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Risk and uncertainty in urban and transport economics

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Risk and uncertainty in urban and transport economics

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Urban and transportation economics often require discrete decision making in risky situations. Inoa, Picard, and Palma, in "Effect of an accessibility measure in a model for choice of residential location and type of employment," develop discrete choice models to understand residential and professional choices. They study the best way for residents to acquire information in a sequential choice, with an application to Île-de-France. Xin and Levinson, in "A Stochastic congestion and pricing model with endogenous departure time selection and heterogeneous travelers," describe the choice of departure time with risky travel times and simulate its effects on transportation policies. They use the standard dynamic model for this purpose. Cohen, in "risk perception, risk attitude, and decision: a rank-dependent analysis," reviews the literature on decision making under risk and uncertainty either with expected or with non-expected utility. She shows how the expected utility model is extended in the context of non-expected utility theory.

Inoa, Picard, and Palma combine discrete choice theory with the modeling of choice in risky alternatives. The decision process is hierarchical. In practice, when the decision-maker faces many alternatives, usual economic models are inoperative and both the decision-maker and the modeler must simplify and regroup different alternatives concerning residential location choice and employment choices. The authors analyze a three-level decision process: residential location, workplace, and type of employment.

If decision is sequential, the information available *ex ante*, at the first step, is different from the information available *ex post*, once the first step choice is made. The decision-maker, who only knows the probability distribution of errors, forms some expectation about the quality of the alternatives available in the next stage of the decision process. The authors use the accessibility measure developed in discrete choice theory to take into account both the imperfect information on the subsequent realizations of random variables and the

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maximization behavior of travelers. After the first stage decision (for example, the choice of residential location), information, initially known through a probability distribution, is revealed. For example, an individual deciding to move to the pleasant city of Fontainebleau, before demanding a position, knows the distribution of available positions but not the quality of each position. The choice of a residence reveals the quality of each position accessible from this residence. The resulting structural model is applied to the French region Île-de-France.

Xin and Levinson extend Vickrey's model (see the original contribution: Vickrey, 1969) popularized in the transportation literature by Arnott et al. (1996) and in civil engineering by Palma et al. (1981). Vickrey describes the time when a congestible facility is used. Users wish both to minimize queuing time and to be served as close as possible to an ideal arrival time. However, offices open at the same time, which leads to traffic congestion. Similarly, popular movie theaters are also those with long queues, especially at the most desired periods. Congestion accompanies popular success. Pricing, priorities, capacity expansion, and information could be used for regulation, not only for automobile but also for air or electricity traffic. When travel time is uncertain, and users anticipate the average travel time correctly, the government either knows the preferences of users and can charge accordingly, or ignores them except the value they grant to time. In this case, it is efficient to tax transportation based on the level of congestion. Then, beside the level of information known to users, the type of knowledge they have modifies the issue. For example, some agents may have preferences just ignored by others. This structural uncertainty is combined with uncertainty on state variables. Such research is also essential to better understand driver information systems.

Cohen, presents risk and uncertainty in decision theory. In the expected utility model (EU), the decision-maker optimizes a function of utilities, reflecting different outcomes, weighted by the probabilities of these outcomes. In non-EU theories, these weights also reflect optimism or pessimism. The EU model has been used in transportation economics, be it in the short run (travel times are often risky, especially in congested situations), in the medium run (purchasing a vehicle is a bet that the current technology will last and that gasoline will remain affordable), and in the long run (residential location decisions depend on anticipated employment opportunities and real estate). The difference between risk (known probabilities) and uncertainty (unknown probabilities) was discussed as early as 1921 in the transportation context (Knight, 1921), but has sunk into oblivion since then. The level of risk is variable in transportation systems, but the distribution functions are seldom known. Radical uncertainty occurs when the state of nature is unknown. The rank-dependent utility model extends the EU model to describe the aversion to ambiguity and different attitudes towards risk. This model is used to explain paradoxes (such as the Allais paradox), where EU fails and is replaced by non-EU.

Risk and uncertainty are introduced in testable econometric models such as discrete choice models (Palma et al., 2008). Structural models allow us to estimate the determinants of attitudes towards risk and uncertainty in transportation (Palma and Picard, 2005). Beside residential location and departure time choice, route choice, mode choice and activity pattern, these models are essential in transportation engineering and in particular for cost benefit analysis.

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