Impact of individual accessibility on travel behavior and its propagation through intra-household interaction

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Keywords: constraint-based accessibility, travel behavior, intra-household interaction

This study is from a broader research program about how proximal and distal environment affects households’ allocation of time to different types of activities. It is well known that travel demand has a very close relationship with urban development patterns because each sub-area of a city has different potentials to generate or attract traffic by providing opportunities for different types of activities. For this reason, transportation modelers have made efforts to include the impact of this spatial distribution of opportunities in demand models through different modeling strategies. Disaggregate activity-based models that moved us away from the trip-based aggregate modeling help us to analyze in more detail activity choices and their relationship to the environments where they take place. In terms of space, we have seen many efforts to delineate and characterize the extent of space that is accessible to an individual and that has direct impacts on his/her behavior. Most activity based models do not penetrate into the level of every activity and every movement in time and space of every individual in a sample failing to represent the diversity of behavior that emerges from changing contexts. In this paper we explore a possible solution that uses a constraint based measurement method developed in time geography in which each individual’s temporal schedules, time budgets, and spatial movements are considered jointly [1][2].

Accessibility measures based on space-time constraints have been assumed to impact behavior patterns. To measure them we track every movement of each individual’s activity participation and we measure accessibility based on the complete trace in time and space of individuals in a given time interval (e.g., a day or sub-day periods). This type of accessibility measurement is feasible and tractable using Geographic Information Systems for even very large geographic areas.
The other crucial aspect in building this new analytical framework is human interaction. Our daily activities are more or less coordinated with other people. When they are with household members and close kin the ties are stronger. This is partially due to the role that each household member has in the household and certain activities or parts of activities that are shared among the household members. The interaction patterns vary according to relations within a household, time budgets and activity opportunities each member faces within their schedule. There exist many studies on interaction between household members and they are focused on many different contexts, but to our knowledge the complex correlation patterns among spatio-temporal constraints of household members, their interaction patterns, and the propagation of opportunities across individuals have not been studied yet.

We model the intra-household interaction using household-based utility maximizing framework and structural equations that were also used in the past to model interactions of two persons ( [3] [4] [5] [6] ). This framework of household decision making is expanded for larger (more than 2 members) households to take into account the different types of interactions in households of different compositions. Different assumptions on household decision making processes in the two modeling techniques provide an opportunity to look at the intra-household interaction from different perspectives and their implication on travel behavior findings will be compared and discussed together. Using the constraint-based accessibility as a representation of activity opportunities we also study different interaction models of travel behavior that improve their power of behavioral explanation.

This measurement and modeling framework is being applied to the California Statewide Household Travel Survey which was collected in 2000-2001. The measurement of accessibility considering each individual’s spatial and temporal constraints using a realistic highway network dataset is a computationally challenging task, but it was found to be feasible even for a very large sample such as the California Statewide Household Travel Survey, which has about 17,000 households. Using this database we also computed home-based and work-based accessibility measures (called location-based herein) and compared them to the time geography accessibility measures. Then, within household interaction patterns based on one day activity and travel diaries are compared by household composition and socio demographic status.

Our preliminary results show that:

- The individual-based accessibility measures are more or less correlated with conventional location-based accessibility measures but show larger variation according to each individual’s time scheduling and the locations of important pegs in daily activity participation (i.e., home location, work location or school location).
- There are gender differences in the impact of accessibility on time allocation.
- The interaction between male and female heads is asymmetric in time allocation and also in the
propagation of accessibility impacts on time allocation.

- Different socio demographic groups exhibit different interaction patterns in time allocation and in the propagation of accessibility impacts on time allocation.
- These results heighten our expectation that the individual constraint-based measurement contributes in an informative and substantial way to the explanation of travel behavior.
- A conceptual framework of intra-household interactions offers a more informative approach to develop travel demand forecasting models.
- Policies of urban development and their impacts on travel demand should account for these complex interactions.

[References]