A Two-Level Multiple Discrete-Continuous Model of Time Allocation to Virtual and Physical Activities

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Extended abstract
The transport impacts of Information and Communication Technology (ICT) have been studied for decades. Research in the past has focused on empirical studies and four different types of impacts of ICT on activity and travel have been reported: complementarity, substitution, modification or neutrality (Pendyala, et al, 1991; Mokhtarian and Salomon, 2002). Recently, research in this field has been extended into investigating how ICT leads to the reorganization of activities in time and space. Lenz & Nobis (2007) study the concept of fragmentation and argue that ICT facilitates the breaking up of activities into discrete pieces in time and space. Three types of fragmentation were differentiated: spatial fragmentation; temporal fragmentation and fragmentation of the manner in which activities are preformed. Kenyon and Lyons (2007) examine another important change that ICT has brought to the implementation of activities: multitasking, which refers to the simultaneous conduct of two or more activities during a given time period. They argue that multitasking may increase efficiency and consequently individuals may be able to use more than 24 hours a day. These recent attempts provide important insights into the ways that ICT facilitates the reorganization of activities in space and time. Nevertheless, similar to most existing studies, they treat ICT as a factor exogenous to individuals’ activity-travel patterns and assume that the impact is uni-directional, i.e., how ICT changes activity-travel. However, the use of ICT may also be influenced by activities and travel, i.e., the interactions between ICT and activity-travel are bi-directional (Dijst, 2006). More importantly, ICT has been fully integrated into individuals’ daily life and created an important living space additional to the physical space: the virtual space. A significant part of our daily time is now spent in the virtual space for browsing the website, shopping and chatting with friends, etc. Thus, we believe that the investigation into the interactions between ICT and activity-travel should go one step further to analyze how individuals allocate their time between activities in virtual and physical spaces. In this regard, to develop a time allocation model to analyze individuals’ tradeoffs between spending time in virtual space and physical space becomes a necessary and important extension to the existing literature.

This paper develops a so-called two-level multiple discrete-continuous model to study time allocation to physical and virtual activities. We consider this time allocation as a two-level multiple discrete-continuous decision problem that
involves the choice of imperfectly substitutable alternatives and the allocation of a continuous variable (time in this case) at two levels: Firstly, individuals need to decide what activities to perform on a day (usually more than one activity is chosen). Secondly, there is a choice regarding where to conduct the activities: in virtual space or physical space or both (e.g., shopping can be implemented in shops (i.e., in physical space) or online (in virtual space) or partly in virtual space (gathering information about products online) and partly in physical space (actual purchasing in shops))? Thirdly there is a decision regarding how long time to be allocated to the chosen activities.

The discrete-continuous modeling framework has been developed to address discrete-continuous choice problems. Traditionally, discrete-continuous models handle the allocation of time or money to a single alternative chosen from a set of mutually exclusive alternatives (e.g., Chintagunta, 1993; etc.). Recently, this methodology has been extended to deal with cases involving imperfect substitution, i.e., the choice of multiple alternatives simultaneously (Bhat, 2005). But their modeling framework can handle multiple choices at only one level. In this paper we extend the existing modeling framework to handle multiple discrete-continuous choices at two levels. Method for estimating the model is developed. The model is calibrated by data collected from a sample survey conducted in December 2007 in Hong Kong. The sample involves 390 individuals, whose time use and activity participation in both physical and virtual spaces during 24 hours are recorded. Data on their socio-economic characteristics and ICT accessibility, availability as well as consumption are also collected. Sensitivity analysis and policy simulation are performed to evaluate the applicability of the model for policy analysis.

The model developed in this paper helps us understand more about the interactions between time allocation to physical and virtual spaces. The modeling approach may be applied to investigate activity choices and time allocations in activity-travel behavior modeling in general. It may also be used to study product and service choices and money allocation in marketing and choices of tourism products and money allocation in tourism studies.

References:
the 11th International Conference on Travel Behaviour Research (IATBR),
August 16-20, 2006, Kyoto, Japan.
and ICT: Examining its extent and assessing its potential importance”.
Transportation Research Part A, 41, 161-175.
time by the use of ICT - Fragmentation as a new concept and empirical results”.
Transportation Research Part A, 41, 190-204.
telecommunications make a difference?” In H. S. Mahmassani (Ed.), In
Perpetual Motion: travel Behavior Research Oppotunities and Application Challenges.
Amsterdam, London, New York, Oxford, Paris, Tokyo, Boston, San Francisco,
Singapore, Sydney: Pergamon.
telecommuting on spatial and temporal pattern of household travel”.
Transportation 18, 383 – 409.