The Day Activity Schedule Approach to Travel Demand Analysis

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Synopsis

This study develops a model of a person's day activity schedule that can be used to forecast urban travel demand. It is motivated by the notion that travel outcomes are part of an activity scheduling decision, and uses discrete choice models to address the basic modeling problem—capturing decision interactions among the many choice dimensions of the immense activity schedule choice set.

An integrated system of choice models represents a person's day activity schedule as a set of tours and at-home activity episodes tied together by an overarching day activity pattern, or pattern for short (Figure 1). Decisions about a specific tour in the schedule are conditioned by the choice of day activity pattern. This is based on the notion that some decisions about the basic agenda and pattern of the day's activities take precedence over details of the travel decisions. The probability of a particular day activity schedule is therefore expressed in the model as the product of a marginal pattern probability and a conditional tours probability

$$p(schedule) = p(pattern)\,p(tours|\,pattern)$$

where the pattern probability is the probability of a particular day activity pattern and the conditional probability is the probability of a particular set of tours, given the choice of pattern.

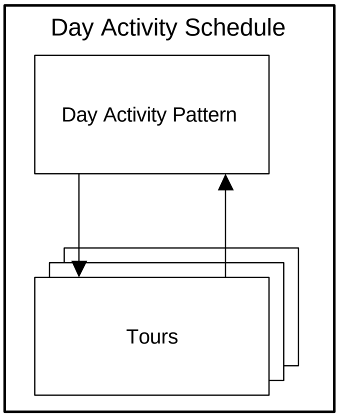

Figure 1: The day activity schedule. An individual's multidimensional choice of a day's activities and travel consists of tours interrelated in a day activity pattern.

The day activity pattern represents the basic decisions of activity participation and priorities, and places each activity in a configuration of tours and at-home episodes. Each pattern alternative is defined by (a) the primary activity of the day, (b) whether the primary activity occurs at home or away, (c) the type of tour for the primary activity, including the number, purpose and sequence of activity stops, (d) the number and purpose of secondary tours, and (e) purpose-specific participation in at-home activities. For each tour, details of time of day, destination and mode are represented in the conditional tour models. Within each tour, the choice of timing, mode and primary destination condition the choices of secondary stop locations.

We assume the utility of a pattern includes additively a component for each activity, a component for the overall pattern, and a component for the expected utility of its tours. The activity components can capture basic differences among people in the value of various kinds of activity participation. The pattern component captures the effect of time and space constraints in a 24-hour day. The expected utility component captures the effect of tour conditions on pattern choice. Through it the relative attractiveness—or utility—of each pattern, depends not just directly on attributes of the pattern itself, but also on the maximum utility to be gained from its associated tours. Patterns are attractive if their expected tour utility is high, reflecting, for example, low travel times and costs. This ability to capture sensitivity of pattern choice—including inter-tour and at-home vs on-tour trade-offs—to spatial characteristics and transportation system level of service distinguishes the day activity schedule model from tour models, and is its most important feature.

An empirical implementation of the model system for Portland, Oregon, establishes the feasibility of specifying, estimating and using it for forecasting. It is specified as an integrated hierarchical system of logit models, with parameters estimated by maximum likelihood. Of the 633 estimated parameters, 297 measure the importance of lifestyle and mobility variables, 95 measure the importance of the activity and travel environment—including expected utility, and 241 measure unexplained preferences and the influence of marginal choice dimensions on conditional dimension utility.

The model system demonstrates the benefits of its design in various policy applications, including peak period pricing. There, in response to a toll levied on all travel paths during the morning and evening peak travel periods, the model predicts not only shifts in travel mode and timing, but also shifts in pattern purpose and structure. As shown in Table 1, the net result is an increase in the predicted number of tours for leisure purposes; increases in leisure tours induced by pattern changes more than offset leisure tour decreases caused by the peak period toll.

Table 1: Peak period toll—induced leisure travel captured by the day activity schedule model

	Percent change in number of tours, by tour purpose, in response to $.50 per mile peak period toll on all roads		
Time of day	Work	Maintenance	Leisure
A.M. peak period	-7.1%	-8.4%	-6.2%
P.M. peak period	-7.4	-7.7	-1.5
Midday	3.1	3.6	2.8
Outside peaks	6.8	2.3	2.7
Total	-2.5%	-0.3%	+.8%

Analysis of model response to additional policies, including transit improvements, vehicle ownership restrictions, fuel taxes, auto registration fees, parking regulation, neighborhood walkability improvements, mixed use development, and ITS highway capacity increases, and telecommunications advances indicate that the day activity schedule model structure enables the capture of pattern shifts and associated changes in travel demand in a great variety of situations.

Chapter 1 of the thesis introduces the problem and summarizes the research. In Chapter 2, the theory of activity-based travel demand is examined, resulting in a set of behavior-theoretical requirements for an activity-based travel demand model system based on a day activity schedule. Chapter 3 studies previous attempts to model travel demand as part of a larger activity schedule, leading to the selection of the discrete choice modeling approach. Chapter 4 presents the concepts and mathematical form of the day activity schedule model, and identifies important model design issues. Chapters 5 and 6 present the results of an empirical implementation in Portland, Oregon. Chapter 7 draws the final conclusions of the thesis and discusses specific ideas for future research to build on those conclusions.