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Risky time prospects and travel demand

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Risky time prospects and travel demand

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Every traveler makes choices in a stochastic environment, because of unpredictable disturbances coming from both exogenous incidents (for example weather conditions) and aggregate endogenous behavior of other travelers (accidents, unexpected congestion). These non-recurring disruptions to a traffic system result in variable travel times. A structurally assembled and robust modeling of demand and supply under risk is however far from being achieved in transportation analysis. It should explicitly be accounted for as it affects related choices of modes, routes, and travel schedules (Palma et al., 2008). Appraisal of transportation policies would be more accurate if considering not only the value of travel time savings but also the value of travel time reliability (Bates et al., 2001; Palma and Picard, 2006, 2010).

Assuming that travel choices are made under risk modifies the modeling of demand and the analysis of the distribution of traffic flows on transportation networks. Despite contributions (Abdel-Aty et al., 1995; Noland and Small, 1995; Noland et al., 1998; Bates et al., 2001; Small et al., 2005; Brownstone and Small, 2005; Avineri and Prashker, 2005; Palma and Picard, 2005, 2006; Chorus et al., 2006; Lapparent, 2010; Ben-Elia, 2011), there is no general consensus on choice behavior under risk because of competing theories, lack of appropriate data, and testable empirical models.

The three contributions on modeling travel choices under risk presented in this special issue reflect the current state of the art and extend usual models. The authors focus on mode choice, route choice, and departure time choice.

First, assumptions on the agents' behaviors are based expected utility (Neuman and Morgenstern, 1944), rank dependent utility (Quiggin, 1982), and reinforcement learning (Abdulhai and Kattan, 2003).

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Second, as highlighted by Palma and Picard (2005), Stott (2006), and Palma et al. (2008), there are multiple ways to express utility and probability functions. The results are sensitive to such a choice. There is no clear evidence which formulation fits the best.

Third, the authors of this issue use experimental data for parametric and non-parametric estimation. They also derive solutions analytically. Using stated preference surveys or laboratory experiments might both fail to describe empirical observations on revealed preferences.

Fourth, their contributions also show that considering “network” equilibrium models based on joint decisions and interactions differ from considering only “single-traveler” based on individual preferences.

In “Risk aversion in travel mode choice with rank-dependent utility”, Matthieu de Lapparent and Moshe Ben-Akiva develop mixed logit discrete choice models (Train, 2009) based on rank-dependent utility theory. Using data from 2004 on stated preference for a mode of transport collected in the Zürich area, they estimate alternative parametric specifications of the rank-dependent utility function to infer risk aversion profiles of travelers for work and leisure trip purposes. They combine two probability weighting functions with five utility functions. They find that commuters are weakly averse to small time losses. The results also justify Yaari (1987)’s dual theory of choice under risk: the utility function is linear on outcomes but the perception of corresponding probabilities is biased. For leisure travel, the travelers are risk-neutral to small losses of time.

In “Travelers’ day-to-day route choice behavior with real-time information in a congested risky network”, Xuan Lu, Song Gao, Eran Ben-Elia, and Ryan Pothering deal with individual route choice behavior when faced to risky travel times and how it affects the resulting network equilibria under different schemes of information provision. They also study how these vary over time. They present route choice experiments, where individuals repeat route decisions in a fictious road network subject to random capacity restrictions on one of its vertex. Providing real time information increases network efficiency. They also design and calibrate the reinforcement learning model of Barron and Erev (2003) using stochastic optimization. The model captures the “day-to-day” traffic flow and completes the usual traffic assignment model in accounting for the effects of real-time information on the choices of travelers.

In “The variability of travel time, congestion, and the cost of travel”, Nicolas Coulombel and André de Palma treat how time variability affects choices of departure time and how it modifies the traffic on a route with limited capacities. Palma and Picard (2012) studied a similar case focusing on route choice instead of departure time choice. Coulombel and Palma start from the bottleneck model of road congestion with inelastic total traffic. The model is augmented of an additive random delay in travel time, the distribution of which is known by travelers. They prove that there exists a single Nash equilibrium under specified preferences on departure time (Vickrey, 1969; Small, 1982). They show that this equilibrium has properties different from those obtained when travel times are deterministic: departure times spread more evenly, the maximum level of congestion decreases, and the peak depends on individual preferences and on the given distribution of travel time. Variability of travel time alleviates congestion. The equilibrium mechanism mitigates both congestion and the cost of unreliability. Treating congestion as an exogenous phenomenon in modeling individual departure time leads to overestimate the value of travel time reliability. Coulombel and Palma show that the generalized cost of travel with risky time prospects is substantially lower when accounting for an equilibrium mechanism.

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