Stochastic Variability in Trip Distribution Predictions of a Rule-Based Model of Activity-Travel Demand

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Introduction

The latest generation of activity-based models of travel demand is inherently stochastic. Two major modeling approaches may be distinguished: discrete choice models and rule-based models. Discrete choice models predict the probability that a particular choice, such as departure time, transport mode or destination will be made. Micro-simulations based on such choice models will generate different choice outcomes because different realizations from the underlying probability distribution will be drawn. In contrast, rule-based models use a decision tree to link a set of socio-demographic and condition variables to an action state. Models such as Albatross (Arentze and Timmermans, 2004) are based on probabilistic decision tables, which represent these relationships in a probabilistic manner. Thus, although the representation formalism differs, different runs of probabilistic rule-based models will result in different outcomes.

This inherent stochastic nature of the latest generation of activity-based models implies that formal uncertainty analysis is needed to differentiate policy effects from model uncertainty (Castiglione et al. 2003). The purpose of the poster is to highlight some results of the effects of model uncertainty of the Albatross model system on predicted OD matrices and destination choices for the city of Rotterdam, the Netherlands. It contributes to this emerging field of interest (e.g., Cools et al., 2011; Rasouli and Timmermans, 2012a, 2012b).

Study design

Synthetic population

The application of the Albatross system requires a sample of individuals with a particular socio-demographic profile. Because such data do not exist, a synthetic population needs to be created. This means that a population of individuals is created such that (i) aggregations of the derived data are consistent with available distributions for the city and (ii) the correlations in the derived profiles are consistent with correlations observed in the National Travel Survey for similar cities. Iterative proportional fitting was used to create the synthetic population.

Uncertainty analysis

First, a 10% random sample was drawn from the synthetic population. It consists of 42000 individuals. This fraction was kept constant across the analyses to rule out the possibility that results are influenced by the sampled fraction. Next, for each sampled individual of this fraction, the Albatross model was run 1000 times. That is, in each run, the 27 decision trees making up the Albatross model system were activated according to the sequence of the process model, underlying the model system. The simulated realization of each of these decision tables was used as input in activations of subsequent decision tables. Choices for the various facets underlying activity-travel scheduling decisions were simulated by Monte Carlo draws from the probabilistic decision tables, making up the Albatross model system. The different runs thus result in different simulated activity-travel patterns. The number of trips between pairs of origins and destinations was calculated by aggregating these patterns across individuals. The 1000 runs then provide the basis for analyzing the effects of model uncertainty on the predicted number of trips for OD pairs and destination choices at the level of four digits postal code areas. Rotterdam has 65 of those zones. The coefficient of variation was used as a measure of uncertainty.

Results

Figure 1 portrays the frequency distribution of the calculated coefficients of variation for estimates of the cells in the OD-matrix, across all travel purposes. It shows that approximately 30 per cent of the OD pairs has a coefficient of variation between 0.35 and 0.40. The average coefficient of variation is 0.454 with a standard deviation of 0.250.

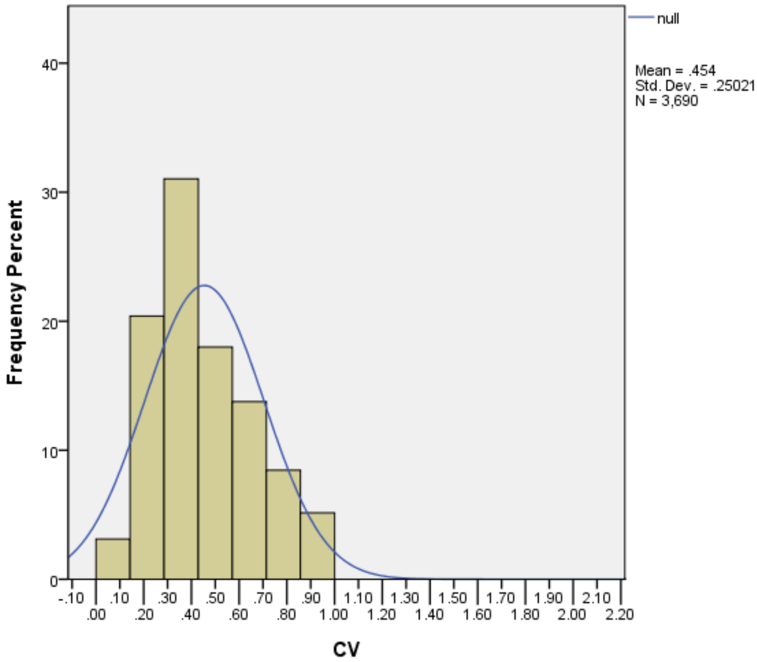

Figure 1: Distribution of coefficient of variation for traffic volume on OD pairs

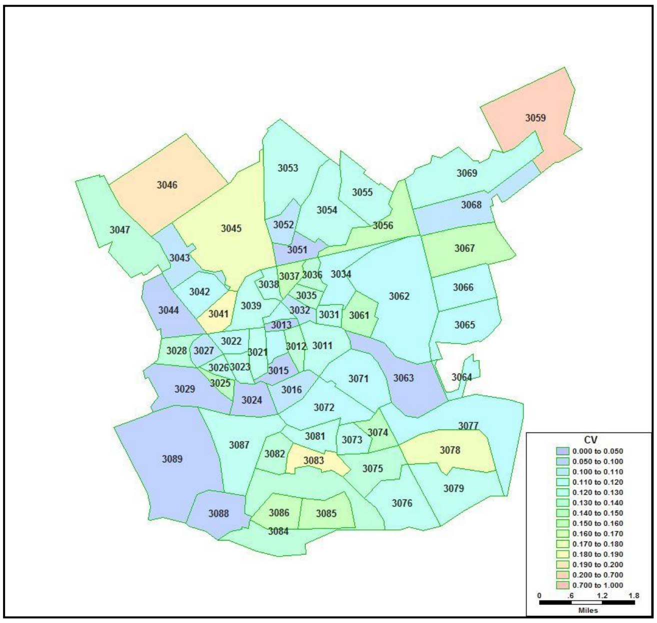

Figure 2: Coefficient of variation for destination choice

Figure 2 shows the coefficient of variation for the number of trips to Rotterdam four digits postal code areas. It indicates that 58 postal code areas out of the 65 have a coefficient of variation of less than 0.15.

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