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How do individuals adapt their personal travel? Objective and subjective influences on the consideration of travel-related strategies for San Francisco Bay Area commuters

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Abstract

This study operationalizes the conceptual analysis presented in a companion paper, to examine the effects of objective and subjective variables on the consideration of 16 travel-related strategies reflecting a range of individuals' potential reactions to congestion. Using 1283 commuting respondents to a 1998 survey conducted in the San Francisco Bay Area, binary logit models were developed for the consideration of each individual strategy. The proportion of information explained by these models ranges from 0.18 to 0.63. It was found that the consideration of travel-related strategies is affected not only by the amounts of travel that individuals actually do, but also by their subjective assessments, desires and affinities with respect to travel, as well as their travel attitudes, personality and lifestyle. The previous adoption of these strategies greatly affects their current consideration, demonstrating an effect of past experience. Mobility constraints and socio-economic and demographic characteristics exhibit distributional effects with respect to the options individuals consider. These findings imply that policies designed to alleviate congestion may be less effective than expected, because individuals' responses to the travel-related strategies analyzed here—many of them directly tied to public policies intended to reduce vehicle travel—are influenced by a large variety of qualitative and experiential variables that are seldom measured and incorporated into demand models. Therefore, understanding the role of such variables will improve our ability to design effective policies and to accurately forecast the response to policy interventions as well as natural trends.

Keywords: Travel behavior; Adaptation; Transportation demand management; Logit model; Choice set

1. Introduction

According to the US Department of Energy, the majority of travel in metropolitan areas in 2001 took place in congestion (Energy Efficiency and Renewable Energy, 2003). The consequences of congested conditions accordingly have become major concerns for society. To alleviate congestion, many transportation demand management (TDM) strategies have been adopted. However, they have been of limited effectiveness. Among other reasons, the discrepancy between policy assumptions and individuals' adaptation process greatly contributes to the ineffectiveness of such policies (Salomon and Mokhtarian, 1997). Since it is the higher-cost strategies that are often the focus of public policy, the nature of individuals' responses to congestion further worsens this gap, adopting lower-cost strategies first before moving to higher-cost ones (Arentze et al., 2004; Loukopoulos et al., 2004; Raney et al., 2000). Individuals' travel-related attitudes, predispositions, and prior choices also greatly impact their reaction to the policies (Gärling et al., 2001; Tertoolen et al., 1997). Therefore, for policy makers and planners, understanding the determinants of the adoption and consideration of travel-related strategies may contribute to improved predictions of the impacts of proposed policies and the design of more effective policies.

Previous studies (Cao and Mokhtarian, 2005; Clay and Mokhtarian, 2004) provided conceptual foundations for empirically investigating the consideration of 16 travel-related adaptations, ranging from low-cost travel

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maintaining/increasing strategies (such as getting a better car or changing work trip departure time), to medium-cost travel reducing strategies (such as changing mode or telecommuting), to higher-cost major location/lifestyle change strategies (such as residential relocation or retiring). This paper aims to develop behavioral models (specifically, binary logit models) for the consideration of each strategy and examine any patterns that emerge across models. Although we collected data on both adoption and consideration, we use current 'consideration' rather than past adoption of a strategy as the dependent variable due to the cross-sectional nature of the available data (i.e. since we have only current measures for most explanatory variables).

One aspect of our purpose is to explore the relationship between the prior adoption of a strategy and its reconsideration. An earlier empirical study using a similar methodology suggested that the previous adoption of some strategies would reduce the probability of considering the strategies in the same bundle (Raney et al., 2000). In the present study, we are able to examine this question more rigorously. We wish to know how the previous adoption of a strategy and the time since adoption of the strategy affect its reconsideration. This exploration will help us to better understand the dynamic nature of individuals' behavior in this context.

The organization of this paper is as follows. Section 2 will briefly describe the data and variables. Section 3 provides an overview of the model building approach and goodness-of-fit measures. Section 4 presents a summary of the consideration models for each travel-related strategy and examines the patterns that emerge across these models. Section 5 recapitulates the key findings and discusses the policy implications of the results.

2. Data and variables

The data analyzed in this study came from a 14-page self-administered survey mailed in May 1998 to 8000 randomly selected households in three neighborhoods of the San Francisco Bay Area. Half of the total surveys were sent to an urban neighborhood of North San Francisco and the other half were divided evenly between the suburban cities of Concord and Pleasant Hill. These areas were chosen to represent the diverse lifestyles, land use patterns, and mobility options in the Bay Area. Approximately 25% of surveys were completed by a randomly selected adult member of the household and returned. For this study, we chose to focus on the 1283 commuting workers in the dataset (having relatively complete responses on key variables) since they will contribute most heavily to peak congestion, and are likely to be the most active in the adoption and consideration of travel-related strategies. Further, some strategies analyzed apply only to workers. Among the rest, the importance of various explanatory variables is likely to differ substantially between commuters and non-commuters, indicating that a pooled analysis would not be appropriate. Table 1 summarizes the sample distribution of key characteristics. The sample is relatively balanced in terms of representation by neighborhood and gender. Higher incomes are over-represented compared to Census data. However, since the focus of our study is on explaining the relationships of other variables to travel-related strategies rather than on describing the distributions of these variables and strategies per se, this potential bias is not expected to materially affect the results (Babbie, 1998).

Table 1
Demographic characteristics of sample used in this study

		Number	Percent
Neighborhood ($n=1283$)	Concord (suburban)	294	22.92%
	Pleasant Hill (suburban)	346	26.97%
	North San Francisco (urban)	643	50.11%
Gender ($n=1279$)	Female	651	50.90%
	Male	628	49.10%
Employment status ($n=1283$)	Full-time worker	1080	84.18%
	Part-time worker	203	15.82%
Family status ($n=1283$)	Single	319	24.86%
	2+ adults, no children	609	47.47%
	1 adult, with children	34	2.65%
	2+ adults, with children	321	25.02%
Personal income ($n=1255$)	<$15,000	91	7.25%
	$15,000–34,999	266	21.20%
	$35,000–54,999	386	30.76%
	$55,000–74,999	229	18.25%
	$75,000–94,999	126	10.04%
	>$95,000	157	12.50%
Age ($n=1283$)	18–23	42	3.27%
	24–40	563	43.88%
	41–64	640	49.88%
	>65	38	2.97%

As described in more detail in Cao and Mokhtarian (2005), the variables analyzed in this study can be classified as travel-related strategies, objective mobility, subjective mobility, relative desired mobility, travel liking, attitudes, personality, lifestyle, mobility constraints, and socio-economic and demographic (SED) characteristics. The travel-related strategies were grouped into three conceptual bundles and eight factor-based bundles, as shown later in Tables 2 and 8. The expected influences of the explanatory variables on the consideration of these strategies were also discussed in detail in Cao and Mokhtarian (2005). For example, we hypothesize that (1) those who travel a lot are more likely to consider the travel-reducing and major location/lifestyle change strategies, (2) those who like travel are more likely to consider travel-maintaining/increasing strategies, but less likely to consider travel reducing and major location/lifestyle change strategies, and (3) favorable attitudes towards commuting are negatively associated with the consideration of strategies that reduce travel.

Table 2
Goodness-of-fit of the individual models (grouped by conceptual bundles)

	Dependent variables: consideration of…	N	MS ρ^2	ρ_1^2	ρ_2^2	ρ_2^2/ρ_1^2 (%)	Adj. ρ^2
Travel maintaining/ increasing (low-cost)	A. Buy a car stereo system	1172	0.385	0.450	0.450	100	0.432
	B. Get a mobile phone	1263	0.124	0.202	0.191	95	0.184
	C. Get a better car	1118	0.039	0.183	0.167	91	0.158
	D. Get a more fuel efficient car	1155	0.132	0.229	0.220	96	0.208
	E. Change work trip departure time	1265	0.332	0.438	0.415	95	0.421
	F. Hire somebody to do house or yard work	1238	0.219	0.319	0.298	93	0.304
	G. Adopt flextime	1278	0.388	0.477	0.435	91	0.464
Travel reducing (medium-cost)	H. Adopt compressed work week	1278	0.476	0.547	0.510	93	0.534
	I. Change from driving alone to work to other means	987	0.443	0.571	0.565	99	0.543
	K. Buy equipment/service to help work from home	1206	0.211	0.381	0.360	95	0.363
	L. Telecommute	1253	0.265	0.430	0.418	97	0.414
Major location/ lifestyle change (high-cost)	M. Change jobs closer to home	1254	0.302	0.440	0.440	100	0.427
	N. Move your home closer to work	1269	0.554	0.628	0.614	98	0.615
	O. Work part- instead of full-time	1279	0.327	0.403	0.354	88	0.392
	P. Start home-based business	1277	0.318	0.451	0.446	99	0.434
	Q. Retire or stop working	1234	0.415	0.510	0.468	92	0.492

ρ_1^2 denotes the proportion of total information explained by the full model, which consists of the constant term and true variables. ρ_2^2 denotes the proportion of total information explained by the true variables. Adj. ρ^2 denotes the proportion of total information explained by the full model but penalized for the number of parameters.

3. Overview of model building approach and goodness-of-fit

We developed binary logit models for the consideration of 16 individual strategies[1]. Each dependent variable was defined as one if the strategy was considered by a respondent and as zero if not. Among the 180 explanatory variables tested, more than half are statistically significant at the 0.05 level or better in one or more consideration models (the insignificant variables are not presented).

Goodness-of-fit measures for the consideration models are shown in Table 2. The proportion of total information explained by the models (ρ^2) ranges from 0.183 for the consideration of getting a better car, to 0.628 for the consideration of moving your home closer to work. The adjusted ρ^2 s for these models range from 0.158 to 0.615.

Since in many cases the shares of consideration and non-consideration are quite unbalanced, the market share (MS) ρ^2 (the ρ^2 for the model containing only a constant term, whose predicted probability of considering a given alternative is simply the sample share considering that alternative) for those cases is relatively high, with the full model ρ^2 not much higher. As an example, the ρ^2 for 'move your home closer to work' is 0.628, but the incremental proportion of information explained by the model variables (Model ρ^2–MS ρ^2) is only 0.074. To measure the explanatory contribution of the true variables to the models, we re-estimated the final models with the constant term fixed to zero and computed the ρ^2's again. The comparison between ρ^2's for models with and without the constant term shows that the true variables in the model always account for at least 88% of the information explained by the full model, and carry at least 95% of the explanatory power of the model in more than half of the cases (as shown in the seventh column in Table 2). Thus, even when the MS ρ^2 is already high due to unbalanced shares, we contend that the full model is still useful, since it provides behavioral insight into *why* the market shares are so unbalanced. Such a model is more robust, and transferable to contexts having different market shares, than a model containing only a constant term and hence incapable of providing that behavioral insight.

[1] For a 17th strategy, changing from some other means of travel to work to driving alone, the applicable subsample and its share of consideration were too small to support a viable model. All models presented here are developed on the full sample. For seven strategies, we also estimated consideration models based on non-adopters only. Refer to Cao and Mokhtarian (2003) for reasons and results.

4. Effect patterns across consideration models

Tables 3–7 summarize the binary logit models for the consideration of 16 individual strategies, presented by blocks of explanatory variable categories. For economy of presentation, only the signs indicating the direction of effects are shown. In the following subsections, the effect patterns for each block of variables are discussed one by one. The interpretation of each variable in the individual models, as well as specific coefficients and P-values for each model, are provided in Cao and Mokhtarian (2003).

4.1. Objective mobility and subjective mobility

Table 3 presents the effects of objective mobility and subjective mobility on the consideration of travel-related

Table 3
Effects of objective mobility and subjective mobility (grouped by conceptual bundles)

Dependent variable: consideration of…	Travel maintaining/increasing (low-cost)							Travel reducing (medium-cost)				Major location/lifestyle change (high-cost)				
	A	B	C	D	E	F	G	H	I	K	L	M	N	O	P	Q
Objective mobility																
Frequency of commuting (SD)					+											
Frequency of work/school-related travel (SD)		+														
Frequency of grocery shopping travel (SD)		+			+											
Frequency of entertainment travel (SD)	+															
Frequency of travel taking others where they need to go (SD)		+														
Frequency of other purpose travel (SD)	+															
Weekly miles in a bus (SD)					+							+				
Weekly miles in a train/BART/light rail (SD)	−															
Total weekly miles (SD)		+		+												
Weekly miles of commuting (SD)								+								
Weekly miles of grocery shopping travel (SD)		−														
Weekly miles to eat a meal (SD)		+	+							+						
Weekly miles of entertainment travel (SD)						+			+							
Weekly miles of travel taking others where they need to go (SD)		−														
Commute time					+											
Commute distance												+				
Number of trips by personal vehicle (LD)										+						
Number of trips by other means (LD)												+				
Sum of log of miles for each trip by personal vehicle (LD)													−			
Sum of log of miles for each trip by air (LD)	−	+														
Log total miles by personal vehicle (LD)											+					
Subjective mobility																
Commute (SD)							+	+								
Travel for grocery shopping (SD)	+											+				
Travel for eating a meal (SD)															−	
Travel for entertainment (SD)		+														+
Take others where they need to go (SD)			+		+											
Travel by personal vehicle (SD)		+							+							
Travel by train/BART/light rail (SD)				−												
Travel by personal vehicle (LD)				+												

SD, short-distance; LD, long-distance. Strategies corresponding to the codes A–Q are given in Table 2.

Table 4
Effects of relative desired mobility and travel liking (grouped by conceptual bundles)

Dependent variable: consideration of…	Travel maintaining/increasing (low-cost)							Travel reducing (medium-cost)				Major location/lifestyle change (high-cost)				
	A	B	C	D	E	F	G	H	I	K	L	M	N	O	P	Q
Relative desired mobility																
Overall (SD)	−				−											
Commute (SD)											−	−	−			
Work/school-related travel (SD)									−	+						
Travel for grocery shopping (SD)						−										
Travel for eating a meal (SD)												+				
Take others where they need to go (SD)															+	
Travel by bus (SD)			−						+							
Travel by walking/jogging/bicycling (SD)													+			
Travel by air (LD)								+				−				
Travel liking																
Travel for eating a meal (SD)									+							
Travel for entertainment (SD)			+	+	+											
Travel by personal vehicle (SD)									−							
Travel by train/BART/light rail (SD)															−	
Overall (LD)			+	+												
Work/school-related travel (LD)																−
Travel for entertainment (LD)																+

SD, short-distance; LD, long-distance. Strategies corresponding to the codes A–Q are given in Table 2.

strategies. Consistent with our expectation, objective mobility variables are generally positively associated with the consideration of these strategies. Interestingly, the *frequencies* of short-distance travel for all the purposes positively affect, and only affect, the consideration of the travel-maintaining/increasing strategies. The majority of weekly *distances* of short-distance travel by mode and by purpose positively impact the consideration of the strategies in all three categories, but they are most likely to affect the consideration of the travel-maintaining/increasing strategies. Clearly then, the more an individual travels for short-distance, the more likely she is to consider the low-cost travel-maintaining/increasing strategies. Whether the large amount of short-distance travel is by necessity or by choice (which cannot be distinguished in our data), the low-cost travel-maintaining/increasing strategies offer appealing options for making that travel more pleasant or productive. While the lower-cost strategies are influenced by both frequency and distance of short-distance travel, for travel-reduction strategies, it is logical enough that not the frequency but the distance of short-distance travel has a more important

Table 5
Effects of attitudes, personality, and lifestyle (grouped by conceptual bundles)

Dependent variable: consideration of…	Travel maintaining/increasing (low-cost)							Travel reducing (medium-cost)				Major location/lifestyle change (high-cost)				
	A	B	C	D	E	F	G	H	I	K	L	M	N	O	P	Q
Attitudes																
Pro-environmental solutions factor score				+			+	+	+	+				+	+	
Commute benefit factor score					−											
Travel stress factor score												+			+	
Pro-hi density factor score			−	−												
Personality																
Adventure seeker factor score	+				+		+			+	+				+	
Loner factor score									−							−
Calm factor score									−							
Lifestyle																
Frustrated factor score			+	+						+			+		+	
Family and community-oriented factor score								+						+		
Status seeker factor score				−		+										
Workaholic factor score					+											

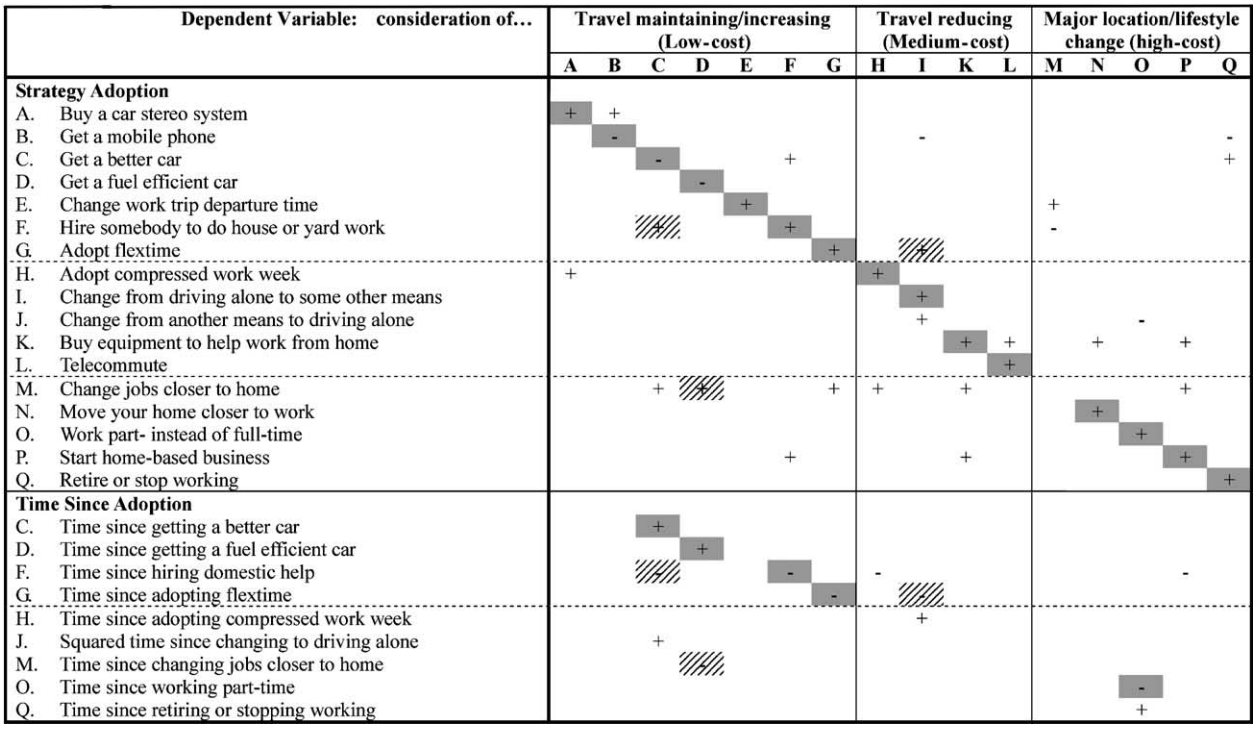
Strategies corresponding to the codes A–Q are given in Table 2.

Table 6
Effects of mobility constraints and SED characteristics (grouped by conceptual bundles)

Dependent variable: consideration of…	Travel maintaining/increasing (low-cost)							Travel reducing (medium-cost)				Major location/lifestyle change (high-cost)				
	A	B	C	D	E	F	G	H	I	K	L	M	N	O	P	Q
Mobility constraints																
Limitations on driving during the day	+									+	+					+
Limitations on driving on the freeway		+														
Limitations on flying in an airplane					+						+					
Limitations on riding a bicycle					+									+	+	
Percent of time a vehicle is available							−			−	−				−	
SED characteristics																
North San Francisco													−			
Time living in the neighborhood									+							
Age	−	−														+
Years lived in the US			−		−	+			−	−	−	−				+
Female	−					+										
Number of vehicles in the household								−	−					+		+
Year of personal vehicle	−		−	−												
Total workers in the household													+			
Household size																−
Anyone in the household needing special care		+					+						+		+	+
Household with single adult			−	−						+						
Household with two or more adults											−					
Household with two or more adults and children							+									
Sales occupation								−								
Service/repair occupation	+															
Clerical/administrative support occupation														+		
Production/construction/craft occupation						−										
Manager/administrator occupation											+					
Professional/technical occupation											+					
Full-time worker							+	+			+					
Household income category																+
Personal income category			+			+										
Vehicle type is pickup										+						
Vehicle type is small			+	+												

Strategies corresponding to the codes A–Q are given in Table 2.

Table 7
Effects of previous strategy adoption (grouped by conceptual bundles)



Shaded cells denote impacts of the former adoption and/or time since adoption of one strategy on the consideration of the same strategy; cross-hatched cells denote cases in which the more recently one strategy is adopted, the higher the likelihood of considering another strategy.

impact. The long-distance objective mobility variables appear in the models less frequently than the short-distance objective mobility variables, which is not surprising since the strategies are oriented toward short-distance travel (mainly commuting). However, the presence of long-distance variables in several models suggests a carryover effect from the long-distance to the short-distance realm.

Generally, short-distance subjective mobility variables (i.e. individuals' perceptions of the amount they travel, on a five-point scale anchored by 'none' to 'a lot') are positively associated with the consideration of the travel-related strategies, and they follow the same pattern as weekly distance for short-distance travel discussed above. This suggests that the effect of subjective mobility on the consideration of the travel-related strategies is quite similar to that of objective mobility. This result is not surprising since the amount of travel that individuals actually do heavily affects their subjective assessment of their mobility (Collantes and Mokhtarian, 2002).

4.2. Relative desired mobility and travel liking

The effects of relative desired mobility (i.e. how much a person wants to travel compared to what she is doing now, on a five-point scale ranging from 'much less' to 'much more') and travel liking (how much she enjoys traveling, on a five-point scale ranging from 'strongly dislike' to 'strongly like') on the consideration of these strategies are shown in Table 4. The negative association of the relative desired mobility variables with the consideration of the travel-maintaining/increasing strategies was counter to our initial expectation: we thought that the more people want to increase their travel, the more likely they would be to consider strategies that support traveling equal or greater amounts. Instead, these strategies appear to be more desirable to those who want to *decrease* their travel, as a way of making their undesired (but perhaps necessary) current travel more palatable. On the other hand, both effects may be at work and cancel each other out in many cases, which may explain why only a few relative desired mobility variables are significant in this group of models. By contrast, the effects of the relative desired mobility variables on the consideration of the travel-reducing and major location/lifestyle change strategies are bi-directional; that is, they may positively or negatively affect the consideration. However, the positive coefficients of these variables indicate competing preferences—the adoption of the strategies in these two bundles would decrease the amount of commute travel, so as to be able to increase the amount of time devoted to the desired activity/travel. Worth noting is that individuals wanting *less* commuting are *more* likely to seek medium- and high-cost adjustments (telecommuting, residential and employment relocation in this case) to reduce the commute.

With respect to travel liking variables, the most prominent result is that liking short-distance travel for entertainment and liking long-distance travel overall increase the probability of considering the travel-maintaining/increasing strategies, as expected. It is striking, however, that liking for short-distance personal vehicle travel is significant in only one model (negatively associated with consideration of commute modes other than driving alone), and liking for long-distance personal vehicle travel does not appear at all. In general, the relative absence of travel liking variables from these models is noteworthy. At least with respect to the travel-maintaining/increasing strategies, the same explanation may apply as for the relative desired mobility variables: both those who like travel and those who dislike it may consider ways of making it more pleasant.

4.3. Attitudes, personality, and lifestyle

As shown in Table 5, pro-environmental solutions (attitude), adventure seeker (personality), and frustrated (lifestyle) factor scores most commonly affect the consideration of these strategies, and they are consistently positive in the models. The pro-environmental solutions variable affects the consideration of seven strategies studied, of which five are medium- or high-cost ones involving commute reduction or usage of travel means other than driving alone. This suggests, not surprisingly, that individuals advocating environmental protection are more likely than others to consider reducing their commute and/or minimizing solo driving to decrease their personal energy consumption and impacts on the environment. Also, they are more likely to consider getting a fuel-efficient car to decrease their fuel consumption. Compared to other travel attitude factors, this factor appeared much more frequently in the models. This suggests that such individuals are potentially more susceptible to a change, although other studies (Cullinane, 1992; Gärling and Sandberg, 1997; Nilsson and Küller, 2000) have found discrepancies between individuals' stated attitudes toward the environment and their willingness actually to change their behavior accordingly.

The adventure seeker factor score influences the consideration of six strategies. Given that adventure seekers have high objective and subjective mobilities (Mokhtarian et al., 2001; Collantes and Mokhtarian, 2002) and tend to be variety seeking, it is quite natural that this factor has a positive impact on the consideration of several strategies in all three conceptual categories. The frustrated factor score is significant in five models. Interestingly, in previously estimated models of objective mobility (Mokhtarian et al., 2001) and relative desired mobility (Choo et al., 2005), frustration was, respectively, associated with *traveling less*, and *wanting to travel more*, than others. Here, individuals who are frustrated may view travel-related strategies as potentially one way to increase their control and/or life satisfaction.

It was expected that the commute benefit and travel stress factors would often be significant in the models of consideration of the travel-related strategies. However, the commute benefit factor is significant only for one model, and the travel stress factor only affects the consideration of two strategies. In view of their pervasive correlations with mobility-related variables, we believe that the effects of these two factors are generally accounted for through those variables that do appear in the models.

4.4. Mobility constraints and SED characteristics

Table 6 presents the effects of mobility constraints (i.e. physical or psychological limits on various types of travel, measured on a three-point scale anchored by 'no limitation' and 'absolutely prevents') and SED characteristics on the consideration of the strategies. Mobility constraints increase the probability of considering the travel-related strategies in all three conceptual bundles. It is noteworthy that limitations on driving during the day and vehicle availability are each significant in four models, and that these two constraints are more likely to affect the consideration of work style adjustments (such as telecommuting). This suggests that a desire to shorten the commute is an important motivation for individuals with such constraints to consider these travel-related strategies. The effect patterns of mobility constraints show that such individuals are more likely to consider medium- and high-cost strategies, consistent with the findings of Hildebrand (2003).

Among the SED characteristics, age-related variables (age category and years lived in the US) appear most commonly in the models. Their generally negative effects are consistent with expectation and with the results of Arentze et al. (2004). In these models, year of personal vehicle is only (and, logically, negatively) associated with the auto improvement strategies. The natural implication is that, to the extent that an aging vehicle is a problem needing a solution (i.e. a stimulus promoting consideration of a change), it is a problem that is solved by an auto improvement strategy, not by some more costly or indirect strategy such as residential relocation. The presence of anyone in the household needing special care is consistently positively associated with the consideration of five strategies, a natural outcome of the need for flexibility.

The effects of personal and household incomes on the consideration of these strategies are interesting to note. Both variables could be expected to greatly affect consideration; however, they collectively enter only three different models. There are several possible explanations for this. First, several strategies do not involve a significant financial investment (such as flextime), and hence, income is somewhat irrelevant to their consideration. Second, although respondents were asked to indicate only strategies they were 'seriously' considering, they may not have felt

constrained by the realities of whether they could afford such a strategy in their response. In their descriptive analysis of these strategies, Clay and Mokhtarian (2004) found that income was much more strongly related to adoption than to consideration. Finally, it may well be that the effects of income in some cases are being captured by other variables that are correlated with income (such as the former adoption of getting a better car and household auto ownership). This reflects the subtle interconnectedness between the explanatory variables.

4.5. Previous adaptation

It is particularly interesting to analyze the effects of former adoption variables on the consideration of each strategy studied. Apart from 'change jobs closer to home', the former adoption of each individual strategy (a binary variable) significantly affects its reconsideration, as shown by the shaded cells in Table 7. On one hand, among the 15 strategies, the former adoption of getting a mobile phone, getting a better car, and getting a fuel-efficient car are negatively associated with their respective reconsiderations. In these three cases, the nature of the strategy is such that, once it is adopted, it is less likely to be reconsidered in the short term because its repetition does not substantially improve the benefits of the previous adoption. Further, the relatively high costs of getting a newer car may decrease the probability of its reconsideration in the short term. Therefore, this relationship generally implies that the former adoption is still in force and the individual is enjoying the utility of such an adoption. On the other hand, the former adoption of the other 12 strategies has a positive impact on their reconsideration. The natural implication is either that the individual is enjoying and still wants to enjoy the benefits from the former adoption, or that such strategies become attractive again as circumstances change.

Interestingly, whenever time since adoption of a strategy is significant to its reconsideration (specifically, for the five strategies C-a better car, D-more fuel efficient car, F-hiring domestic help, G-adopting flextime, and O-working part-time), it appears with the opposite sign to that of the binary former adoption variable. If the former adoption of a strategy is *negatively* associated with its reconsideration (e.g. getting a better or fuel efficient car), time since adoption of this strategy is *positively* related to its reconsideration. That is, the more *recently* an individual adopts this strategy, the *less* likely she is to reconsider it. This suggests that the recent previous adoption of such a strategy, which is still in force, inhibits its reconsideration. Conversely, if the former adoption of a strategy is *positively* associated with its reconsideration (as is the case for the hiring domestic help, adopting flextime, and changing to part-time work strategies), time since adoption of this strategy is *negatively* related to its reconsideration. This further implies that individuals who are enjoying the benefits from the former adoption of a strategy still want to enjoy such benefits.

In addition, the effects of three pairs of former adoption variables on the consideration of another strategy (specifically, the impacts of binary adoption and time since adoption of strategies F on C, M on D, and G on I, as shown by the cross-hatched cells in Table 7) follow a common pattern. Specifically, the more *recently* an individual adopts a strategy, the more likely she is to consider the other strategy. This indicates that the adoption of one strategy is *more* likely to trigger the consideration of the other related strategy in the short term.

As shown in the off-diagonal blocks of Table 8, when the former adoption of a strategy is significant, its dominant effect on the consideration of another strategy is positive: the former adoption of strategy i increases the probability of considering strategy j. It is very likely that frustrating situations still persist although a travel-related strategy was adopted (Loukopoulos et al., 2004); or as circumstances change and/or the utility of the adoption is exhausted, dissatisfaction recurs; or the reduction of frustration from one source leads to increased dissatisfaction from another source (e.g. a change in work trip departure time adopted by one household member may require her partner to shoulder more household responsibilities). In view of all these possibilities, it is perhaps natural to view the individual as being frequently in search of new solutions, with a state of some dissatisfaction being more common than one of complete satisfaction. The few negative influences of former adoption all occur when the former adoption of low-cost strategies reduces the likelihood of considering medium- and high-cost strategies. This again suggests that individuals will avoid policy-favored options such as shifting to shared-ride modes if they can adequately ameliorate their dissatisfaction through the adoption of travel-maintaining/increasing alternatives, consistent with the results of Loukopoulos et al. (2004).

Additional insights emerge when the strategies are grouped by factor-based bundle, as shown in Table 8. Complementary effects are obviously exhibited in the home-based work bundle, which is consistent with the previous study of a similar set of strategies (Raney et al., 2000). The former adoption of each strategy in the alter employment bundle does not affect the consideration of any other strategies studied here. This suggests that working part-time and quitting work are likely to be the most radical and exhaustive changes to cope with congestion. Although not as radical, mode change strategies are also isolated in their nearly complete lack of influence on the consideration of other strategies (with the exception that changing to driving alone has a negative influence on the consideration of changing to part-time work).

Ironically, although the former adoption of changing jobs closer to home does not significantly affect its reconsideration (the only such case out of the 16 models developed), it frequently appears with a positive coefficient in models of

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Table 8
Relationships between former adoption and current consideration of strategies (grouped by factor-based bundles)

Current consideration	Auto improvement			Mobile phone	Work schedule change			Hire domestic help	Mode change	Home-based work			Relocation		Alter employment	
	A	C	D	B	E	G	H	F	I	K	L	P	M	N	O	Q
Former adoption																
A. Buy a car stereo system	+			+												
C. Get a better car		−						+								+
D. Get a fuel efficient car			−													
B. Get a mobile phone				−					−							−
E. Change work trip departure time					+								+			
G. Adopt flextime						+			+							
H. Adopt compressed work week	+						+									
F. Hire somebody to do house or yard work		+						+					−			
I. Change from driving alone to some other means									+							
J. Change from another means to driving alone									+						−	
K. Buy equipment to help work from home										+	+	+		+		
L. Telecommute											+					
P. Start home-based business								+		+		+				
M. Change jobs closer to home		+	+			+	+			+						
N. Move your home closer to work														+		
O. Work part- instead of full-time															+	
Q. Retire or stop working																+

he consideration of other strategies—in fact it is the adoption variable appearing most often across the 16 models (significant to the consideration of six strategies, while most other prior adoptions influenced the consideration of only one or two strategies besides its own). Conversely, the former adoption of 'move your home closer to work', which is in the same bundle as the employment relocation, is only significant in the model of its own reconsideration. This may imply that, in contrast to a new residential location, some aspects of a new job (e.g. a higher salary, increased flexibility) offer individuals an opportunity to seek other kinds of changes, which, of course, may not only be for transportation reasons.

Finally, it should be kept in mind that, as stressed in previous related studies (Raney et al., 2000; Clay and Mokhtarian, 2004), there can be many reasons other than transportation motivations prompting the consideration of each strategy, although each strategy has transportation implications. It is even possible that the adoption or consideration of a strategy has nothing to do with transportation issues, especially for the high-cost strategies. However, the transportation perspective taken by this study does provide plausible explanations for many if not most of the relationships appearing in the models, while recognizing that 37–82% of the information represented by the consideration responses remains unexplained by the variables available in this research.

5. Conclusions and policy implications

As one element of an ongoing study of individuals' adoption and consideration of travel-related strategies, this paper developed behavioral models for the consideration of each strategy and examined some patterns that emerge across models as well as the relationships between former adoption and current consideration of the strategies.

The consideration of travel-related strategies is affected not only by the amounts of travel that individuals actually did, but also by their subjective assessments, desires, and affinities with respect to travel. Generally, objective and subjective mobilities are positively associated with the consideration of these strategies. However, the influences of relative desired mobility and travel liking are somewhat more complex. In contrast to objective mobility, relative desired mobility tends to negatively affect the consideration of these strategies in general, but there still exist some plausible positive effects on consideration (referred to as competing preferences). The influences of travel liking seem to be diverse although it consistently positively affects the consideration of low-cost strategies. In a word, this study helps us further understand the influences of these mobility-related variables on the consideration of each strategy. However, the effects of objective mobility, subjective mobility, relative desired mobility and travel liking are always intertwined in individuals' adaptation processes,

which contributes to the substantial diversity of their responses. Further, since it is objective mobility that is often the basis of public policy, these relationships further imply that individuals may not respond to public policies designed to adjust their behaviors in the way that policy makers expected.

An individual's travel attitudes, personality, and lifestyle play an important role in her consideration of travel-related strategies. The frequent appearances of these factors further illustrate how different people respond to congestion, and hence provide helpful information to better understand individuals' diverse behaviors. However, it is difficult for policy makers to acquire such information. For one thing, qualitative indicators such as personality are 'fuzzy' by nature, which poses certain measurement challenges (Prevedouros, 1992). Thus, compared to objective variables such as vehicle type, it involves more effort to collect and analyze measures of such attributes. Further, an individual's nature changes over time as circumstances change, and there is very little experience with forecasting or modeling these internal changes, compared to changes in external SED characteristics. In particular, one inducement of attitudinal change over time can be public policy itself, whether designed to suppress auto use or to promote environmentally friendly alternatives. Various policies can have the effect of modifying public opinion by (1) highlighting the social importance of the intended goals, and (2) changing individual behavior, which will change attitudes.

On the other hand, mobility constraints and SED characteristics also affect the response to public policies. An overview indicates that older people are generally more resistant to the consideration of travel-related strategies, which may suggest that older people are more likely to be indifferent to public policies to some extent. On the other hand, higher personal and household incomes either directly or indirectly have a positive impact on the consideration of travel-related strategies. This implies that low-income people have a more constrained choice set than do high-income people—an unsurprising distributional effect on individuals' behaviors. And, individuals with mobility constraints are more likely to consider adaptation alternatives, especially the medium- and high-cost ones. The influence of mobility constraints and SED characteristics supports the argument that market-segmented policies are essential for maximizing the effectiveness of a given measure while addressing its equity impacts.

Finally, an individual's past experience greatly affects her consideration of travel-related strategies. Here, there is evidence that (1) the former adoption of a strategy, and sometimes the time since adoption as well, has an important impact on the consideration of the same strategy, with a positive association dominating; and (2) the adoption of one strategy sometimes triggers the consideration of another related change in the short term. These findings suggest that the effectiveness of public policies is impacted by individuals' past experiences. An interesting avenue for further research would be to explore the 'lifetime' of a given strategy, that is, the length of time after adopting one strategy that elapses before the next one is adopted. It would also be of interest to analyze sequential patterns of adoption, i.e. identifying and explaining differences between people who adopt low–medium–high-cost sequences versus low–low–low, etc.

The single key theme underlying this study is that individuals' responses to the travel-related strategies analyzed here—many of them directly tied to public policies intended to reduce vehicle travel—are influenced by a large variety of qualitative and experiential variables that are seldom measured and incorporated into demand models. Although there are challenges associated with that measurement and incorporation, those challenges are not insurmountable (see Steg et al. (2001) for an initial approach). Devoting further efforts to understanding the role of these attitudinal, personality, lifestyle, and experience variables will improve our ability to design effective policies and to accurately forecast the response to policy interventions as well as natural trends.

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