Ridership Forecasting for High-Speed Rail
Data and Models within an Uncertainty Framework

presented to
Northwestern University

presented by
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Transportation leadership you can trust.
Established in 1972

Largest travel demand forecasting firm in the U.S.

Pioneered many advances in forecasting

Practical worldwide experience
  » 16 statewide and 30+ urban models
  » High-speed rail models in the U.S. and abroad
The Context of Travel Demand Modeling

- Support to the decision-making process
  - An objective approach
  - Understanding travel behavior
  - Measurement of potential benefits

- Factors affecting our work
  - Schedule and budget
  - Data availability and quality
  - Balance between theory and practicality

- Need to “tell a story”
Presentation Outline

- Modeling approaches
- Data
  - Travel surveys
  - Socioeconomics
  - Networks and levels of service
- Uncertainty and its sources
  - Uncertainty related to data
  - Real-world competitive responses
  - Relative importance in statistical models
  - Attractiveness of high-speed rail – a “new mode”
Models

Black Box or Crystal Ball?
The Black Box

Highway Network
Population and Employment
Land Use
Transit Network
Service and Pricing

Model System

Forecasts
Ridership Forecasts
Traffic Forecasts
**Questions**

- What is the market size?
- Where are trips attracted?
- What are key travel markets?
- How many trips by HSR?
- Where are rail trips distributed?
- Level of highway congestion?

**Model System**

**Components**

- Trip Generation
- Trip Distribution
- Market Segmentation
- Mode Choice
- Transit O-D Flows
- Highway Assignment
Model System
Structure and Complexity

- Balance between model theory and practicality

- Model structure
  - Sketch forecasts
  - Traditional “4-step” models
  - Disaggregate models of travel behavior

- Tradeoffs among
  - Model sophistication versus intensity of data needs
  - Cost and scheduling of data collection and development

- The need for transparency
  - Assumptions – inputs and model properties
Model System
A Choice Approach

No Trips
One Trip
Two-Plus Trips

Zone 1
Zone 2
Zone N-1
Zone N

Car
Rail
HSR
Air

Drive and Park
Drop Off
Rental Car

Taxi
Transit
Walk

Unpark and Drive
Picked Up
Rental Car

Taxi
Transit
Walk
Model Estimation
- Understanding of traveler behavior
- Analysis of policy-sensitive variables
- Development of statistical relationships (“models”)

Model Validation
- Base-year socioeconomics
- Base-year levels of service
- Base-year validation data as targets
- Adjustments to meet ridership and traffic targets

Forecasting: Application for the Future-year
### Model Estimation

<table>
<thead>
<tr>
<th>If you want to evaluate changes in:</th>
<th>You need to know the relative importance of:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running times</td>
<td>In-vehicle travel time</td>
</tr>
<tr>
<td>Station location</td>
<td>Walk time</td>
</tr>
<tr>
<td>Frequency of service</td>
<td>Schedule convenience</td>
</tr>
<tr>
<td>One ride versus multiple transfers</td>
<td>Number of transfers</td>
</tr>
<tr>
<td>Fare changes</td>
<td>Transit fares</td>
</tr>
<tr>
<td>Gasoline prices</td>
<td>Travel costs by auto</td>
</tr>
<tr>
<td>Terminal processing time</td>
<td>Wait time</td>
</tr>
<tr>
<td>On-board and terminal amenities</td>
<td>Lounge, wi-fi access, seating, etc.</td>
</tr>
</tbody>
</table>
Model Estimation
Relative Importance

Access | Wait | Travel | Egress

1:00

2:00

3:00

4:00

Actual travel time

Perceived travel time
Data
Data Sources

- **Travel Data**
  - Census Transportation Planning Package
  - Statewide Travel Survey (NHTS and NHTS add-on)

- **Air Passengers** - U.S. DOT, FAA 10% ticket sample

- **Rail Passengers** (rail providers and MPOs)

- **Highway Volumes** (State DOTs and MPOs)

- **Revealed and stated preference surveys**
Travel Surveys

- Urban area household surveys
- Statewide household travel survey
- Intercity passenger surveys
  - Revealed preference
  - Choice-based sampling
    - Air intercept
    - Rail intercept
    - Auto household
  - Stated preference
    - New mode
    - Choice exercises
## Stated Preference Survey

<table>
<thead>
<tr>
<th>TRAVEL BY CAR</th>
<th>TRAVEL BY AIR</th>
<th>TRAVEL BY HIGH SPEED RAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Travel to and from the airports is the same as you described earlier in the survey (questions 15 - 19)</td>
<td>Travel to and from the stations is the same as you described earlier in the survey (questions 20 - 27)</td>
</tr>
<tr>
<td></td>
<td>You should arrive at the airport at least <strong>1 hour</strong> before your flight.</td>
<td>You should arrive at the station at least <strong>10 min.</strong> before your train</td>
</tr>
<tr>
<td>You travel whenever you would like</td>
<td>There is a flight <strong>every 1 hour</strong></td>
<td>There is a train <strong>every 1 hour</strong></td>
</tr>
<tr>
<td>The typical travel time in the car is <strong>6 hrs 30 min.</strong> (not including stops for rest, food, etc.)</td>
<td>The scheduled travel time in the plane is <strong>1 hr 20 min.</strong></td>
<td>The scheduled travel time in the train is <strong>2 hrs 40 min.</strong></td>
</tr>
<tr>
<td><strong>50%</strong> chance of arriving within <strong>15 min.</strong> of the typical time</td>
<td><strong>80%</strong> of flights arrive within <strong>15 min.</strong> of schedule</td>
<td><strong>85%</strong> of trains arrive within <strong>5 min.</strong> of schedule</td>
</tr>
<tr>
<td>The roundtrip fuel cost is <strong>$70</strong></td>
<td>The roundtrip fare is <strong>$320</strong></td>
<td>The roundtrip fare is <strong>$140</strong></td>
</tr>
</tbody>
</table>

*Travel by Car  □  Travel by Air  □  Travel by High Speed Rail  □*
Uncertainty
Forecasting in the Base Year

Base Highway Network
Base Population and Employment
Base Land Use
Base Transit Network
Base Service and Pricing

Model System

Observed Ridership
Ridership Forecasts
Traffic Forecasts
Traffic Counts
Market Segments

- **Purpose**
  - Business (peak period)
  - Commute (peak period)
  - Recreation (off-peak period)
  - Other (off-peak period)

- **Distance range**
  - Short: Less than 100 miles
  - Long: Over 100 miles

- **Party size**
  - Traveling alone
  - Traveling with others

- **Household classifications**
  - Size
  - Income range
  - Auto ownership
  - Number of workers
Forecasting in 2035

- 2035 Highway Network
- 2035 Population and Employment
- 2035 Land Use
- 2035 Transit Network
- 2035 Service and Pricing

Model System

Ridership Forecasts
Traffic Forecasts
Recognizing Uncertainty

- Properties of the model
- Sensitivity to service frequency
- Acceptance of high speed rail
  - By market segment
  - By origin-destination market
- Evaluation of “what if” scenarios
Recognizing Uncertainty

- Demand for total travel
- Model sensitive to future year inputs
  - Macroeconomic trends
  - The impact of the great recession
- Growth assumptions
  - Traveler incomes
  - Population and employment
  - Are MPO growth forecasts reasonable?
- Evaluation of “what if” scenarios
Recognizing Uncertainty

- Competitive landscape
- Travel by auto
  - Gasoline costs
  - Highway level of service
- Competitive response by air carriers
  - Air fares
  - Frequency of air service
  - Competing vs. complementary service
- Evaluation of “what if” scenarios
Addressing Uncertainty

- Range of forecasts
- Estimates bounded by international experience
- Sensitivity runs to evaluate “what if” scenarios
- Downside risk and upside potential
  - Statement of assumptions
  - Discussion of range of outcomes
A Case Study

- An urban rail corridor evaluation
- Range of forecasts from two previous studies
  - 19,300 to 21,900 daily riders
  - 17,500 to 28,500 daily trips
- New study produced much lower estimates
- Sources of differences
  - Alignment?
  - Model platform?
  - Service characteristics?
  - Headways, fares, parking and land use
Summary

- Data as a strategic resource
- Range of modeling approaches
- Understanding the black box is critical
- Recognizing uncertainty
  - Properties of the model
  - Data and input assumptions
- Ranges to reflect “what if” scenarios