Incorporating the influence of latent modal preferences on travel mode choice behavior

Akshay Vij [a], André Carrel [b], Joan L. Walker [c,*]

[a] University of California at Berkeley, 116 McLaughlin Hall, Berkeley, CA 94720-1720, United States
[b] University of California at Berkeley, 109 McLaughlin Hall, Berkeley, CA 94720-1720, United States
[c] University of California at Berkeley, 111 McLaughlin Hall, Berkeley, CA 94720-1720, United States

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ABSTRACT

Latent modal preferences, or modality styles, are defined as behavioral predispositions characterized by a certain travel mode or set of travel modes that an individual habitually uses. They are reflective of higher-level orientations, or lifestyles, that are hypothesized to influence all dimensions of an individual's travel and activity behavior. The objectives of this paper are to understand and quantify different modality styles, and to show how the modality styles construct can be operationalized within the context of traditional models of travel mode choice. We employ the six-week MOBI*DRIVE* travel diary and estimate behavioral mixture models in which the modality style provides a behavioral rationale to the way in which unobserved heterogeneity is specified in the travel model. Our analysis consists of two stages: First, we explore the presence and types of modality styles suggested by the data through the means of a descriptive analysis. Next, we develop a model that captures the influence of modality styles on two dimensions of an individual's travel behavior: travel mode choice for work tours and travel mode choice for non-work tours. The modality styles are specified as latent classes; heterogeneity across modality styles include both the modes considered (choice set) and the values of taste parameters. The modality style of an individual then influences all of his/her travel mode choice decisions for work and non-work tours. In addition, error components capture unobserved correlation across travel mode choice decisions made by the same individual. Results indicate the presence of habitual drivers who display a strong bias for using the automobile and multimodal individuals who exhibit variation in their modal preferences. Multimodal behavior is further distinguished by those who appear to be sensitive to travel times and those who appear to be insensitive. Estimation results further find that modality styles are strongly correlated with more long-term travel decisions and life-cycle characteristics.

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1. Introduction

The automobile's continued preeminence in much of the developed world, and its more recent proliferation in many developing countries, is a source of grave concern to the health of our cities and the global environment at large. Alternative modes of travel, such as public transit and bicycling, have the potential to offer a more sustainable solution to our mobility requirements. However, policies meaning to effect a modal shift often come unstuck against long ingrained lifestyles and deeply entrenched habits built around the use of the automobile. Travel demand models constitute an important component of the planning and policy-making process, being widely used to make forecasts, which in turn are driven by the assumptions that these models make about how individuals arrive at decisions. Traditional travel demand models assume that

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* Corresponding author. Tel.: +1 5106426897.
  E-mail addresses: a.vij@berkeley.edu (A. Vij), acarrel@berkeley.edu (A. Carrel), joanwalker@berkeley.edu (J.L. Walker).
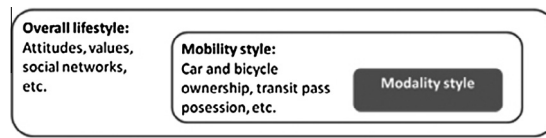
Fig. 1. Relationship between lifestyle, mobility style, and modality style.

an individual is aware of the full range of alternatives, and that a conscious choice is made based on a tradeoff between perceived costs and benefits associated with level-of-service attributes, and individual and household characteristics. Heterogeneity in the choice process is typically represented as systematic taste variation or random taste variation to incorporate both observable and unobservable differences in sensitivity to attributes. Often though, these models overlook the effects of inertia, incomplete information and indifference that are reflective of more profound individual variations in preferences and attitudes. Furthermore, the shared influence of these variations across different choice dimensions is either only indirectly captured or captured in a manner that lacks behavioral underpinning.

Empirical evidence increasingly indicates the existence of higher-level orientations, or lifestyles, that influence all dimensions of an individual's travel and activity behavior. These include both short-term decisions, such as where to go and what modes to use (Krizek and Waddell, 2002; Srinivasan and Ferreira, 2002; Johansson et al., 2006), and more long-term choices, such as whether to buy a car (Choo and Mokhtarian, 2004). Past research examining the role of lifestyles on travel behavior has used the term "mobility style" to refer to the mobility-related component of an individual's lifestyle (Lanzendorf, 2002). An intricate part of mobility behavior, and therefore lifestyle, is travel mode choice. Given that lifestyle is a longer-term and partially subconscious choice, we argue that the assumption that people choose their mode of travel independently for every trip or tour likely does not hold true. Instead, we introduce the construct of "modality styles", or behavioral predispositions, characterized by a certain travel mode or set of travel modes that an individual habitually uses. For instance, consider a unimodal auto user who views the world from behind the steering wheel, imagining distances in terms of driving times and locations in terms of parking availability. A unimodal auto user might not be aware of the alternatives at his disposal, or chooses not to consider them, irrespective of the nature of the trip. He knows merely to drive. At the other end of the spectrum, we have a multimodal user who thinks of the available destinations in conjunction with their accessibility by different modes, and optimizes her choice of mode prior to every trip. Irrespective of where an individual lies within the spectrum, we hypothesize that the individual's modality style is inextricably linked with other short and long-term travel decisions. Fig. 1 outlines the relationship between lifestyle, mobility style, and modality style. In this paper we focus on the innermost component, namely modality styles and their effects on two different choice situations: mode use for work tours and mode use for non-work tours.

The objectives of this paper are twofold: (1) to identify different modality styles, recognizing the repetitive nature of mode choice to demonstrate the influence exerted upon it by higher level orientations; and (2) to show how the modality style construct can be integrated into the framework of traditional travel demand models. We hypothesize that modality styles are difficult to infer from standard 1 or 2 day activity diaries, leading us to employ longitudinal travel-diary data over a six-week observation period. The discrete choice modeling approach that we adopt is the behavioral mixtures model, where a behavioral rationale is used to inform the mixing distribution that captures unobserved heterogeneity. Our analysis consists of two stages: First, we identify different modality styles within the sample population through a descriptive analysis, investigating possible correlations between travel mode choices for work and non-work tours. This is followed by the econometric analysis, where we develop travel demand models using both latent class choice models and continuous logit mixture models to deduce unobserved modality styles and their effects on travel behavior. The stages are linked as findings from the first stage inform the process of model development.

Conceptually, our work builds upon the existing body of literature on the influence of lifestyles on travel and activity behavior through the introduction of the modality style construct and its pervasiveness in travel mode choice behavior over different types of tours over a period of time. Methodologically, our work synthesizes recent advances in discrete choice models in the fields of taste heterogeneity, choice set generation and simultaneous choice models in an attempt to incorporate the influence of modality styles within existing representations of travel and activity behavior. While our focus here is on travel mode choice, the model framework developed can be extended along multiple choice dimensions, lending a more behaviorally realistic representation of individual travel behavior.

The paper is organized as follows: Section 2 reviews pertinent literature. Section 3 describes the dataset. Section 4 undertakes a descriptive analysis of the dataset that is used in the subsequent section to develop an appropriate model framework. Section 5 details said model framework. Section 6 presents estimation results for the proposed model framework. Finally, Section 7 concludes the paper with directions for future work.

2. Literature review

We first review literature examining the notions of lifestyles, mobility styles and modality styles in a more conceptual setting. We then discuss the different methodological approaches used in the past to incorporate the effects of mobility and modality styles in discrete choice models of travel and activity behavior.