DEMAND FORECASTING AND UNCERTAINTIES

ESD.00

Recitation 4

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MOTIVATION FOR DEMAND MODELING

- Why forecast demand?
  - To estimate future demand levels for planning purposes.
  - To analyze proposed projects or policies.

- Who does it?
  - Transportation planning agencies.
  - Private transportation service providers.

MOTIVATION FOR DEMAND MODELING

- What other large-scale engineering systems might have a need to forecast demand?

Energy

Image courtesy of janie.hernandez55 on Flickr.

Mobile Phones

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Internet

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Water

Image courtesy of Steven Depolo on Flickr.

TRAVEL DEMAND FORECASTING METHODS

- Econometric “top-down” forecasting:
  - Often used for national, and regional-level forecasts.
  - Examples: total annual air traffic between New York and Boston, total vehicle miles travelled in the U.S.

- Choice-based “bottom-up” forecasting:
  - Often used to determine mode choice.
  - Examples: mode share for travel between New York and Boston (auto, air, or rail), mode choice for daily commute (personal vehicle, transit, biking or walking).

TRAVEL DEMAND FORECASTING METHODS

- Econometric "top-down" forecasting:

  Functional form:

  $$y = \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n + \varepsilon$$
  $$= \beta x + \varepsilon$$

- Choice-based "bottom-up" forecasting:
  - Functional form:

  $$U_{in} = \beta_{in} x_{in} + \varepsilon_i$$

  We compare U_1, U_2, U_3, … U_n. Select i with highest utility.

DISCRETE CHOICE FRAMEWORK

- Decision-Maker (e.g. traveler)
  - Attributes of Decision-Maker (e.g. age, gender, income, etc.)
- Alternatives (e.g. auto, high-speed rail, auto)
  - Attributes of Alternatives (e.g. travel time, cost, frequency)
- Choice
  - Decision-maker n selects one and only one alternative from set $C_n = \{1,2,\ldots,i\ldots,J_n\}$ with J alternatives.
- Decision Rule
  - Dominance, satisfaction, utility, etc.
  - Utility = happiness

Adapted from Ben-Akiva, 1.201, Fall 2010, Lecture 3

CHOICE EXAMPLE: INTERCITY TRAVEL

- Decision maker: an individual traveler.
- Choice: whether to travel between Boston and New York by air , high-speed rail, or auto.
- Goods: air, high-speed rail, auto.
- Utility function: U(X) = U (Air, HSR, Auto)
- Consumers maximize utility:
  - If U(Air) > U(HSR), U(Auto) → choose Air
  - If U(HSR) > U(Air), U(Auto) → choose ?
- What goes in U(X)?

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CONSTRUCTING THE UTILITY FUNCTION

- U(Air) = U (travel_time, access_time, cost, …)
- Assume linear (in the parameters)
  - U(Air)= β_1 * travel_time + β_2 * access_time + …
- Parameters represent tastes, which may vary over people
  - Include socio-economic characteristics (e.g. age, income)
  - U(Air) = β_1 * travel_time + β_2 * access_time + β_3 * (cost/income) + …

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EVALUATING FUTURE CHANGES

Given this framework:

- U(Air) > U(HSR), U(Auto) → choose Air
- U(HSR) > U(Air), U(Auto) → choose HSR
- U(Auto) > U(Air), U(HSR) → choose Auto

How might utility and choice change:

- If air fares go up?
- If cost of traveling by auto goes up?
- If congestion goes up?
- If high-speed rail travel time goes down?