

Accounting for choice set formation in mode choice models based on awareness and consideration of transit options

Rising concerns regarding energy consumption, greenhouse gas emissions, and urban sustainability have metropolitan areas around the world striving to enhance transit ridership through a variety of approaches including the introduction of new transit modes, the expansion of existing systems, and the implementation of innovative marketing campaigns designed to raise the level of awareness about transit among the traveling public. Many urban areas around the world are experiencing declining transit mode shares. As they consider alternative transit enhancement strategies to boost ridership, the need for robust behavioral models capable of representing transit choice behavior accurately has never been greater. This paper aims to fill this critical research need by presenting new mode choice model formulations that are capable of accounting for choice set formation based on people's awareness and consideration of alternative transit options.

Traditional mode choice models have generally taken the form of multinomial or nested logit models (or, more recently, mixed logit models) in which the choice set for each individual is considered to be deterministic. Either all modes are assumed to be available to all individuals in the sample (thus assuming a constant choice set across all observations) or simple deterministic rules are applied to determine whether certain modes are available to the individual. For example, individuals residing in zero-car households do not have "drive alone" in their choice set, or individuals residing more than ½ mile from a transit stop do not have "transit" in their choice set. Similarly, the absence of a reasonable transit path (within a certain travel time and number of transfers) for an origin-destination pair may result in its exclusion from the mode choice set for an individual who is undertaking a trip between those locations. While these deterministic choice set generation rules are not necessarily unreasonable, they do not truly represent or capture the consideration of transit as an option by the individual traveler. Even if transit were extremely accessible and available, convenient and comfortable, and fast and inexpensive, it is entirely possible that an individual may not have considered it as a viable modal option. The consideration (or lack thereof) of transit as a modal alternative may be influenced by numerous factors that may not have much to do with the physical availability of the mode per se. Personal and household constraints (for example, need to drop off child at school on way to work), individual attitudes, perceptions, and preferences, and simple lack of awareness (information) may all contribute to the non-consideration of transit as a viable modal alternative. Presumably, for transit to be included as a modal option in a traveler's choice set, he or she must be aware of the existence of the service (for the specific origin-destination pair of interest) and actually consider it as an option when exercising mode choice behavior.

The absence of data on individual awareness and consideration of transit options in the mode choice context has thus far precluded the ability to effectively represent choice set formation in a behaviorally robust framework. In connection with an ongoing research effort aimed at better understanding transit mode choice behavior, particularly in the context of the introduction of premium transit modes with non-traditional service attributes (such as real-time information provision, enhanced station amenities, on-board wifi services), data that provides valuable

insights into people's awareness and consideration of transit options has been collected. In the study, data has been collected for the cities of Charlotte, North Carolina and Chicago, Illinois in the United States. The data collection effort included a series of elements. First, the survey collected detailed information about traveler household and person demographic and socio-economic characteristics, along with a host of data on attitudes, perceptions, preferences, and values. The first section also collected some basic travel information recording data about modes used by the respondent over the past week. Second, the survey collected detailed information about a specific trip undertaken by the respondent. In addition to all of the regular travel characteristics data (origin, destination, departure time, trip purpose, travel party size), this section of the survey included a slate of questions that probed the awareness and consideration of transit alternatives for that specific trip. Answers to these specific questions provided the information necessary to develop choice set formation models in this specific study. The final section of the survey data collection effort included an elaborate stated preference (SP) questionnaire. The respondents were asked to respond to eight stated preference scenarios and three alternative modes were provided for each of these scenarios. The alternatives displayed were a car alternative, a bus alternative, and a rail alternative. Twelve dimensions of variables characterized each of the alternatives in the SP scenarios and included non-conventional level of service variables such as on-board amenities and station design attributes. The values for the in-vehicle travel time (IVTT) in the SP experiments were obtained by pivoting about the reported IVTT for the reference trip (from the revealed preference portion of the survey) so that the SP scenarios provided are realistic variations of the reported reference trip.

This paper offers a model system that accounts for transit awareness and consideration in the generation of choice set for mode choice modeling. The choice set formation step of the model system is modeled as an independent bivariate binary probit model system that represents the awareness and consideration of transit by an individual traveler. If an individual is both aware of and considers transit for the journey, then transit is included in the choice set for the mode choice model. The mode choice model itself takes the form of a joint revealed preference – stated preference (RP-SP) model with SP model parameters suitably scaled based on RP data. This two step model system, in which the choice set formation is modeled first and mode choice is modeled subsequent to choice set generation, offers a behaviorally appealing framework for including transit awareness and consideration dimensions in mode choice modeling. Model estimation results suggest that individual socio-economic and demographic characteristics, modal level of service attributes, and attitudinal variables significantly affect transit awareness and consideration. It is found that positive attitudes towards transit modes more strongly influence the awareness and consideration of transit than do negative attitudes take away from such awareness and consideration. It is found that attitudinal variables are also significant in the joint RP-SP model, as are traditional demographic and socio-economic variables, level of service attributes, and non-traditional premium service attributes.

Model estimation results in this study are used to infer the effects of different attributes on awareness and consideration of transit by travelers. The findings provide key insights into the types of marketing campaigns and information dissemination strategies that may have a positive influence on the awareness and consideration of transit, which is inevitably the first step in facilitating transit mode choice by travelers. Model parameter estimates are used to compute elasticity measures that depict changes in share of travelers who would be aware of and consider

transit in response to changes in explanatory factors. The study demonstrates how ignoring the two step “choice set formation – mode choice” process may lead to erroneous policy inferences and inaccurate mode choice elasticity estimates. The endogeneity of the choice set formation step is explicitly recognized in the model system presented in this paper, and the findings will be of considerable value to transit modelers interested in devising policy and marketing strategies aimed at enhancing transit ridership. Finally, the study findings are also used to infer values of various components of travel time by mode, and assessing the role of non-traditional attributes in influencing mode choice behavior.