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Travel satisfaction effects of changes in public transport usage

Maya Abou-Zeid · Satoshi Fujii

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Abstract We study the effects of public transport use incentives on changes in travel satisfaction of participants that undergo behavior change. We use the results of an experiment conducted recently at the Massachusetts Institute of Technology and requiring a temporary use of public transport for commuting to work by habitual car drivers. We observe an increase in the average level of satisfaction with the commute to work of participants who switch to public transport after the temporary intervention. This increase is sustained to some extent several months after the intervention. Moreover, participants' dissatisfaction is almost eliminated. We conclude that public transport use incentives are promising not only for encouraging sustainable travel behavior but also for increasing people's satisfaction.

Keywords Travel satisfaction · Public transport use incentives · Travel demand management · Sustainable travel behavior

Introduction

There has been an increasing interest in soft policies or interventions aimed at travel behavior change from auto to more sustainable means including public transport and non-motorized modes as well as reducing the amount of driving (e.g., Cairns et al. 2008; Fujii and Taniguichi 2006; Gärling and Fujii 2009). Such interventions, often referred to as travel demand management (TDM), have taken many forms such as information and

M. Abou-Zeid (✉)
Department of Civil and Environmental Engineering, American University of Beirut,
P. O. Box 11-0236, FEA-CEE, Bechtel Room 527, Riad El-Solh, Beirut 1107 2020, Lebanon
e-mail: ma202@aub.edu.lb

S. Fujii
Department of Urban Management, Kyoto University, C1-2-432, Nishikyo-Ku, Kyoto 615-8540, Japan
e-mail: fujii@trans.kuciv.kyoto-u.ac.jp

feedback, goal setting, incentives, commitment, or a combination of strategies. At the same time, there has been interest among transport researchers in measuring subjective well-being (SWB) in the context of travel and activities and examining its causes, correlates, and relationship to travel and activity choices and to policy (e.g., Abou-Zeid and Ben-Akiva 2012a; Archer et al. 2013; Delbosc 2012; Duarte et al. 2010; Ettema et al. 2010; Jakobsson Bergstad et al. 2012; Ory and Mokhtarian 2005). While studies evaluating TDM strategies have analyzed changes in psychological variables such as attitudes, perceptions, intentions, and habits, there has been limited focus in these studies on measuring subjective well-being.

The purpose of this paper is to test the hypothesis that public transport (PT) use incentives that motivate people to try public transport increase their travel satisfaction. We utilize data from a public transport experiment conducted at the Massachusetts Institute of Technology (MIT) in the fall of 2008 to test this hypothesis. The PT incentive was a free one-month pass given to MIT employees with full-time parking permits. As described later, the experimental treatment consisted of commuting by PT for 2–3 days using the free pass. Previous analyses of this experiment focused on analyzing changes in satisfaction with the commute by car for all participants. In this paper, we focus instead on changes in satisfaction with the commute by the chosen mode of those who switched to PT after the treatment or intervention. That is, we are interested in testing whether people become more satisfied with their commutes after they switch to PT due to the intervention. This change in satisfaction after the intervention is expected to be observed because people might switch to PT if they found that PT is satisfactory compared to car, but people might not switch to PT if they found that PT is not satisfactory. Thus, those who switched to PT might become more satisfied than before. If this hypothesis is supported, this would hold promise for public transport incentive-based programs to not only lead to more sustainable behavior in society but to also increase people's travel satisfaction.

The remainder of this paper is organized as follows. "Literature review" section is a review of some of the main findings of the incentive-based travel demand management literature, the subjective and travel well-being literature, and their connection. "Experiment description and satisfaction measures" section describes the experiment and the satisfaction measures that are analyzed in this paper. "Findings" section presents the findings, and "Conclusion" section concludes with a summary of findings and limitations and discusses the policy implications of this study.

Literature review

Incentive-based travel demand management strategies

There is a large literature on travel demand management strategies, and trials and implementations in various countries particularly in Australia, Japan, and the United Kingdom (e.g. Cairns et al. 2008; Fujii and Taniguchi 2006; Rose and Ampt 2001). These "soft" strategies essentially aim at behavior change and may utilize various mechanisms, such as communication/deliberation, incentives, commitments, etc. Since the experiment analyzed in this paper uses a public transport free pass as an incentive, we discuss briefly here the main findings of incentive-based TDM experiments. These can be broadly classified into experiments aimed at encouraging the use of public transport and those aimed at reducing driving especially in peak hours.

A number of experiments have been conducted whereby a free public transport pass or tickets are given to participants for a limited time period so that they can try public transport. Their subsequent frequency of use of public transport and the change in their mode use intentions, attitudes, and perceptions are measured. Although the majority of these studies find evidence for changes in psychological variables (e.g. corrections of misperceptions about PT attributes), the evidence for mode switching is mixed. For example, Fujii and Kitamura (2003), through a 1-month free bus ticket given to a sample of students at Kyoto University who were habitual car drivers, found that bus use increased by 20 % even 1 month after the experiment. Similarly, Thøgersen (2009) observed a positive effect of a free one-month PT card given to non-PT residents of the Greater Copenhagen area, whereby 0.70 out of 10 trips on average were made by public transport 6 months later. Abou-Zeid and Ben-Akiva (2012b) observed that about 30 % of their MIT participants switched to public transport after they tried it. And Beale and Bonsall (2007) found that free cards still had an effect several months later but mainly on those that are positively disposed to riding buses. On the other hand, Matthies et al. (2006) and Abou-Zeid et al. (2012), through experiments employing free PT cards combined with commitment to try PT, did not find evidence for significant mode switching after the trial. Some recent experiments have employed incentives to specifically shift PT demand from the peak hour to less congested times of day (before or after the peak). One example is an experiment in Bangalore, India, where employees of a major firm have the potential to earn a reward if they arrive to work earlier than usual (Merugu et al. 2009), and a recent trial that was started in Singapore where metro riders can use the metro to the city center for free if they arrive before 7:45 AM on weekdays (Peace 2013). Both these experiments found evidence for time-of-travel shifts as desired.

There are other experiments where the financial incentive is aimed at reducing driving. One example is the peak avoidance congestion management program in the Netherlands, known as Spitsmijden (www.Spitsmijden.nl), whereby commuters are rewarded for traveling outside the peak hour or by modes other than the car. Studies evaluating the impacts of this program (Ben-Elia and Ettema 2011a, b; Tillema et al. 2013) found that a peak avoidance reward was effective in shifting trips outside the peak period and especially more effective compared to pricing peak travel, as inferred from a survey (37 vs. 15 % reduction in peak period car travel, respectively).

The findings of these studies should in general be analyzed with caution as individuals who participate are often self-selected and may exhibit a stronger predisposition to use modes other than the car or to reduce their driving. Moreover, the observed effects are often stronger in the short term (following the experiment) but their longer term impacts are rarely assessed.

Subjective and travel well-being

The study of subjective well-being (SWB) has been prominent among psychologists, social scientists, behavioral economists, and researchers in other disciplines. SWB is also being adopted by various governments to supplement GDP as an indicator of progress and well-being in society despite certain potential caveats related to the validity of SWB measures (see e.g. such a discussion in Levinson 2013). SWB is generally defined as an overall evaluation of a person's life from his/her own perspective, satisfaction with different domains of life, and positive and negative affect (Diener et al. 2003). Advances have particularly been made in the measurement of well-being and in the understanding of its determinants. Scales such as the Satisfaction with Life Scale (Diener et al. 1985) have been

commonly used to measure overall life satisfaction, and recently there has been interest in measuring well-being associated with different daily activities, using for example the Day Reconstruction Method (Kahneman et al. 2004), and how it relates to time use. As to the determinants of SWB, life circumstances and events, activities that people conduct, and personality and socio-demographic characteristics are major factors. SWB is also influenced by how people compare themselves to others and how they adapt to situations (Kahneman et al. 1999).

In the transportation domain, it has been postulated that travel contributes to SWB in various ways: by facilitating the participation in daily activities which are important for well-being, by its effect on health through e.g. physical activity or stress, and by providing an opportunity to experience the enjoyment and freedom of travel (Delbosc 2012; Ettema et al. 2010; Reardon and Abdallah 2013). Various studies have empirically demonstrated that travel well-being and participation in out-of-home activities contribute to overall well-being (e.g. Duarte et al. 2010; Jakobsson Bergstad et al. 2012; Spinney et al. 2009).

Travel well-being has been studied in different forms, including stress, satisfaction, liking, and happiness. These studies have made contributions to the understanding of the determinants of travel well-being, its relationship with travel behavior, and ways to measure it. It has been found that travel well-being is affected by modal attributes including travel time, cost, congestion, predictability of travel, comfort (crowding, etc.), the freedom to conduct activities during travel, the occurrence of negative incidents, and other factors (e.g. Abou-Zeid and Ben-Akiva 2011; Friman et al. 2001; Koslowsky et al. 1995; Olsson et al. 2013). Correlations of travel well-being and behavior have been demonstrated in few studies: Duarte et al. (2009) found using data from a stated preferences survey that the travel environment, conceptualized through cartoons, influences mode choice; Abou-Zeid and Ben-Akiva (2010) demonstrated through data from a public transport experiment that commute satisfaction by mode is an indicator of the utility of a mode; and Pedersen et al. (2011) found through path analysis of experimental data that remembered satisfaction of commuting by public transport influences current use of public transport. Finally, the measurement of travel well-being has relied on scales similar to those used in the general SWB literature, including the Satisfaction with Travel Scale (Ettema et al. 2011) and ratings of emotions experienced during travel. While most measurement efforts have been cross-sectional, recently few studies have measured travel well-being dynamically, such as Abou-Zeid et al. (2012) in the context of a public transport experiment that involved a temporary change in the mode of commute to work. The latter study demonstrated that well-being measured under routine or cross-sectional contexts may be different from that measured when the routine is disrupted.

For more detailed reviews of travel well-being, the reader is referred to Abou-Zeid and Ben-Akiva (2013), De Vos et al. (2013), and Ettema et al. (2010).

The linkage

The two streams of literature reviewed above still seem to be disconnected. Most travel well-being studies tend to be cross-sectional and involve no behavioral change. And while travel demand management studies typically measure changes in attitudes, perceptions, and intentions, only a few TDM studies also measure changes in SWB resulting from those soft interventions, as reviewed below. This paper then tries to fill part of this gap by contributing to the understanding of the effects of public transport use incentives on changes in travel satisfaction for those individuals who change their travel behavior following the public transport trial.

A TDM study was carried out in Kyoto, Japan, using persuasive communication to change daily travel mode (Suzuki et al. 2010). SWB and daily mode share were measured before and after the intervention. Participants in this study reported higher levels of SWB after the study, and the change in SWB was correlated with the change in daily mode share. But the causal relation from mode choice to satisfaction was weakly demonstrated by the experiment. Moreover, Suzuki et al. (2010) tried to test the effects on daily satisfaction rather than travel satisfaction. On the other hand, our experiment allows for a stronger demonstration of the effect of mode choice on satisfaction since the intervention itself consisted of a temporary mode switch as opposed to persuasive communication and since our focus specifically is on commute satisfaction as opposed to general daily satisfaction.

Two other studies/experiments employed a TDM intervention consisting of the required use of public transport by a habitual sample of car commuters in return for a free PT pass. In an experiment conducted with 62 individuals in Sweden, Pedersen et al. (2011) measured satisfaction with PT at three points in time: predicted satisfaction with PT before the intervention, experienced (on-line) satisfaction with PT during the intervention which lasted for one month, and remembered satisfaction with PT two years after the intervention. As in other studies in the SWB literature (e.g. Kahneman et al. 1993; Wirtz el al. 2003), they found that predicted and remembered satisfaction were significantly different from experienced satisfaction and that travel mode choice 2 years after the intervention was influenced by remembered satisfaction (53 % of the participants were regular PT users 2 years later). Their study thus indicated that even though people may experience a good level of satisfaction with public transport when they try it, their memory of the experience is biased leading them to remember lower levels of PT satisfaction. In the other experiment conducted with a sample of 30 employees of three Swiss institutions (none of whom switched to PT) and 67 employees of MIT (20 of whom switched to PT), the researchers analyzed the dynamics of the satisfaction with car commuting which was found to change from before to after the intervention (Abou-Zeid et al. 2012) and found that travel satisfaction measures are valid indicators of the utility in a mode switching model (Abou-Zeid and Ben-Akiva 2010).

Experiment description and satisfaction measures

An experiment was conducted at MIT in the fall of 2008 to measure commute satisfaction and mode choice of a sample of MIT employees who commute to MIT by car. These participants received a free one-month public transport pass, given by MIT as part of a MIT-wide initiative to encourage employees who drive to switch to public transport. As a condition of participation in this experiment, the participants were required to commute by public transport for 2–3 days during a specified week in this period. MIT is well served by public transport in the form of bus or subway, or a combination of public transport modes such as commuter rail and subway.

After the study was approved by the Institute Research Board of MIT, participants were recruited via emails sent by the researchers to all MIT employees who had full-time parking permits at MIT and hence were eligible for the free PT pass. A total of 93 MIT employees volunteered to participate, but only 74 of them ended up commuting by PT during the treatment period as required by the experiment. Seven participants were further removed from the analysis due to not filling out questionnaires, changing jobs, or switching to MIT-provided transport or carpooling post-treatment. Therefore, a final sample of 67 participants was retained for analysis.

Surveys of commute satisfaction, intentions, attitudes, and perceptions were carried out before the experiment, immediately after the expiration of the free pass, and several months afterwards. Moreover, data about the participants' post-experiment parking permit cancellation/renewal and public transport pass purchases were obtained.

As mentioned above, the emphasis in this paper is on the commute satisfaction of the 20 participants[1] of the MIT experiment who actually switched to public transport (and cancelled their full-time parking permits at MIT) after the expiration of the 1-month free PT pass given to them as part of the experiment. Six months after the experiment, these participants were contacted again and of the 19 that answered the survey, 15 had continued to commute by PT at that time while 4 had switched back to the car. For a more detailed description of the MIT experiment, the reader is referred to Abou-Zeid and Ben-Akiva (2012b).

We analyze the commute satisfaction of these participants as follows:

- Before the experiment, for all 20 participants the commute satisfaction refers to the satisfaction with commuting by car since the car is the regular commuting mode. The satisfaction measure is a response to the following question with a 5-point satisfaction scale ranging from "1-very dissatisfied" to "5-very satisfied":
  Taking all things together, how satisfied are you with your commute by car between your residence and MIT?
  We refer to this satisfaction measure as H_0 and the corresponding time period as t_0.
- Immediately after the experiment when the pass had expired, the commute mode of these 20 participants is public transport. Therefore, their commute satisfaction at that time is their satisfaction with PT, which was measured by the following question with a 5-point satisfaction scale ranging from "1-very dissatisfied" to "5-very satisfied":
  Taking all things together, what is your level of satisfaction with a public transport commute between your residence and MIT?
  We refer to this satisfaction measure as H_1 and the corresponding time period as t_1.
- Finally, 6 months after the experiment, the commute satisfaction is the satisfaction with car for the 4 participants who switched back to the car and the satisfaction with PT for the 15 participants who continued to commute by PT at that time. These satisfaction measures are a response to the following questions, respectively, with a 5-point satisfaction scale ranging from "1-very dissatisfied" to "5-very satisfied":
  Thinking about commuting by car and by public transport:
  Taking all things together, what is your level of satisfaction with a car commute between your residence and MIT?
  Taking all things together, what is your level of satisfaction with a public transport commute between your residence and MIT?
  We refer to this satisfaction measure as H_2 and the corresponding time period as t_2. We also refer to the 15 participants who continued to commute by PT as the "switchers" and the 4 participants who switched back to the car as "relapsers".

[1] In research that tries to test a hypothesis that was theoretically led, i.e. developed a priori, rather small sample sizes have been typically used as in various studies in psychology (e.g. Fujii and Kitamura 2003; Fujii and Gärling 2003; Haney et al. 1973). This research is of this type. The statistics that we calculate all consider the sample size.

Findings

In this section, we first examine the pattern of commute satisfaction at times t_0, t_1, and t_2 in "Commute satisfaction at t0, t1, and t2" section. This is followed in "Change in commute satisfaction (from t0 to t2)" section by a more detailed analysis of the change in commute satisfaction from t_0 to t_2.

Commute satisfaction at t_0, t_1, and t_2

Table 1 shows the average and standard deviation of the H_0, H_1, and H_2 satisfaction ratings and the sample size at each time period. The average reported satisfaction with the commute increases immediately after the experiment. Even though the average reported satisfaction decreases 6 months later compared to immediately after the experiment, it remains higher than before the experiment.

Since the H_0, H_1, and H_2 satisfaction ratings are not normally distributed (based on the Kolmogorov–Smirnov test; p-values less than 0.01), we use the Friedman test for repeated-measures data to test the null hypothesis that the averages of the H_0, H_1, and H_2 satisfaction ratings are equal. The Chi squared statistic (degrees of freedom = 2; sample size = 19) is 8.04 and the p value is .018, indicating that the averages of the H_0, H_1, and H_2 satisfaction ratings are significantly different. If the same test is applied to the sample of 15 "switchers", it yields a Chi squared statistic of 5.27 (degrees of freedom = 2) and a p-value of 0.072, which indicates marginally different happiness ratings in the three time periods.

The above results suggest that participants who are given monetary incentives for using public transport and who modify their travel behavior as a result of the intervention become more satisfied with their new choices even several months afterwards. The diminishing satisfaction several months after the experiment compared to immediately post-experiment could be due to several reasons such as missing the flexibility and convenience of the car or to adaptation to the new commuting conditions, similarly to the hedonic treadmill process observed in subjective well-being studies (Brickman and Campbell 1971; Brickman et al. 1978).

We also use statistical contrasts for repeated measures data (Furr and Rosenthal 2003) to test the hypothesis that commute satisfaction increases immediately post-treatment and then decreases 6 months later but remains higher than pre-treatment. The predicted pattern of satisfaction responses of the 15 participants who switched to PT (the "switchers") was assumed to be 2, 4, 3 at times t_0, t_1, and t_2, respectively. The hypothesis was supported by the data (t value = 2.32; p-value for a one-tailed test = 0.019). Nevertheless, these results should be interpreted with caution given the small sample size.

Table 1 Average commute satisfaction before and after the experiment

	H_0	H_1	H_2
Average	2.80	3.70	3.37
Standard deviation	1.01	0.470	0.684
Sample size	20	20	19

Change in commute satisfaction (from t_0 to t_2)

In this section, we focus on the long term change in satisfaction after the intervention, i.e. on differences between H_0 and H_2. Table 2 shows a cross-classification of the number of participants by their H_0 and H_2 satisfaction responses, and Table 3 shows the same cross-classification but separately for the switchers (15 participants) and relapsers (4 participants). In these tables, the "very dissatisfied" and "dissatisfied" categories are merged, and so are the "satisfied" and "very satisfied" categories. This is because there were very few or no observations in the extreme categories. At time period t_2, out of the 15 participants who switched to PT and remained switchers at that time, none gave a satisfaction rating of 1 or 5. At time period t_0, out of the 19 switchers to PT, 3 gave a satisfaction rating of 1 but none gave a satisfaction rating of 5.

The main conclusion that can be drawn from these tables is that the distribution of satisfaction changes from time t_0 to time t_2 in such a way that almost all dissatisfied commuters are no longer dissatisfied with their commutes (either become satisfied or neutral). While it is true that a number of satisfied commuters become neither satisfied nor dissatisfied possibly because of the loss of some of the benefits of car commuting (like flexibility, etc.), the fact that public transport use incentives seem to significantly reduce the level of dissatisfaction is a significant goal that should be further monitored and pursued by such types of interventions.

Furthermore, we conducted a statistical test to test the hypothesis that the intervention is effective in increasing the level of satisfaction by means of reduction of unhappiness rather than increase of happiness, that is implied by the abovementioned result. We define the following 4 variables indicating whether a participant is satisfied or dissatisfied at each of times 0 and 2:

- $\text{Happy}_0 = 1$ if $H_0 = 4$ or $H_0 = 5$ (satisfied or very satisfied); and 0 otherwise
- $\text{Happy}_2 = 1$ if $H_2 = 4$ or $H_2 = 5$ (satisfied or very satisfied); and 0 otherwise
- $\text{Unhappy}_0 = 1$ if $H_0 = 1$, $H_0 = 2$, or $H_0 = 3$ (very dissatisfied, dissatisfied, or neither satisfied nor dissatisfied); and 0 otherwise
- $\text{Unhappy}_2 = 1$ if $H_2 = 1$, $H_2 = 2$, or $H_2 = 3$ (very dissatisfied, dissatisfied, or neither satisfied nor dissatisfied); and 0 otherwise

We wish to test the hypothesis that ($\text{Unhappy}_0 = 1$) is more significantly frequent than ($\text{Unhappy}_2 = 1$) but ($\text{Happy}_2 = 1$) is NOT more significantly frequent than ($\text{Happy}_0 = 1$).

Table 2 Distribution of H_0 and H_2 satisfaction responses

H_0	H_2			
	Dissatisfied (1, 2)	Neither satisfied nor dissatisfied (3)	Satisfied (4, 5)	Total
Dissatisfied (1, 2)	1	1	4	6 (31.6 %)
Neither satisfied nor dissatisfied (3)	0	5	3	8 (42.1 %)
Satisfied (4, 5)	0	5	0	5 (26.3 %)
Total	1 (5.3 %)	11 (57.9 %)	7 (36.8 %)	19

Table 3 Distribution of H_0 and H_2 satisfaction responses—relapsers and switchers

Switcher status	H_0	H_2			
		Dissatisfied (1, 2)	Neither satisfied nor dissatisfied (3)	Satisfied (4, 5)	Total
Relapser	Dissatisfied (1, 2)	0	0	1	1
	Neither satisfied nor dissatisfied (3)	0	1	2	3
	Satisfied (4, 5)	0	0	0	0
	Total	0	1	3	4
Switcher	Dissatisfied (1, 2)	1	1	3	5
	Neither satisfied nor dissatisfied (3)	0	4	1	5
	Satisfied (4, 5)	0	5	0	5
	Total	1	10	4	15

To conduct the test, we pool the data from time t_0 and from time t_2, and estimate two ordered logit models. In the first model, the dependent variable is the level of unhappiness, i.e. $Y = \text{Unhappy}_0$ or Unhappy_2, and the independent variable is "Time" which is equal to 0 if it corresponds to time t_0 and is equal to 1 if it corresponds to time t_2. In this model, Time has a marginally significantly negative coefficient of -2.12 ($t = -1.90$, $p = 0.063$). But, in the second ordered logit model where the dependent variable is level of happiness, i.e. $Y = \text{Happy}_0$ or Happy_2, the coefficient of Time is 0.49 and is insignificant ($t = 0.70$, $p = 0.49$). These results support the hypothesis that the positive effects on satisfaction by the intervention are caused by reduction of the frequency of dissatisfied responses rather than increase of the frequency of satisfied responses.

Note that the abovementioned test did not consider the covariance between dependent variables measured at different times for the same participants. In order to test the hypothesis after eliminating possible biases due to the covariance, we have tested different ordered logit models where the dependent variable is Happy_2 or Unhappy_2 and the independent variable is Happy_0 or Unhappy_0, respectively. If the threshold for Happy_2 or Unhappy_2 is significant, the result would indicate significant difference between different times that accounts for the correlation between measurements taken at different times. The models can be described as follows.

$$\text{Happy}_2 = \begin{cases} 1 \ \textit{if} \ (a_h \text{Happy}_0 + \varepsilon_h \geq \theta_h) \\ 0 \ \textit{if} \ (a_h \text{Happy}_0 + \varepsilon_h < \theta_h) \end{cases}$$

$$\text{Unhappy}_2 = \begin{cases} 1 \ \textit{if} \ (a_u \text{Unhappy}_0 + \varepsilon_u \geq \theta_u) \\ 0 \ \textit{if} \ (a_u \text{Unhappy}_0 + \varepsilon_u < \theta_u) \end{cases}$$

where, a_h and a_u denote coefficients, θ_h and θ_u denote thresholds, and ε_h and ε_u denote error terms with logistic distribution. The results of these ordered logit models were that the threshold for Happy_2, i.e. θ_h, was not significant ($t < 0.01$, $p = 0.99$), but that for Unhappy_2, i.e. θ_u, was significantly positive ($t = 20.01$, $p < .001$). These results indicate that UnHappy_2 is statistically significantly less frequently "1" than Unhappy_0 is, but the frequency that Happy_2 is "1" is not statistically significantly different from that for Happy_0. Thus, these results support again the hypothesis that the positive effects on satisfaction by the intervention are caused by reduction of the frequency of dissatisfied responses rather than increase of the frequency of satisfied responses.

Conclusion

Summary of findings

An analysis of an experiment requiring the temporary use of public transport for commuting to work and offering participants a free public transport pass as an incentive was conducted. The focus was on analyzing the impacts of a public transport use incentive on the subjective well-being of those who actually undergo behavior change towards public transport after the temporary intervention. It was found that immediately after the intervention the average satisfaction of the PT switchers increases significantly. This increase is not completely maintained several months after the experiment but it remains higher than before the experiment. And importantly, the effect of the public transport use incentive seems to be targeting mostly those who are initially dissatisfied with their commutes to work. Even 6 months after the experiment, we observe that dissatisfaction with the commute is almost eliminated. That is, the increase in well-being seems to arise from a decrease in the frequency of dissatisfied commuters rather than an increase in the frequency of satisfied commuters.

The increase in commute satisfaction that we observe in this research can also be interpreted through the concept of experienced utility and decision utility (see e.g. Abou-Zeid and Ben-Akiva 2010; Ettema et al. 2010; Kahneman et al. 1997; Suzuki et al. 2013). Experienced utility is the satisfaction or extent of liking/disliking an outcome of a choice during the experience of that outcome. On the other hand, decision utility refers to the extent to which an outcome is desired at the moment that the choice is made. Empirical research has established discrepancies between experienced and decision utilities, because of the lack of information or due to cognitive distortions (e.g. Kahneman 2000; Kahneman and Sugden 2005).

Our research suggests that the "experience" that was induced by our intervention produced "experienced utility" of commuting by public transport that was different from the decision utility that was used to make the initial decision for commuting mode (i.e. the choice of car). Such experience or experienced utility modifies the post-experiment decision utility (of public transport relative to car) and such change in decision utility leads to behavior change. Through this process of (second) behavior change induced by a change in decision utility due to the experimental intervention, it is inferred that experienced utility of commuting by public transport increased as far as participants select modes with larger decision utility.

Implications

Regardless of the outcome (i.e. mode switching decision) of the public transport incentive employed in the context of the dynamic experiment described in this paper, we believe that public transport use incentives are beneficial for people's well-being because the experience of an alternative mobility option makes people more aware of the options they have. If they decide to continue commuting by car, they are probably more convinced of the mode choice they had made earlier yet more aware that they have public transport available to them if they decide to use it occasionally (see, for instance, the analysis of car happiness changes in Abou-Zeid et al. 2012 and Abou-Zeid and Ben-Akiva 2012b). If, on the other hand, people decide to switch to public transport for their commute, they have probably done so because they think it is better for them. Overall, we believe that such incentives and trials make people more rational through raising their awareness of

attributes of the alternative travel options after trying them, which may enhance their well-being. Several comments from MIT participants who didn't switch to public transport support these observations explicitly or implicitly. An example of a quote from a MIT participant who didn't switch to public transport is the following: "*The September free pass was a great way to get me to start thinking about using public transport more. I may not change my ways overnight, but am thinking more about using the bus.*" An example of a quote from a MIT participant who switched to public transport is the following: "*My commute to MIT used to drive me crazy every single day. Now that I take the train, my mood has gotten better, I have time to think, read or engage in other activities I didn't have time for before; I'm on time to pick up my daughter in the afternoon and I'm saving big money in gas.*" These statements do not necessarily represent the opinions of all participants but they are telling of the likely impacts of interventions employing public transport use incentives on people's attitudes and opinions.

The policy implication is that providing travelers with easier access to unfamiliar options through monetary incentives such as free tickets or through information may enhance their well-being in two ways: by making them aware of other options in their choice set that could be used occasionally and by helping them reconfirm earlier decisions they had made. The practical implications are that institutions that occasionally give their employees free public transport tickets may encourage mode switching if employees are happy with their public transport experience. Similarly, cities that have occasional car-free days and/or that experiment with discounted or free public transport occasionally (such as the recent Singapore one-year trial of free subway rides to the central city before 7:45 AM) may encourage such modal switching.

However, it is important to keep in mind the consequences on people's well-being of giving up the car. A study by Gärling et al. (2002) on the psychological consequences of car use reduction postulates that reduced car use can result in lower subjective well-being due to changes in lifestyle (such as having to compress activities in time, change leisure activities, or endure more stress) unless it is mitigated by adaptation or coping to the new lifestyle. Such reduction in subjective well-being was not observed in the MIT experiment because the participants who switched to PT did so on a voluntary basis, still had the option to go back to the car if they wanted to, were generally less satisfied with their car commutes before the experiment, and may also have adjusted some of their activity patterns in the short term after switching to PT. Therefore, when behavioral change is voluntary as in travel demand management interventions, as opposed to being dictated by external circumstances, negative psychological consequences of reduced car use may be limited or not present.

Nevertheless, recognizing that for some individuals a multimodal commuting pattern may work better than relying on one mode exclusively (see e.g. Block-Schachter 2009), institutions should provide transport options that allow individuals the flexibility of commuting by multiple modes. An example of this is occasional parking permits offered by MIT to employees who do not have a full-time parking permit (e.g. they commute mainly by public transport) yet need to commute occasionally by car. This type of permit allows them to park their cars at MIT up to 8 times a month. The provision of such flexible commuting options may encourage modal switching in a way that commuters do not feel a decrease in well-being as a result of giving up the car as a main commute mode.

Another implication of this study is that travel demand management experiments should aim to measure and monitor subjective and travel well-being more systematically. While previous TDM studies have focused primarily on the measurement of behavior change and change in psychological variables such as attitudes, intentions, and habits, less attention

has been given to SWB. The importance of measuring SWB before and after such experiments, and monitoring it in the longer term, lies in the fact that well-being has been observed to be correlated with travel behavior. Thus, behavior change is likely to be sustained if people remain happy with the new choices they have made.

Caveats and extensions

There are a few limitations of this study related to the experimental design, satisfaction measures, and potential unmeasured psychological processes. First, the study was limited to a small sample of 67 participants, 20 among whom switched to public transport. Larger samples and other experimental contexts (e.g. different quality of the public transport system) are desirable to validate the findings of this study. Second, the experimental design was limited to data collected 6 months post-experiment. Longer term measurements of well-being (e.g. 1 or 2 years later) would allow the evaluation of how long lasting the well-being impacts of public transport incentive-based interventions are. It may be that in the long term factors such as hedonic adaptation and potential regret may reduce the intensity of increases in well-being. However, other confounding factors, such as life cycle events including marriage, birth of children, etc. (see e.g. Lazendorf 2003), are likely to be present in longer term assessment periods which would make it more difficult to identify the pure effect of such interventions. Third, the internal validity of the travel satisfaction scale used in this study was not tested. Other more elaborate well-being measurement scales based on multiple items, such as the Satisfaction with Travel Scale (Ettema et al. 2011), may be used in future research to test the robustness of the results. Fourth, further research should be done to better understand the underlying factors for the reduction in satisfaction of some participants who voluntarily switched from the car to public transport. Finally, even though the results point to an increase in travel satisfaction for the sample of participants that switched modes due to the public transport use incentive and intervention, other psychological explanations may also affect the patterns of reported satisfaction measures such as post hoc rationalization to reduce cognitive dissonance or changes in reference points for the satisfaction judgments. And since the participants in this study were self-selected (i.e. they volunteered for the experiment), the results may be affected by self-selection bias; it may be that people who opt to try incentive-based trials have a tendency to react more positively to such incentives. Additional data not collected in this experiment would be needed to test these various psychological processes.

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Maya Abou-Zeid is an Assistant Professor of Civil and Environmental Engineering at the American University of Beirut and a research affiliate of the Intelligent Transportation Systems Program at the Massachusetts Institute of Technology. Her research interests are in the areas of travel behavior modeling and forecasting and urban transportation planning.

Satoshi Fujii is a professor of Urban Management at Kyoto University, a Director of Resilience Research Unit at Kyoto University, and a special advisor to the Cabinet about Abenomics and building national resilience. His research interest is infrastructure planning including transportation planning, social psychology, macro economy, and social dilemmas.