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Final Report

Project Title:

Capturing Well-Being in Activity Pattern Models within Activity-Based Travel Demand Models

Project Number:	**Project End Date:**	**Submission Date:**
MITR22-1	04/30/2013	03/31/2013

Problem:
The activity-based approach which is based on the premise that the demand for travel is derived from the demand for activities, currently constitutes the state of the art in metropolitan travel demand forecasting and particularly in a form known as the day schedule approach. This approach first models the day activity pattern of an individual (number of activities and tours by type), and then models the travel dimensions including destination, mode, and time-of-travel given an activity pattern. Several modeling developments have been incorporated into these models over the last decade or so. Yet, the specification of the activity pattern model in operational activity-based model systems is not founded in a behavioral theory, but rather combines in ad-hoc ways a number of socio-economic, demographic, lifestyle, and accessibility variables based on empirical considerations. We postulate that activities are planned and undertaken to satisfy needs so as to maintain or enhance subjective well-being, and extend activity pattern models in this direction.

Approach:
We develop two extensions to enhance the specification of the activity pattern model. The first extension maintains the standard activity pattern utility specification but adds information about the utility using well-being measures in addition to the usual choice indicators. It is expected that the activity pattern models that incorporate well-being would be behaviorally more realistic and would enhance the efficiency of the activity pattern models thereby yielding better prediction of travel patterns. The second extension explicitly models the drivers of activity participation, based on the notion that individuals pursue different activities to satisfy their needs (sustenance, social, recreation, etc.). Each activity that an individual conducts may satisfy one or several of his/her needs. Conversely, each need may be satisfied by one or several activities. We model an individual's choice of activity dimensions including frequency, sequence, location, mode, time-of-travel, etc. as one that maximizes his/her need-satisfaction.

Methodology:
The development of state of the art activity-based models usually requires travel information of the individual from a household travel/activity survey, transportation network data, land use data, and socioeconomic data. In order to incorporate well-being measures in the activity pattern model, an extended household travel survey needs to be conducted. We collaborated with a transportation planning agency, Denver Regional Council of Governments (DRCOG), to accomplish the data collection goal. In 2010, DRCOG conducted an extensive household travel survey in which we added supplementary questions in order to capture subjective well-being associated with the overall activity and travel pattern of the individual and also to infer the deviation of the resulting well-being from the expectation. Our modeling methodology for the first extension consists of re-estimating DRCOG's activity pattern model (maintaining the existing model specification developed by Cambridge Systematics (2010)) using the 2010 data with and without the happiness indicators to test the improvement that would result from adding the happiness indicators. The latter model is an extended random utility model whereby the responses to the happiness questions are used as indicators of utility through additional measurement equations.

Regarding the second extension, we developed a conceptual model of the relationship between needs and activities based on inventory theory. Every need is associated with a psychological inventory that reflects the level of satisfaction with respect to the need. When an activity that satisfies a need is conducted, the need is satisfied and the corresponding psychological inventory is replenished by a quantity called the activity production. Over time, this inventory gets consumed and the need builds up. The choice of activity dimensions is modeled as a psychological inventory maximizing (i.e. utility-maximizing) problem, subject to time and cost budget constraints. The framework also accounts for satiation in need-satisfaction. An analytical model is formulated, solved and empirically estimated for a single need and the activity that satisfies the need under steady-state conditions. The problem is solved in two stages, for discrete (location) and continuous (duration and frequency) decision variables. The properties of the general solution are studied, and then explored for a translog form of the activity production function. An empirical estimation method that can be applied to single day travel diary data is proposed and validated using Monte-Carlo experiments. The model is empirically estimated using standard travel diary data from the Denver metropolitan area (Pattabhiraman, 2012; Pattabhiraman et al., 2012).

Finding and Conclusion:
With respect to the first extension, we have processed the 2010 DRCOG survey data and computed the accessibility variables, which are mode and destination choice logsum variables. We are currently estimating the activity pattern model without the well-being measures using the data collected in 2010. Following this we would estimate the extended activity-pattern model including the well-being measures and would compare these two models on a number of criteria including goodness of fit, prediction capabilities, and efficiency. A description of the methodology for extending activity pattern models and descriptive statistics related to the happiness questions added to the DRCOG survey are reported in Abou-Zeid and Ben-Akiva (2012). As to the second extension, the estimation results of the needs-based framework using shopping trips from the 2010 DRCOG data indicate the potential of the needs-based approach to enrich the specification of activity generation models in conventional activity-based model systems. We are currently working on enhancing the specification of the model by including socio-economic variables and extending the framework to capture multiple needs and activities.

References:
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3. Pattabhiraman (2012) "A needs-based approach to activity generation for travel demand analysis", MST Thesis, Massachusetts Institute of Technology, Cambridge, Massachusetts. Available at: http://dspace.mit.edu/bitstream/handle/1721.1/74470/813838532.pdf?sequence=1

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