Trip Generation

Destination Choice

Mode Choice

Route Choice

Professor
David Levinson
Objective of Mode Choice

- **AGGREGATE**: Estimate the number of trips from each zone to each zone by purpose that take mode m.
- **DISAGGREGATE**: Estimate the probability that a particular trip (purpose, time, zone–zone) by a specific individual will take mode m.
- Typically forecasters use a “discrete choice” model, that predicts distinct (or discrete or qualitative) choices (bus vs. car) rather than continuous ones (3.4 trips vs. 3.6).
- **Logit** is the most popular version of mode choice model.
The Pac-Man Theory of Mode Choice:
Drive Alone Eats All Other Modes
Insufficiently Formal
Daniel McFadden

• In addition to being my Econometrics Professor in grad school, University of Minnesota graduate Daniel McFadden won the Nobel Prize in Economics for developing the Logit model for transportation mode choice.
• In particular, his application of Logit to forecasting for the BART rail system in the San Francisco Bay Area was noted.
• [http://emlab.berkeley.edu/users/](http://emlab.berkeley.edu/users/)
The Logit Model

- $P_m$ - probability of taking mode $m$
- $U_{ijm}$ - Utility of mode $m$ between OD pair $ij$ for an individual (or a representative traveler)
- $U_{ijm} = f(C_{ij},...)$

$$P_m = \frac{e^{U_{ijm}}}{\sum_m e^{U_{ijm}}}$$

$s.t.$

$$\sum_m P_m = 1$$
Utility vs. Mode Share
(Binomial Logit)
What Affects Choice of Mode?
What Affects Choice of Mode?

- Travel Time of trip
- Travel time to access mode
- Wait Time \( f(\text{headways of transit vehicles}) \)
- Transfer Time
- Fare
- Parking Costs
- Tolls
- Alternative Specific Constant
- Other Qualitative Data (Sidewalks, Bus Shelters)
Relationship of Logit and Gravity

- The functional relationship between the modern gravity model (negative exponential form) and the logit mode choice model are very similar, enabling simultaneous choice models to be easily developed.
- The key difference is that the gravity model is typically much more aggregate.
Typical Model Structure

- Alternative Structures include Nests
- Advantages: Nests Allow Model to Capture Relationships between modes, skirt IIA property.
- Disadvantages: Increased computation, Marginal Improvement in Estimation

(WCT) walk connected transit
(ADT) auto connect transit (drive alone/park and ride)
(APT) auto connect transit (auto passenger/kiss and ride)
(AU1) auto driver (no passenger)
(AU2) auto 2 occupants
(AU3+) auto 3+ occupants
(WK/BK) walk/bike
Independence of Irrelevant Alternatives

• Property of Logit (but not all Discrete Choice models)
• If you add a mode, it will draw from present modes in proportion to their existing shares.
• Example: Suppose a mode were removed. Where would those travelers go. IIA says they will go to other modes in same proportion that other travelers are currently using them. However, if we eliminated Kiss and Ride, a disproportionate number may use Park and Ride or carpool. Nesting allows us to reduce this problem. However, there is an issue of the proper Nest.
• Other alternatives include more complex models (e.g. Mixed Logit) which are more difficult to estimate.
Example

You are given this mode choice model

\[ U_{ijm} = -0.412 \left( C_{\text{cents/w}} \right) - 0.0201 \times C_{\text{ivt}} - 0.0531 \times C_{\text{ovt}} - 0.89 \times D_1 - 1.78 \times D_3 - 2.15 \times D_4. \]

Where:
- \( C_{\text{cents/w}} \) = cost of mode (cents) / wage rate (in cents per minute)
- \( C_{\text{ivt}} \) = travel time in-vehicle (min)
- \( C_{\text{ovt}} \) = travel time out-of-vehicle (min)
- \( D \) = mode specific dummies:
  - \( D_1 \) = driving,
  - \( D_2 \) = bus with walk access, [base mode]
  - \( D_3 \) = bus with auto access,
  - \( D_4 \) = carpool
Solve for Probabilities of Modes

- ModeChoice.xls
Problem

You are given the following mode choice model.

\[ U_{ijm} = -1 \, C_{ijm} + 5 \, D_T \]

Where:

- \( C_{ijm} \) = travel cost between \( i \) and \( j \) by mode \( m \)
- \( D_T \) = dummy variable (alternative specific constant) for transit

A. Using a logit model, determine the probability of a traveler driving.

B. Using the results from the previous problem (#2), how many car trips will there be?
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<td>Fargo</td>
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Solution Steps

• Compute Utility for Each Mode for Each Cell
• Compute Exponentiated Utilities for Each Cell
• Sum Exponentiated Utilities
• Compute Probability for Each Mode for Each Cell
• Multiply Probability in Each Cell by Number of Trips in Each Cell
## Auto Utility

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## Transit Utility

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## Sum eUtility

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The choice of mode influences locational decisions
Questions ?
Abbreviations

- WCT - walk connected transit
- ADT - auto connect transit (drive alone/park and ride)
- APT - auto connect transit (auto passenger/kiss and ride)
- AU1 - auto driver (no passenger)
- AU2 - auto 2 occupants
- AU3+ - auto 3+ occupants
- WK/BK - walk/bike
- IIA - Independence of Irrelevant Alternatives
Key Terms

- Mode choice
- Logit
- Probability
- Independence of Irrelevant Alternatives (IIA)
- Dummy Variable (takes value of 1 or 0)
Variables

- $U_{ijm}$ - Utility of traveling from $i$ to $j$ by mode $m$
- $D_n$ - Dummy variable
- $P_m$ - Probability of mode $m$
- $c_{cents}$ = cost of mode (cents)
- $w$ = wage rate (in cents per minute)
- $c_{ivt}$ = travel time in-vehicle (min)
- $c_{ovt}$ = travel time out-of-vehicle (min)