Using Mobile Phone Location Data to Develop External Trip Models

A Case Study for the French Broad River Metropolitan Planning Organization

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Outline

- Study Motivation
- Literature Review
- Overview of Data
- Data Processing and Reasonableness Checking
- Through Trip Development
- IE/EI Model Estimation
- Summary and Conclusions

Study Motivation

Literature Review

Mobile Phone Data	• US 1 Corridor Study, NC • Average trip patterns, AL • Special Events, CA • Long Distance Travel, AZ
External Trip Models	• Significant component of travel • Roadside or license plate surveys • Synthetic methods • Mobile data low cost alternative

Data Collection

- Study Area:
- French Broad River MPO, NC (FBRMPO)
- Study Period: Month of May, 2013 (weekdays)
- Data Provider: AirSage, Inc.
- Study Funded by NCDOT

Data Format

- 11 External Zones
  - Trip ends outside these zones are mapped to nearest
- 139 Internal Zones
  - Aggregations of model zones
- OD Data:
  - OD Zone Pair
  - Resident vs Visitor
  - Synthesized Trip Purpose
    - HBW
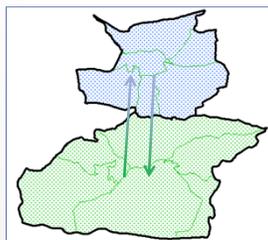   - HBO
    - NHB
  - Time of Day
- Expanded Trip Count

| Origin_Zone	Destination_Zone	Start_Date	End_Date	Aggregation	Subscriber_Class	Purpose	Time_of_Day	Count
56	7	20130501	20130530	WD	Visitor	NHB	H00:H24	2.01
131	91	20130501	20130530	WD	Resident	HBO	H00:H24	13.54
73	56	20130501	20130530	WD	Resident	HBO	H00:H24	1.61
144	34	20130501	20130530	WD	Visitor	NHB	H00:H24	14.92
61	72	20130501	20130530	WD	Resident	NHB	H00:H24	18.38
71	76	20130501	20130530	WD	Resident	NHB	H00:H24	31.26
52	76	20130501	20130530	WD	Resident	NHB	H00:H24	7.7
63	148	20130501	20130530	WD	Resident	HBO	H00:H24	10

Data Processing

- Data provided in user specified districts
- Internal trip ends disaggregated to model TAZs
- External trip ends disaggregated to external stations

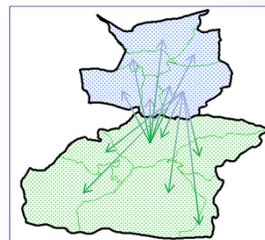**District to District**   **Zone to Zone**
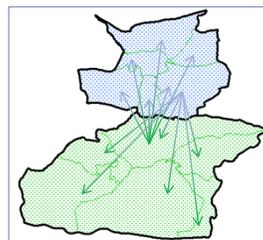
Internal Trip Disaggregation

- Activity index
  - The distribution of population and employment among a district's TAZs determined the trip distribution

$$Activity\ Index = Population + Employment * \frac{Reg.Pop}{Reg.Emp}$$

- The ratios were applied twice
  - First to disaggregate a district's destinations
  - Second for the origins

External Trip Disaggregation

- Average-Weekday Daily Travel (AWDT)

Sub-District	Node ID	Facility Type	AWDT	Total AWDT in Sub-District	% of AWDT in Sub-District
146	644	Major Thoroughfare	7,848	48,918	16.04%
146	645	Expressway	40,528	48,918	82.85%
146	656	Minor Thoroughfare	542	48,918	1.11%

Initial Condition   Step 1   Step 3
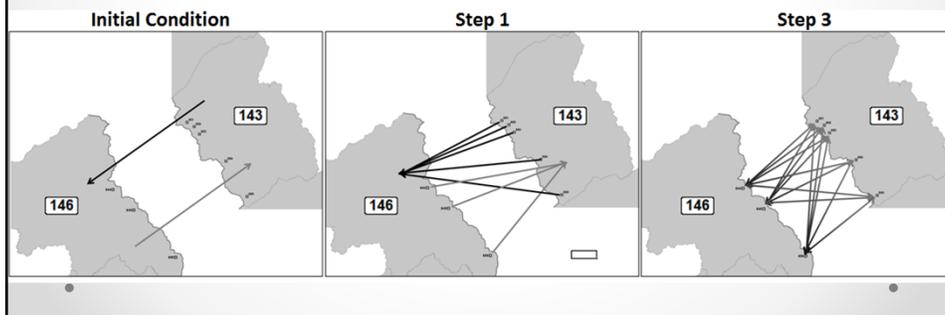
Reasonableness Checking

Trips by Trip Purpose		
	Mobile Percent by Purpose	HHS Percent by Purpose
HBW	13%	16%
HBO	52%	49%
NHB	35%	35%
Trips by Time Period		
	Mobile Percent Trips	HHS Percent Trips
AM	14%	16%
PM	18%	23%
Off Peak	68%	61%
Trips by Resident Status		
	Mobile Trips	Mobile Percent by Resident Status
Resident	951,204	34%
Non-Res	1,882,722	66%

Through Trip Development

	US 19	US 23	US 64	I-40	SR 1407	....
US 19			38	157	2	5
US 23			180	736	6	24
US 64	38	180				
I-40	157	736				
SR 1407	2	6				
...	5	24				
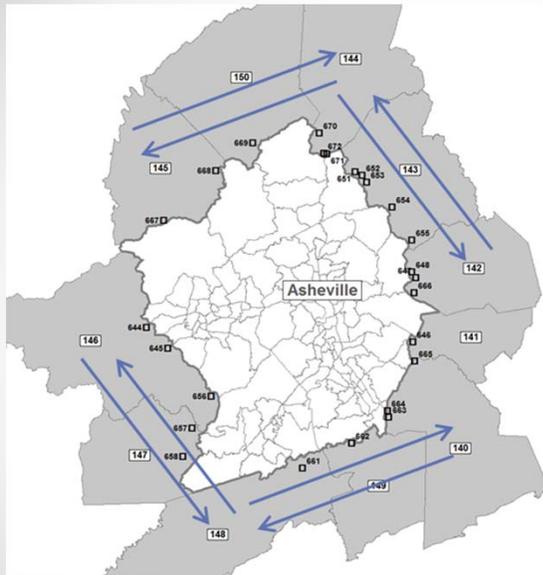
Through Trip Tables: The Adjacency Problem

- The mobile survey included trips between adjacent, external stations
- These are real trips, but do not interact (for the most part) with the model region

Removing Adjacent Trips

- Trips between adjacent zones were removed
- Each cell describes the percent of trips to keep
- Adjacent trips with no potential for interaction with model region were zeroed out

	140	141	142	143	144	145	146	147	148	149	150
140	0	0	100	100	100	100	100	100	100	0	100
141	0	0	0	100	100	100	100	100	100	100	100
142	100	0	0	0	100	100	100	100	100	100	100
143	100	100	0	0	20	100	100	100	100	100	100
144	100	100	100	20	0	50	100	100	100	100	0
145	100	100	100	100	50	0	70	100	100	100	100
146	100	100	100	100	100	70	0	0	100	100	100
147	100	100	100	100	100	100	0	0	0	100	100
148	100	100	100	100	100	100	100	0	0	0	100
149	0	100	100	100	100	100	100	100	0	0	100
150	100	100	100	100	0	100	100	100	100	100	0

IE/EI Model Estimation

- Simplifying assumption:
  o Productions made at external stations
  o Attractions at the TAZs

$$Attractions = 0 + \beta_1 HH + \beta_2 Ind + \beta_3 Ret + \beta_4 Off + \beta_5 Ser + \beta_6 HTRet$$

Initial Estimation Results

Variable	Est Coefficient	t-value
HH	0.24	4.49
Ind	0.32	1.94
Off	0.54	2.21
Ser	0.03	0.37
Ret	0.48	1.45
HTRet	0.04	0.10
R-squared	0.55	

Final Attraction Model Results

$$Attractions = 0 + \beta_1 HH + \beta_2 Ind + \beta_3 NonInd$$

Variable	Est Coefficient	t-value	1997 TRM Est Coefficient	NCSAM Est Coefficient
HH	0.24	4.41	0.25	0.33
Ind	0.37	2.38	0.06	0.34
NonInd	0.18	3.06	0.27	NA
R-squared	0.53			

Trip Distribution: Standard Gravity Model with OBS trip length from mobile data

$$T_{ij} = P_i * \frac{A_j * F_{ij} * K_{ij}}{\sum\limits_{k=1}^{zones}(A_k * F_{ik} * K_{ik})}$$

Coefficients:

a = 1.069

b = -0.400

c = 0.-67

Average Travel Time:

OBS = 30.4 mins

EST = 30.0 mins

%Diff = -1.23%

Summary and Conclusions

- Purpose:
  - Evaluate the usefulness of mobile phone data in the development of external trip model

- Results:
  - Methodology for processing and checking the data
  - Through trip table development including tips and traps
  - Estimated IE/EI model and demonstrated reasonable results

- Supports mobile phone data as a low cost approach for external trip models

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Questions?

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Leta F Huntsinger: huntsinger@pbworld.com
D. Kyle Ward: warddk@pbworld.com