, C.F., 2000. Economic analysis of social interactions. The Journal of Economic Perspectives 14 (3), 115–136.
McFadden, D., 2005. The New Science of Pleasure: Consumer Behavior and the Measurement of Well-Being. Frisch Lecture, Econometric Society World Congress, London. <http://elsa.berkeley.edu/wp/mcfadden0105/ScienceofPleasure.pdf>
McFadden, D., 2010. Sociality, rationality, and the ecology of choice. In: In: Hess, S., Daly, A. (Eds.), Choice Modelling: The State-of-the-Art and the State-of-Practice: Proceedings from the Inaugural International Choice Modelling Conference. Emerald, United Kingdom, pp. 3–17.
Messick, D.M., Sentis, K.P., 1985. Estimating social and nonsocial utility functions from ordinal data. European Journal of Social Psychology 15, 389–399.
Muthén, B., 1984. A general structural equation model with dichotomous, ordered categorical, and continuous latent variable indicators. Psychometrika 49 (1), 115–132.
Muthén, L., Muthén, B., 1998–2006. Mplus User's Guide, fourth ed. Muthén and Muthén, Los Angeles, California.
Muthén, B., du Toit, S.H.C., Spisic, D., 1997. Robust Inference Using Weighted Least Squares and Quadratic Estimating Equations in Latent Variable Modeling with Categorical and Continuous Outcomes. Working Paper. <http://www.gseis.ucla.edu/faculty/muthen/full_paper_list.htm>.
National Opinion Research Center at the University of Chicago, 2010. General Social Survey. <http://www.norc.org/projects/general+social+survey.htm>.
Novaco, R.W., Stokols, D., Milanesi, L., 1990. Objective and subjective dimensions of travel impedance as determinants of commuting stress. American Journal of Community Psychology 18, 231–257.
Novaco, R.W., Kliewer, W., Brouet, A., 1991. Home environmental consequences of commute travel impedance. American Journal of Community Psychology 19, 881–909.
Ory, D., Mokhtarian, P., 2005. When is getting there half the fun? Modeling the liking for travel. Transportation Research Part A 39, 97–123.
Oswald, A.J., Wu, S., 2010. Objective confirmation of subjective measures of human well-being: evidence from the USA. Science 327, 576–579.
Páez, A., Scott, D.M., 2006. A discrete choice approach to modeling social influence on individual decision making. Center for Spatial Analysis, McMaster University, Working Paper 015.
Páez, A., Scott, D.M., 2007. Social influence on travel behavior: a simulation example of the decision to telecommute. Environment and Planning A 39, 647–665.
Redelmeier, D.A., Katz, J., Kahneman, D., 2003. Memories of colonoscopy: a randomized trial. Pain 104 (1–2), 187–194.
Rust, R.T., Zahorik, A.J., 1993. Customer satisfaction, customer retention, and market share. Journal of Retailing 69 (2), 193–215.
Schaeffer, M.H., Street, S.W., Singer, J.E., Baum, A., 1988. Effects of control on the stress reactions of commuters. Journal of Applied Social Psychology 18 (11), 944–957.
Schreiber, C.A., Kahneman, D., 2000. Determinants of the remembered utility of aversive sounds. Journal of Experimental Psychology: General 129 (1), 27–42.
Schwarz, N., Strack, F., 1991. Evaluating one's life: a judgment model of subjective well-being. In: Strack, F., Argyle, M., Schwarz, N. (Eds.), Subjective Well-Being: An Interdisciplinary Perspective. Permagon Press, Oxford, pp. 27–47.
Schwarz, N., Strack, F., 1999. Reports of subjective well-being: judgmental processes and their methodological implications. In: Kahneman, D., Diener, E., Schwarz, N. (Eds.), Well-Being: The Foundations of Hedonic Psychology. Russell Sage, New York, pp. 61–84.
Singer, J.E., Lundberg, U., Frankenhaeuser, M., 1978. Stress on the train: a study of urban commuting. In: Baum, A., Singer, J.E., Valins, S. (Eds.), Advances in Environmental Psychology. The Urban Environment, vol. 1. Lawrence Elrbaum Associates, Hillsdale, New Jersey.

Soderlund, M., 1998. Customer satisfaction and its consequences on customer behaviour revisited: the impact of different levels of satisfaction on word-of-mouth, feedback to the supplier and loyalty. International Journal of Service Industry Management 9 (2), 169–188.
Suls, J., Martin, R., Wheeler, L., 2002. Social comparison: why, with whom, and with what effect? Current Directions in Psychological Science 11 (5), 159–163.
Taylor, S.E., Lobel, M., 2007. Social comparison activity under threat: downward evaluation and upward contacts. In: Stapel, D.A., Blanton, H. (Eds.), Social Comparison Theories. Psychology Press, New York, pp. 95–104.
The ESRC United Kingdom Longitudinal Studies Centre, 2010. British Household Panel Survey (BHPS). <http://www.iser.essex.ac.uk/ulsc/bhps/>.
Theis, G., Adler, T., Clarke, J.-P., Ben-Akiva, M., 2006. Risk aversion to short connections in airline itinerary choice. Transportation Research Record: Journal of the Transportation Research Board 1951, 28–36.
Timmins, C., Murdock, J., 2007. A revealed preference approach to the measurement of congestion in travel cost models. Journal of Environmental Economics and Management 53, 230–249.
Train, K., 2009. Discrete Choice Methods with Simulation, second ed. Cambridge University Press.
van den Berg, P., Arentze, T., Timmermans, H., 2009. Size and composition of ego-centered social networks and their effect on geographical distance and contact frequency. In: Presented at the 88th Annual Meeting of the Transportation Research Board, Washington, DC.
Van Praag, B., Ferrer-i-Carbonell, A., 2004. Happiness Quantified: A Satisfaction Calculus Approach. Oxford University Press.
Van Rooy, D.L., 2006. Effects of automobile commute characteristics on affect and job candidate evaluations: a field experiment. Environment and Behavior 38 (5), 626–655.
VanderZee, K.I., Buunk, B.P., DeRuiter, J.H., Tempelaar, R., VanSonderen, E., Sanderman, R., 1996. Social comparison and the subjective well-being of cancer patients. Basic and Applied Social Psychology 18 (4), 453–468.
Veenhoven, R., 1991. Questions on happiness: classical topics, modern answers, blind spots. In: Strack, F., Argyle, M., Schwarz, N. (Eds.), Subjective Well-Being: An Interdisciplinary Perspective. Permagon Press, Oxford, pp. 7–26.
Verplanken, B., Aarts, H., van Knippenberg, A., Moonen, A., 1998. Habit versus planned behaviour: a field experiment. The British Journal of Social Psychology 37, 111–128.
Walker, J., Ben-Akiva, M., 2002. Generalized random utility model. Mathematical Social Sciences 43 (3), 303–343.
Warr, P., 1999. Well-being and the workplace. In: Kahneman, D., Diener, E., Schwarz, N. (Eds.), Well-Being: The Foundations of Hedonic Psychology. Russell Sage, New York, pp. 392–412.
Wener, R.E., Evans, G.W., Phillips, D., Nadler, N., 2003. Running for the 7:45: the effects of public transit improvements on commuter stress. Transportation 30, 203–220.
Wener, R.E., Evans, G.W., Boately, P., 2005. Commuting stress: psychophysiological effects of a trip and spillover into the workplace. Transportation Research Record: Journal of the Transportation Research Board 1924, 112–117.
Wills, T.A., 1981. Downward comparison principles in social psychology. Psychological Bulletin 90 (2), 245–271.
Wirtz, D., Kruger, J., Scollon, C.N., Diener, E., 2003. Research report: what to do on spring break? The role of predicted, on-line, and remembered experience in future choice. Psychological Science 14 (5), 520–524.
Wood, J.V., Taylor, S.E., Lichtman, R.R., 1985. Social comparison in adjustment to breast cancer. Journal of Personality and Social Psychology 49 (5), 1169–1183.
World Values Survey, 2009. The World's Most Comprehensive Investigation of Political and Sociocultural Change. <http://www.worldvaluessurvey.org/>.