Behavioral micro-dynamics of car ownership, activity and travel in the Seattle metropolitan region from 1989 to 2002

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Abstract

Car ownership and use is a fundamental research area in travel behavior analysis because it is used to assess the success of policies aiming at curbing car use and increasing the use of other modes. Car ownership models are also used in more recent activity-based travel demand forecasting models. Understanding the dynamic interplay between car ownership and car use and the interplay with changing demographics and land use evolution are key in developing these "new generation" models. In this paper we examine changes in car ownership and travel from 1989 to 2002 to identify the triggers of these changes and if households adjust to demographic and land use changes but also if they anticipate them.

The main analytical tool used is longitudinal mixed Markov latent class analysis to explore patterns of car ownership and use change in the ten waves of the Puget Sound Transportation Panel (PSTP). We employ this pattern recognition technique in databases that include households participating in all waves (230 households) matched with land use data surrounding their residence. In essence, we create clusters of behaviors called "states" and groups of households called "classes" as well as transition probabilities from one state to another over time. In this paper the states are based on car ownership, daily vehicle miles travelled, travel time, and the amount of time outside home at each of the ten waves (time points) spanning more than a decade (1989 to 2002). Transitions among different behavioral states are functions of elapsed time, average age of the household, household demographic changes and changes in land uses surrounding the household residence. Classes are groups of households with commonalities in their social and

demographic characteristics. We also tested classes defined by attitudes about different modes in the first of the panel.

Changes within the household and changes in land use around the household's residence are treated as leads and lags of a latent class clustering model system to explain transitions among different states. The lag represents a household's "reaction" or adaptation to a change and the lead represents an anticipation of a forthcoming change. In this way we can statistically test the significance and impact on behavioral change of past events and future events. We examine changes due to newborn children, growth of children in ages 6 to 17, changes in number of adults, number of workers, number of cars, and density and diversity of land use surrounding the panel participants' residences. In the paper we illustrate the method and a selection of important findings.

Multiple classes (hidden Markov chains) of households are found as the best option of behavioral dynamics with one of the classes displaying increases in car ownership and distance traveled and the other classes showing decreases. Intra-household demographic changes (birth of children, coming of age of other children) and land use density and diversity around the household residence cause both adaptation and anticipation by households as they change behaviors. This implies we need a more complex dynamic specification for models of car ownership and use than currently used in micro-simulators of travel demand. We also need repeated observations in the form of panel data surveys of the same households over time that are coupled with data about changes in the built environment surrounding the persons we track to analyze their behavior.