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Multi-dimensional advances in travel modeling

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This issue includes five papers that highlight new developments in the formulation and application of travel demand models. As transportation and land use planners, policy and decision makers, and the traveling public confront increasingly complex travel environments, the need for robust behavioral models capable of simulating people's activity and travel patterns in the time–space continuum has never been greater. Concerns about global climate change, economic development, energy sustainability, the environment, livability of communities, and social equity call for the development and application of new microsimulation model systems that are responsive to a host of policy variables, built environment and network attributes, and socio-economic and demographic characteristics. Over the past decade, the field of travel modeling has stepped up to the challenge with developments in model formulation and specification, application, and implementation happening on multiple fronts. The selection of five papers included in this special issue illustrates the progress that is being made in deploying the types of tools and systems needed to address the transportation, land use, and environmental planning challenges of the 21st century.

The five papers in this issue capture the types of advances that are being made in travel modeling along multiple dimensions. These advances help analysts model and understand the impacts of alternative policies on various segments of society. For example, one could consider the potential effects of a pricing policy. In traditional travel modeling practice, it is extremely difficult—if not impossible—to obtain measures of benefits (or disbenefits) accrued by different socio-economic strata of society. It is possible that lower income segments of society may be more adversely impacted by a pricing policy than higher income groups. Environmental justice or social equity analysis is increasingly being demanded of transport policy analysts and models that microsimulate activity travel patterns at the level of the individual traveler are able to provide the rich level of detail needed for this purpose. Such an application is illustrated in the paper by Kickhöfer, Grether, and

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Nagel, who apply a microsimulation model system called MATSim to analyze benefits accrued from a public transportation speed increase across different income segments. They develop utility functions that are sensitive to income and then apply the microsimulation model system to measure welfare effects resulting from the change in public transport level of service. They find that the inclusion of income in utility function formulations is important and useful, and helps differentiate effects of transport system changes on different income segments in a robust manner. They note that attention should be paid to the way benefits are aggregated across individual agents as a simple aggregation of utilities across agents yields results different from those obtained by aggregating effects based on willingness-to-pay of different income groups. It is heartening to note that their paper represents a key milestone in the application of microsimulation models to large scale regional applications for policy analysis, an enterprise that the research community has hesitated to undertake due to concerns of computational burden and complexity.

It goes without saying that a major area of emphasis for travel model research and development is the integration of new microsimulation models of activity-travel behavior with other key model systems such as those dealing with land use, demographics, energy consumption, and air quality or emissions. The second paper in this issue, by Hatzopoulou, Hao, and Miller, represents a key advance in the field as it describes the integration of an activity-based travel demand model with an emissions model and a pollutant dispersion model. Similar to the first paper, the work described in this paper also utilizes MATSim as the time-dependent network microsimulation model capable of simulating the dynamics of traffic flow in the Greater Toronto Area, where the integrated model system has been applied and tested. The activity-travel model that is integrated with MATSim is TASHA, a behaviorally robust activity scheduling model that is capable of building daily activity schedules for persons while recognizing spatio-temporal constraints and household member interactions that inevitably shape schedules. The model system includes an emissions model (MOBIL6.2C) and a pollutant dispersion model (CALMET/CALPUFF). The integrated model system allows one to measure emissions by time of day resulting from vehicular travel simulated in TASHA and routed in MATSim. The use of the pollutant dispersion model offers new directions for addressing the impacts of transport policies on public health as the paper illustrates how pollutant exposure measures can be derived at small spatial scales to identify vulnerable populations. The authors apply the system to analyze a variety of policies and note the challenges ahead in attempting to decrease greenhouse gas emissions in the face of socio-economic and demographic growth.

The third paper in this issue presents another application from the Greater Toronto Area, but highlights major advances in the microsimulation of transit networks. Over the past decade, much work has been done in the microsimulation of highway networks and automobile modes of transportation; however, progress in microsimulating transit networks and performance has been more limited, presumably due to data limitations, the complexity associated with accounting for schedule and route constraints, and the limited knowledge regarding traveler behavior related to transit access and egress. Wahba and Shalaby attempt to tackle these issues in the development of MILATRAS, a microsimulation model of transit networks at the core of the third paper in this issue. Similar to the first two papers, this paper also involves an application for an entire area signaling that the era of large scale applications of microsimulation models has arrived. The model system is a learning based model with passenger's departure time choice, stop choice, and path choice constantly evolving in response to experiences and information that aid the formation of mental models. A parallel genetic algorithm is used to calibrate model parameters and the model is applied to the network of the Toronto Transit Commission to simulate travel by 332,000 passengers. The authors note, however, the continued challenge of modeling transit access and egress modes in the context of simulating multimodal journeys. The travel modeling community needs to move increasingly towards the continuous representation of space (similar to the continuous representation of time) to adequately account for transit access and egress in modeling intermodal travel.

While the first three papers in this issue collectively demonstrate that large scale applications of microsimulation model systems are feasible and desirable from a policy analysis perspective, the subsequent two papers represent advances in the modeling of behavioral phenomena that could one day make their way into the large scale microsimulation models. Although much progress has been made over the past several decades in modeling behavior, it is imperative that the profession continue to formulate and develop robust econometric models of behavior capable of representing aspects of behavior hitherto ignored in previous formulations. The fourth paper in this issue is one by Rashidi, Mohammadian, and Koppelman. It addresses a topic of much interest and importance in the profession. With growing concerns about energy sustainability and greenhouse gas emissions resulting from increasing vehicle usage worldwide, there is considerable interest among the planning community to develop robust models of vehicle transactions that are capable of capturing the evolution of a household's vehicle fleet over time. In this paper, the authors adopt a joint hazard-based duration model to represent the timing between vehicle transactions while treating several other lifecycle changes endogenous to the system. In previous work, vehicle transactions have been modeled using cross-sectional data and treated numerous lifecycle events exogenous to the vehicle transactions model. In this paper, the model system represents a simultaneous model of job location changes for adults in a household (husband and wife, for example) and residential location change for the household in relation to the timing of a vehicle transaction. The authors use three waves of the Puget Sound Transportation Panel survey data to develop a dynamic model of multiple timing decisions related to job locations, residential location, and vehicle ownership. The model system includes not only socio-economic variables describing the household and individuals as explanatory variables, but also built environment and network attributes that may influence vehicle transaction decisions. The authors also test different distributional assumptions on the baseline hazard functions and note that a log-logistic form (which can be non-monotonic) offers considerable improvement in model fit for two of the three dimensions addressed in the paper.

The final paper in the special issue is that by Pinjari, Pendyala, Bhat, and Waddell. This paper is a bold attempt at developing a joint econometric model formulation that links multiple behavioral dimensions together in an integrated and coherent framework. The challenge addressed by this research is that of representing inter-dependencies among choice dimensions, including those that transcend multiple time-scales. In particular, the model system considers residential location choice, vehicle ownership, bicycle ownership, and commute tour mode choice. The first dimension is a long term choice, the second is a medium term choice, and the third and fourth may be viewed as short term travel choices. The development and estimation of the joint model system is a first step towards integrating land use choices (residential location choice), vehicle ownership, and travel choices in a way that allows one to explicitly represent residential self-selection effects and endogeneity among multiple behavioral phenomena. Endogeneity may arise due to the presence of common observed and unobserved attributes that influence the choice dimensions simultaneously. The paper provides a comprehensive econometric formulation that is applicable to the modeling of a mix of different dependent variable types (continuous and discrete choices) and presents model estimation results in the context of a data set from the

San Francisco Bay Area of the United States. Estimation results show that, within the data set used in the study, there is significant residential self-selection, endogeneity, presence of common unobserved factors affecting multiple choice dimensions, and presence of unobserved heterogeneity (for example, households were found to differ substantially in their sensitivity to commute travel time in making residential location choice decisions and this variation was due to unobserved factors). The paper clearly demonstrates the need for developing and estimating joint model systems that relate multiple behavioral phenomena in an integrated framework.

These five papers were originally presented at the 2009 triennial conference of the International Association for Travel Behaviour Research, which was held December 13–18 in the city of Jaipur located in northwest India. The International Association for Travel Behaviour Research (IATBR) continues to be the premier association for sharing and disseminating the latest developments in travel modeling and these five papers are illustrative of the types of key advances presented and discussed at the conference. The Association conducts a conference once every 3 years and it was held in a developing country for the first time ever in 2009 when India played host to more than 200 delegates from 30 countries. It has been a regular feature of the conference series to produce special issues of journals containing selected papers presented at the conference and this special issue represents a continuation of that legacy, and the strength of the partnership between *Transportation* and IATBR. It is envisioned that IATBR will continue to partner with *Transportation* in the years to come to produce special issues in conjunction with the triennial conference. For more information about IATBR and its varied activities and publications, please visit the Association website at http://www.iatbr.org. The Association thanks *Transportation* and its editorial team for being a partner in sharing the latest advances in travel behaviour research.