Travel Forecasting for New Starts

St. Louis, Missouri

September 19-20, 2007
1. Welcome

- Purpose
- Approach
- Participants
- Logistics
- Agenda
Purpose

- No surprises
  - For project sponsors
  - For New Starts travel forecasters
  - For FTA
Approach to Workshop

- **Goals**
  - Closure on most topics from Minneapolis
  - Discussion of ongoing issues
  - Comments/ideas from participants

- **Elements**
  - FTA presentations
  - Participant presentations – Thanks!
  - Summary of comments; website
Participants

- Affiliation
- Experience with New Starts forecasting
- Attendance at Minneapolis workshop
Logistics

- **Schedule**
  - Lunches provided
  - *Scheduled breaks* *(Phils at Cards, 7:10pm tonight)*
  - Schedule adherence

- **Facilities**
Agenda

- Activities since Minneapolis
- Travel models and New Starts
  - Properties of travel models
  - Data collection
  - Calibration and validation of models
  - Presentation and QC of forecasts
  - Lifting the user-benefits cap
  - CTPP-based forecasts
  - Applying alternative-specific effects
Agenda

- Uncertainties in forecasts
  - Uncertainties analysis
  - Before-and-after studies
  - Contractor performance tracking

- Continuing challenges
  - Representing transit choices
  - Making the case for a project
  - Evaluating economic-development benefits
New Starts Highlights

- SAFETEA-LU implementation
  - NPRM
  - Policy guidance
- Others
  - Discretionary AA funding
- NAS report
SAFETEA-LU Provisions for Ridership Forecasting

- **Before and After Study**
  - Required for FFGA & PCGA comparing forecasts with actual ridership

- **Before and After Study Report**
  - Required annually to Congress documenting results of B&A studies

- **Contractor Performance Report**
  - Required annually to Congress citing contractor forecasts
SAFETEA-LU Provisions for Ridership Forecasting

- Incentives awards
  - Allows more federal funding if actual ridership is at least 90% of forecast and cost no more than 110%
- Reliability as an evaluation criterion
Policy Guidance: Provisions for Ridership Forecasting

- Requires preservation of information for Before and After study as a condition for PE and FD entry, FFGA and two years after project opening
- For projects to enter PE or PD, requires travel models used to be validated against data sufficient to describe current travel conditions
- Allows project sponsors of new modes to receive user benefit credits beyond time and cost based on modal attributes
- Commits FTA to work with sponsors of projects with calibrated constants to ensure those constants are consistent with sponsors of new modes
Discretionary Alternatives Analysis Funding

- FTA solicited proposals for technical work supporting AA studies in 4 areas:
  - Collection of information on ridership patterns for validating travel models
  - Collection of data on transit service reliability for assessing benefits of fixed guideways
  - Development of simplified forecasting methods for Small Starts
  - Development of methods to address improved forecasts of highway user benefits resulting from transit projects
- $12m awarded in August
- Possible funding available in FY08 if earmarks less than $25m authorized
Other Programmatic Issues

- “Medium” rating of cost effectiveness required for Full Funding Grant Agreements more difficult for many projects
- Congressional and transit industry interest in economic development impacts of transit projects is proving difficult to address analytically
- New and Small Starts proposed rule requires more rigor for travel forecasts
2. Status Report

- Topics at the 2006 workshop
  - Project benefits
  - Quality control
  - Guidance topics
- Status report
- FTA staffing
**Project Benefits**

- **Additional transit attributes**
  - Policy guidance: alternative-specific effects
  - Session 9

- **Congestion relief**
  - Report to Congress: barriers → allowance
  - Departmental initiative?
  - Software updates by vendors
Project Benefits (cont’d)

- Variable trip tables
  - Barriers → allowance
  - Eclipsed by next topic
- Variable trip ends
  - Economic development
  - Session 15
Quality Control

- Predicted and actual ridership
  - Release of 2002 study
  - 2007 update underway → TRB session

- Data library

- CTPP-based aggregate model
  - Lots of applications
  - Session 8
Quality Control

- Semi-independent forecasts
  - NCTCOG testing
  - Further development

- Additional QC measures
  - Project contribution, IVT contribution
  - Session 6

- Summit – Version 0.992 still current
Quality Control (cont’d)

- Early service analysis of alternatives
- Dealing with uncertainties
  - Current emphasis
  - Session 10: conceptual direction
- Tracking accuracy of forecasts
  - Reports to Congress underway
  - Session 12: concept direction
Guidance Topics

- Properties of travel models: Session 3
- Calibration and validation: Session 5
- Rider surveys: Session 4
- Before-and-after studies: Session 11
FTA Staffing

- Hires since the Minneapolis workshop
  - Stephanie McVey
  - Nazrul Islam
  - Ken Cervenka

- Emphasis areas
  - Technical assistance and guidance
  - Project reviews
  - Research: contract mgmt.; in-house
3. Properties of Models

- FTA requirements for New Starts
- Implications
- Frequently made FTA comments
FTA Requirements

- Approach to New Starts forecasting
  - Local models
  - Locally prepared forecasts

- Compelling reasons for this approach
  - Absence of standard, “correct” methods
  - Conditions unique to individual metro areas
  - Responsiveness to local decision-making
FTA Requirements

- Models used for New Starts must:
  1. Grasp the current (transit) situation
     - Calibrated (FTA definition, Session 5)
     - Validated (FTA definition, Session 5)
  2. Provide plausible forecasts for alternatives
     - Deltas that make sense
     - Guideway volumes unlikely to embarrass
FTA Requirements (cont’d)

- Models used for New Starts must:
  3. Adequately support “making the case”
     - Primary causes of changes and benefits
     - Main effects on principal markets
  4. Quantify FTA evaluation measures
     - Mobility benefits for all travelers
     - Mobility benefits for “transit dependents”
     - Forecasting conventions for New Starts
Implications

- Inadequacy of traditional:
  - Model testing
  - Reporting
  - QC

- But, nothing has to be perfect
  - Adequacy defined by “no show-stoppers”
  - Range of acceptable approaches
Acceptable Approaches

- Traditional trip-based aggregate models
- Tour-based enumerated models
- Incremental versions of model sets
- Simplified models
- Calculations of travel-time savings

*So long as they meet requirements #1-#4*
Implications

- Technical
  - User-benefits (or time savings) capabilities
  - Plausible mode-choice parameters
    - Coefficients (particularly ratios to $C_{ivt}$)
    - Constants
  - Fixed-trip-table capabilities
  - Fixed-highway-times, perhaps
Implications

- **Strategic**
  - Early FTA review of models
    - Documentation
      - Specifications
      - Calibration results
      - Validation tests
    - Useful to identify likely problems
    - Not conclusive, because proof is in the forecasts
Frequently Made Comments

- Insufficient data
  - Transit travel patterns
  - Highway speeds
- Calibration errors
  - Unrealistic markets for discrete choices
  - Over-specification of constants
  - Overly tight closure on target values
Frequently Made Comments

- Supply-side forecasting problems
  - Unrealistically low highway speeds
  - Unfaithful station coding
- Demand-side forecasting problems
  - Unrealistic access-mode shares
  - Benefits unrelated to the project
Bottom Line

- Models
  - Good models required
  - Fancy models (that work) optional

- Good models
  - Known by their forecasts
  - Forecasts that are coherent, not perfect
Bottom Line

- Keys to success in New Starts forecasting
  - Useful calibration and validation of models
  - Analytical reporting of forecasts
  - Routine and rigorous QC of forecasts
  - Development and communication of insights into the performance and benefits of the alternatives ultimately, the project
4. Data Collection

- FTA requirements for New Starts
- Implications
- Thoughts on good practice
- Three presentations
FTA Requirements

- Transit rider data for model testing
  - For forecasts supporting PE applications
  - Transit travel patterns
  - “Current”

- Rider data for Before-and-After studies
  - Before and 2 years after project opening
  - Part of the project scope → funding
  - FTA approval of plan = condition for $$$
Implications

- Model testing with ridership patterns
  - System-wide data
  - Necessary data items for comparisons
  - Controlled sample $\rightarrow$ representative data

- “Current” ridership
  - Usefulness of older datasets depends on:
    - Rate of growth in the metropolitan area
    - Any major changes to the transit system
    - Any substantial change in transit ridership
  - Older datasets $\rightarrow$ updates with counts?
Implications

- **B-A evaluation of forecast accuracy**
  - Corridor specific data, but system-wide OK
  - Necessary data items for comparisons
  - Controlled samples \(\rightarrow\) meaningful B-A \(\Delta\)'s
Thoughts on Good Practice

- Rider surveys
  - Sampling plan
  - Questionnaire design
  - Data items
Rider Surveys

- Sampling plan
  - Designed with transit markets in mind
  - Sample allocation
  - Survey methods
  - Non-response biases
  - Count data for sample expansion
Rider Surveys

Markets Example

Urban and suburban residential areas

Entertainment district

Central Business District

Rail line

Afternoon west-bound rail markets:
- Within-CBD trips
- CBD-to-residence low-income workers
- CBD-to-residence high-income workers
- CBD-to-entertainment trips
Rider Surveys

- Response rates by market
  - CBD-CBD - low?
  - CBD-entertainment - low?
  - CBD-home-low-income - moderate?
  - CBD-home-high-income - high?

- Implications for uniform expansion
  - Too few: non-work trips; bus transfers
  - Too many: work trips; park-ride cars

- Better: counts? additional survey methods?
Rider Surveys

- Questionnaire design
  - Layout, readability, and wording
  - Avoidance of round-trip reporting
- Instructions
- Example: HOME → bus → train → WORK
- O→D transit paths
  - Questions: first line, next line, next line
  - Chart:
    - 1st
    - 2nd
    - 3rd
    - 4th
Rider Surveys

- Data items
  - Trip origin and destination
  - Purposes at origin and destination
  - Access and egress modes
  - Transit path
  - Rider characteristics
## Rider Surveys

### Trip characteristics

<table>
<thead>
<tr>
<th>Items</th>
<th>Comments</th>
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<tbody>
<tr>
<td>O and D purposes</td>
<td>Required</td>
</tr>
<tr>
<td>O and D locations</td>
<td>Required</td>
</tr>
<tr>
<td>O and D access modes</td>
<td>Required</td>
</tr>
<tr>
<td>Park-ride location</td>
<td>Required</td>
</tr>
<tr>
<td>All routes in O-D path</td>
<td>Required</td>
</tr>
<tr>
<td>Xfer from, Xfer to</td>
<td>Redundant; useful for path checking?</td>
</tr>
<tr>
<td>Number of Xfers</td>
<td>Redundant; useful for path checking?</td>
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<tr>
<td>O-on and D-off locations</td>
<td>Desirable, but adds complexity, length</td>
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<tr>
<td>Fare paid / method</td>
<td>Desirable, but adds length</td>
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</table>
## Rider Surveys

### Traveler characteristics

<table>
<thead>
<tr>
<th>Items</th>
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<tbody>
<tr>
<td>Driver’s license</td>
<td>Required</td>
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<td>Age</td>
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<td>Disabilities</td>
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<tr>
<td>Household drivers</td>
<td>Required</td>
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<td>Household workers</td>
<td></td>
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<td>Household adults</td>
<td></td>
</tr>
<tr>
<td>Household persons</td>
<td>Marginally useful</td>
</tr>
<tr>
<td>Household vehicles</td>
<td>Required</td>
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<tr>
<td>Household income</td>
<td>Necessary if used in mode choice model</td>
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## Rider Surveys

### Other data items

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<th>Comments</th>
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<td>Options if no transit</td>
<td>?</td>
<td>Best for “captivity”</td>
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<tr>
<td>Vehicle available for trip</td>
<td>N</td>
<td>Ambiguous</td>
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<tr>
<td>Path attribute weights</td>
<td>?</td>
<td>May inform pathbuilder calibration</td>
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<tr>
<td>Previous behavior</td>
<td>y</td>
<td>Useful in Before-After studies</td>
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<tr>
<td>Customer satisfaction</td>
<td>?</td>
<td>Length/responsiveness/funding</td>
</tr>
<tr>
<td>Open-ended comment</td>
<td>?</td>
<td>Responsiveness</td>
</tr>
<tr>
<td>Contact information</td>
<td>?</td>
<td>Call-backs for QC checks; responsiveness</td>
</tr>
</tbody>
</table>
Other Data Collection

- Traditional
  - Ride-checks: ons and offs
  - Counts of park-ride lot utilization

- Automated
  - Passenger counters
  - Vehicle locators
Rider Data - Research

- Oklahoma State University
  - FTA funding
  - Tests of rider-data collection methods
    - Questionnaire design and content
    - Ancillary data collection
  - FTA anticipating working relationships between OSU and grantees receiving discretionary AA funding for data collection
Three Presentations

- Fielding the Survey
  - Dr. Johanna Zmud, NuStats

- Intercept Surveys
  - Franco S. Saraceno, Gannett Fleming

- Survey Expansion Weights Computed with Matrix Balancing
  - Robert Farley, LACMTA
Fielding the Survey:
The Entrepreneurial Mind

Dr. Johanna Zmud
NuStats
Overview of Presentation

- Key challenges
- Contextual factors
- Strategic issues
- Tactical solutions
- Overall driver
- Conclusions
Key Challenges

- **Survey timeframe:** short
- **Surveyors**
  - Number: having enough
  - Quality: competency, communications
  - Characteristics: match riders
  - Churn: enthusiasm, motivation
- **Riding public:** interest, literacy, time
Contextual Factors

- Unemployment rate
- Cost of living
- Size of system
- Characteristics of riders
- Service types
- Equipment features
Definitions

- **Strategic**
  - Big picture, anticipate issues, have smart alternatives

- **Tactical**
  - Getting the job done
Strategic Issues

- Optimizing time in field
  - Balance sample, system complexity, size of field staff

- Having experienced field managers
  - Ascertain in-house versus outsourced talent

- Culling the field staff
  - Trade-off quality for quantity; quality for schedule
  - Subcontracting to local field service

- Motivating field staff
  - Determine cost versus benefit of incentives
  - Decide incentive focus - longevity versus production
Tactical Solutions

- **Timeframes**
  - Communicate implications of short schedules

- **Numbers**
  - Multiple temporary agencies
  - Having an account manager
  - Have back-up: Local field service; Craig’s List

- **Quality**
  - Provide detailed job description to temp agency
  - Screen prior to training session
Tactical Solutions (cont)

- Characteristics
  - Seek special skills (e.g., language) elsewhere

- Churn
  - Training
  - Good management

- Riding public
  - Questionnaire design
  - Market survey

- Incentives
- Match surveyors
The Driver of Survey Quality

- Real-Time Information System
  - Continuous processing of data
  - Automatic devices
  - Web-accessible
  - Report templates
  - Distribution channels
Conclusions

- **Staffing the survey linked to:**
  - Context: economic, population, system
  - Client flexibility: schedule, cost

- **Meeting challenges depends on:**
  - Experience
  - Planning
  - Creativity
  - Trial and error

- **Real-time information system = key to quality**
Intercept Surveys:
City of Miami Transit Circulators

Franco S. Saraceno
Gannett Fleming
Background on Project

- **Travel market analysis**
  - Distribution of external trips (external to study area)
  - Circulation of intra-study area trips

- **Model validation**
  - Update factors/targets
  - Calibrate mode choice model
Transit Surveys

- Surveyed Transit Modes
  - Metromover
  - Metrobus
Survey Design

- Nature of Study
  - Systems planning
  - Corridor analysis

- Accurate / Inaccurate Data
  - No English
  - No Spanish
  - No Creole
### On-Board Transit Surveys

#### Tell us how your trip began:
1. At what time did you leave to get to the final bus stop used for this trip? __________ AM / PM
2. Where did you begin this trip? (check only one)
   - Home
   - Recreational Facility
   - Work
   - Shopping
   - School/College
   - Other (specify): _____
3. How did you get from the place where you started this trip to the final bus stop you used? __________ minutes

#### Tell us where you are going:
4. Where are you going? (check only one)
   - Home
   - Recreational Facility
   - Work
   - Shopping
   - School/College
   - Other (specify): _____
5. What is the name of the place where you are going? (store name, home, employer, etc.)
6. How long will it take to get from the bus stop where you are going? __________ minutes
7. How many buses are required to get from where your trip began to where you are going (including this bus)? 1 __________
8. List route numbers of the buses required to get from where your trip began to where you are going: _____

#### Tell us about where you are going:
9. What is the name of the street or nearest intersection of both streets where you are going? (store name, home, employer, etc.)
10. How will you get from your last bus stop to where you are going? __________ minutes

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### On-Board Transit Surveys

#### Tell us how your trip began:

1. At what time did you leave to get to the first bus stop used for this trip? 7:38 AM/PM

2. Where did you begin this trip? (check only one):
   - [ ] Home
   - [ ] Recreational Facility
   - [ ] Work
   - [ ] Friend's or Relative's House
   - [ ] Shopping
   - [ ] School/College
   - [ ] Other (specify):

3. How did you get from the place where you started this trip to the first bus stop you used?

#### Tell us about where you are going:

4. Where are you going? (check only one):
   - [ ] Home
   - [ ] Recreational Facility
   - [ ] Work
   - [ ] Friend's or Relative's House
   - [ ] Shopping
   - [ ] School/College
   - [ ] Other (specify):

5. What is the Street Address or Nearest Intersection (both streets) of the place where you are going?
   - [ ] Inverness Drive and Inverness Blvd.
   - [ ] City/Town: Landerhill ZIP Code: 33

6. What is the name of this place? (store name, home, employer, etc.):
   - [ ] International Village

#### Tell us how your trip began:

2. Where did you begin this trip? (check only one):
   - [ ] Home
   - [ ] Recreational Facility
   - [ ] Work
   - [ ] Friend's or Relative's House
   - [ ] Shopping
   - [ ] School/College
   - [ ] Other (specify):

3. How did you get from the place where you started this trip to the first bus stop you used?

4. What is the Street Address or Nearest Intersection (both streets) of the place where your trip began?
   - [ ] 29th NW Ave.
   - [ ] City/Town: Miramar ZIP Code: 33

5. What is the name of this place? (store name, home, employer, etc.):
   - [ ] From Wynwood to Coral Gables

6. How long will it take to get from the bus stop to where you are going? 40 minutes

7. How many buses are required to get from where your trip began to where you are going (including this bus)? 1

8. List route numbers of the buses required to get from where your trip began to where you are going: 62, 77, 10

9. How long did it take to get from where you began this trip to the first bus stop you used? 25 minutes
On-Board Transit Surveys

What is the Street Address or Nearest Intersection (both streets) of the place where you are going? [163]

City/Town: ____________ ZIP Code: ____________

What is the name of the place where you are going? (store name, home, employer, etc.)

What is the Street Address or Nearest Intersection (both streets) of the place where you are going?

City/Town: ____________ ZIP Code: ____________

What is the name of the place where you are going? (store name, home, employer, etc.) [Hospital]

5. How will you get from your last bus stop to where you are going? [Walk]
On-Board Transit Surveys
Methodology Comparisons

- **Self Administered**
  - Temps
  - More questions
  - Greater distribution
  - Questionable accuracy
  - Interpretation challenges

- **Intercept/interviews**
  - Professionals
  - Limited # of questions
  - Less samples
  - More usable data
  - Easier for data entry
Metromover Survey - Methodology

- 2 Teams of 2 surveyors
  - 3 Days
- Routes surveyed
  - Inner Loop
  - Omni Loop
  - Brickell Loop
- Survey period
  - 7 AM to 6 PM
# Metromover Survey - Instrument

The City of Miami is conducting a survey to help improve transportation in Miami.

1. At which station did you get on the Metromover?
   - Financial District
   - Brickell
   - Twelfth Street / Promenade
   - Eighth Street
   - Fifth Street
   - Bikeway
   - Knight Center
   - School Board
   - College North
   - College / Bayside
   - Freedom Tower
   - Government Center
   - Miami Avenue
   - Third Street

2. How did you get to that station?
   - Walked
   - Biked
   - Metromover
   - Metrobus
   - Metrorail
   - Other

3. Where did you begin this trip?
   - Home
   - Shopping
   - Friends or Relative's Home
   - Personal Business (doctor, errands, etc.)
   - Hotel / Motel
   - Work Related (meetings, etc.)
   - Recreational Facility
   - School / College
   - Meal (Lunch, Snack, etc.)
   - Other

4. Where will you exit the Metromover?
   - Financial District
   - Brickell
   - Twelfth Street / Promenade
   - Eighth Street
   - Fifth Street
   - Bikeway
   - Knight Center
   - School Board
   - College North
   - College / Bayside
   - Freedom Tower
   - Government Center
   - Miami Avenue
   - Third Street

5. Where are you going once you exit the Metromover?
   - Home
   - Shopping
   - Friends or Relative's Home
   - Personal Business (doctor, errands, etc.)
   - Hotel / Motel
   - Work Related (meetings, etc.)
   - Recreational Facility
   - School / College
   - Meal (Lunch, Snack, etc.)
   - Other

6. How will you get there after you exit the Metromover?
   - Walk
   - Bike
   - Metromover
   - Metrobus
   - Metrorail
   - Other

7. How often do you ride the Metromover?
   - # of Days per Week
   - # of Days per Month
   - # of Days per Year
   - First Time Rider
   - Other

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Results - Response Rates

- Recent self-administered survey: 45%
- Metromover intercept survey: 70%

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<th>Question</th>
<th>Self-Administered Methodology</th>
<th>Intercept Methodology</th>
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<tbody>
<tr>
<td></td>
<td>Riders Contacted</td>
<td>Riders Responding</td>
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<tr>
<td>Origin Purpose</td>
<td>17,366</td>
<td>7,780</td>
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<tr>
<td>Origin Location</td>
<td>17,366</td>
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<tr>
<td>Access Mode</td>
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<td>Destination Purpose</td>
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<td>Destination Location</td>
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<tr>
<td>Egress Mode</td>
<td>17,366</td>
<td>7,780</td>
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</table>
Results - Accuracy

<table>
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<tr>
<th>Question</th>
<th>Self-Administered Methodology</th>
<th>Intercept Methodology</th>
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<tbody>
<tr>
<td>Origin Purpose</td>
<td>91%</td>
<td>99%</td>
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<tr>
<td>Origin Location</td>
<td>56%</td>
<td>Not Available</td>
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<tr>
<td>Access Mode</td>
<td>90%</td>
<td>99%</td>
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<tr>
<td>Destination Purpose</td>
<td>90%</td>
<td>99%</td>
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<tr>
<td>Destination Location</td>
<td>43%</td>
<td>Not Available</td>
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<tr>
<td>Egress Mode</td>
<td>76%</td>
<td>98%</td>
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- **Useable-data rates**
  - Vary by question
  - Overall better with intercept survey
Considerations

- Hybrid of methodologies
- Short form / long form
- Study area
- Transit modes
Survey Expansion Weights
Computed with Matrix Balancing

Robert Farley
LACMTA
October 2007
Travel Forecasting for New Starts

LA County
Fixed-Guideway Transit System
Background

- “Customer Satisfaction” Rail On-Board Survey
  - Included station-on and station-off
  - Never expanded to station volumes
- Boarding/alighting counts available
- Proof of concept
  - Test bed for Fratar code development
Approach

- “Balance” survey returns by Station OD
- Seed matrix
  - Volumes from unexpanded survey
  - Missing cells set to 0.1
- O & D targets from ride check surveys
- Resultant table provides weights
  - Ratio of balanced volumes to seed volumes gives weights
Results

- Compare to flat expansion and expansion by boardings
  - More short trips, fewer long trips
- Findings are consistent with expected “time pressure” bias hypothesis
- Demographic profile relatively unchanged
  - Very modest income effect
## Metro Blue Line Statistics
(South Bound Trips)

<table>
<thead>
<tr>
<th>Types of Sample Expansion Methods</th>
<th>Number of Station Traveled</th>
<th>Passenger-Miles per Boarding</th>
<th>Passenger-Minute per Boarding</th>
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<tbody>
<tr>
<td>By Boardings of Entire Line</td>
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<td>Mean</td>
<td>9.1</td>
<td>10.4</td>
<td>22.5</td>
</tr>
<tr>
<td>Std.Dev</td>
<td>4.8</td>
<td>5.8</td>
<td>12.8</td>
</tr>
<tr>
<td>By Boarding at Stations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>8.2</td>
<td>9.5</td>
<td>20.4</td>
</tr>
<tr>
<td>Std.Dev</td>
<td>4.8</td>
<td>5.8</td>
<td>12.9</td>
</tr>
<tr>
<td>By Boarding and Alighting at</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>6.3</td>
<td>7.1</td>
<td>15.0</td>
</tr>
<tr>
<td>Std.Dev</td>
<td>3.9</td>
<td>4.8</td>
<td>10.0</td>
</tr>
</tbody>
</table>
### Demographics (Northbound + Southbound)

#### Frequency of Transit Usage

<table>
<thead>
<tr>
<th>Frequency</th>
<th>&quot;Flat&quot; Weight</th>
<th>&quot;Origin&quot; Weight</th>
<th>&quot;Balanced&quot; Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Valid %</td>
<td>Frequency</td>
</tr>
<tr>
<td>&lt; once mo</td>
<td>1,521</td>
<td>2.1%</td>
<td>1,330</td>
</tr>
<tr>
<td>&lt; once wk</td>
<td>1,798</td>
<td>2.4%</td>
<td>1,630</td>
</tr>
<tr>
<td>1-2 days wk</td>
<td>5,776</td>
<td>7.8%</td>
<td>5,318</td>
</tr>
<tr>
<td>3-4 days wk</td>
<td>10,790</td>
<td>14.6%</td>
<td>11,456</td>
</tr>
<tr>
<td>&gt;=5 days wk</td>
<td>51,989</td>
<td>70.4%</td>
<td>51,668</td>
</tr>
<tr>
<td>first time</td>
<td>741</td>
<td>1.0%</td>
<td>719</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>73,822</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>73,301</strong></td>
</tr>
</tbody>
</table>

#### Ethnicity

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>&quot;Flat&quot; Weight</th>
<th>&quot;Origin&quot; Weight</th>
<th>&quot;Balanced&quot; Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Valid %</td>
<td>Frequency</td>
</tr>
<tr>
<td>latino/hisp</td>
<td>30,943</td>
<td>41.9%</td>
<td>33,173</td>
</tr>
<tr>
<td>black/afram</td>
<td>22,753</td>
<td>30.8%</td>
<td>21,953</td>
</tr>
<tr>
<td>white/cauc</td>
<td>10,531</td>
<td>14.3%</td>
<td>9,255</td>
</tr>
<tr>
<td>asian/pacisl</td>
<td>5,014</td>
<td>6.8%</td>
<td>4,718</td>
</tr>
<tr>
<td>am indian</td>
<td>740</td>
<td>1.0%</td>
<td>636</td>
</tr>
<tr>
<td>mul-rac,mul-eth</td>
<td>454</td>
<td>0.6%</td>
<td>406</td>
</tr>
<tr>
<td>other</td>
<td>1,179</td>
<td>1.6%</td>
<td>1,053</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>73,822</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>73,301</strong></td>
</tr>
</tbody>
</table>

#### Annual HH Income

<table>
<thead>
<tr>
<th>Income Range</th>
<th>&quot;Flat&quot; Weight</th>
<th>&quot;Origin&quot; Weight</th>
<th>&quot;Balanced&quot; Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Valid %</td>
<td>Frequency</td>
</tr>
<tr>
<td>&lt;$7,500</td>
<td>16,906</td>
<td>22.9%</td>
<td>18,022</td>
</tr>
<tr>
<td>$7,500-14,999</td>
<td>13,942</td>
<td>18.9%</td>
<td>14,141</td>
</tr>
<tr>
<td>$15,000-24,999</td>
<td>12,244</td>
<td>16.6%</td>
<td>12,580</td>
</tr>
<tr>
<td>$25,000-34,999</td>
<td>6,533</td>
<td>8.8%</td>
<td>6,185</td>
</tr>
<tr>
<td>$35,000-49,999</td>
<td>6,543</td>
<td>8.9%</td>
<td>5,815</td>
</tr>
<tr>
<td>&gt;=$50,000</td>
<td>10,361</td>
<td>14.0%</td>
<td>8,828</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>73,822</strong></td>
<td><strong>100.0%</strong></td>
<td><strong>73,301</strong></td>
</tr>
</tbody>
</table>

Income shows slight impact in highest category.
Comparison of histograms
Cumulative: Blue Line - SB

# Trips

# Stations Traversed

Flat Os Os & Ds
Conclusions

- Approach for future on-board surveys?
- Resource requirements
  - Quality On/Off control totals by line
  - Base survey complete enough to fill “most” cells in trip table
  - Survey cleaning {directionality}
  - Formatting/processing for Fratar program
- Bus surveys are more challenging
  - Typically many more stops per route