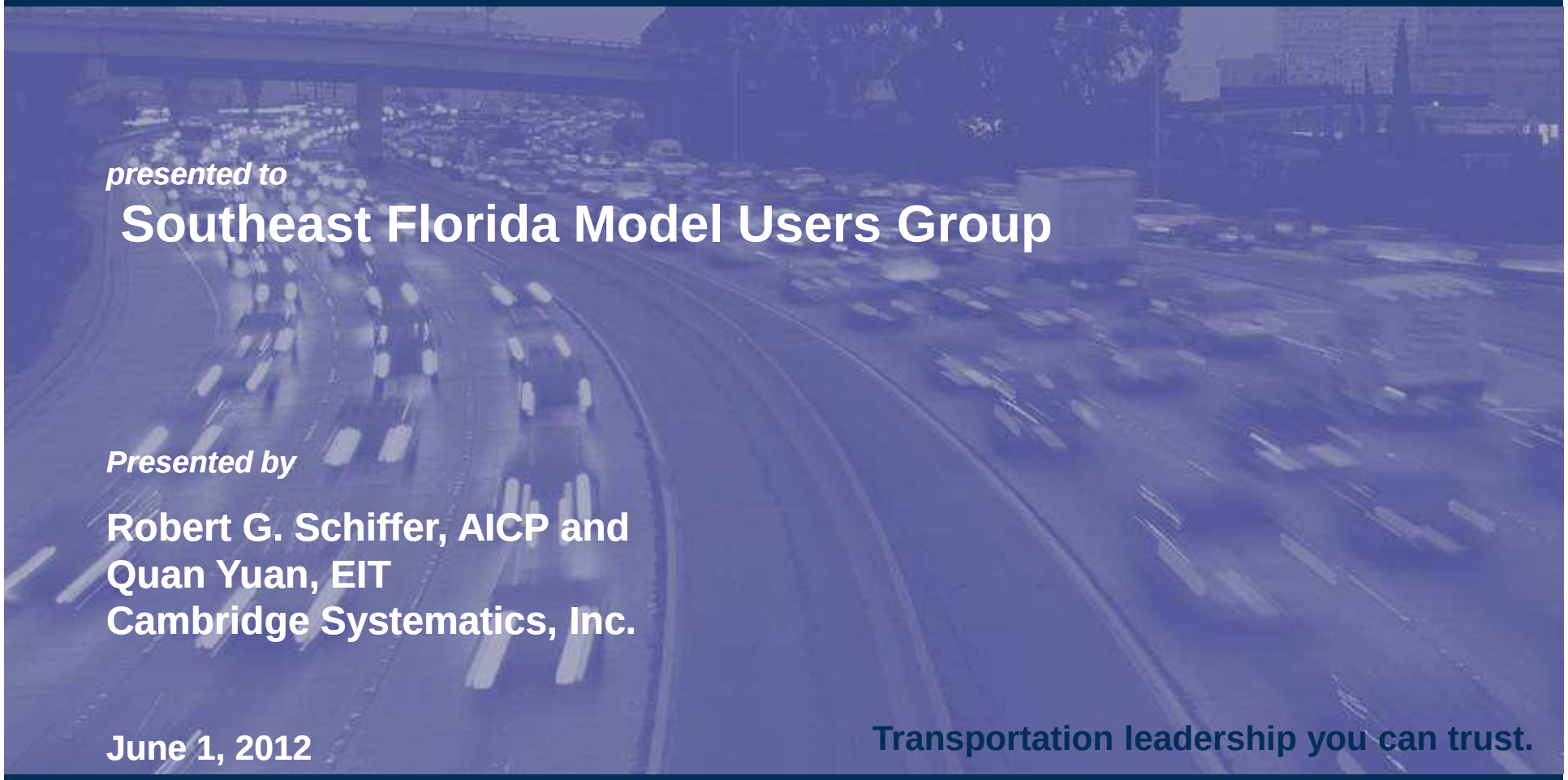
Transferable Model Parameters: NCHRP 8-61 and NCHRP 8-84



presented to

Southeast Florida Model Users Group

Presented by

Robert G. Schiffer, AICP and
Quan Yuan, EIT
Cambridge Systematics, Inc.

June 1, 2012

Transportation leadership you can trust.

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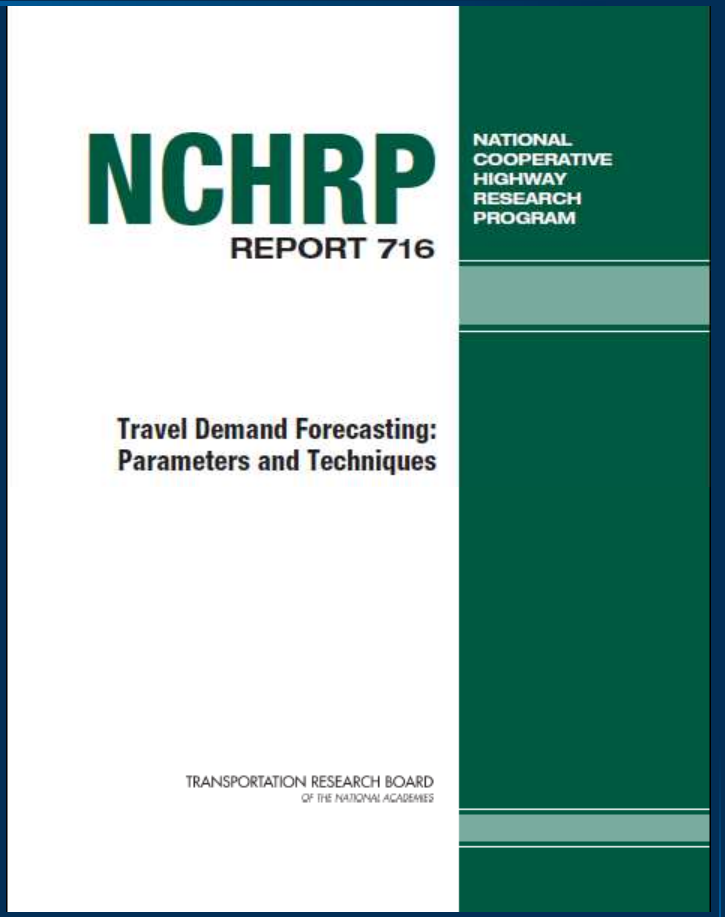
Presentation Outline

- Overview of Projects
- NCHRP 8-61/Report 716, Urban Travel Demand Forecasting: Parameters and Techniques
  - Analysis of NHTS Data
  - Data from existing MPO models
  - What's in NCHRP Report 716?
  - Emerging modeling practices



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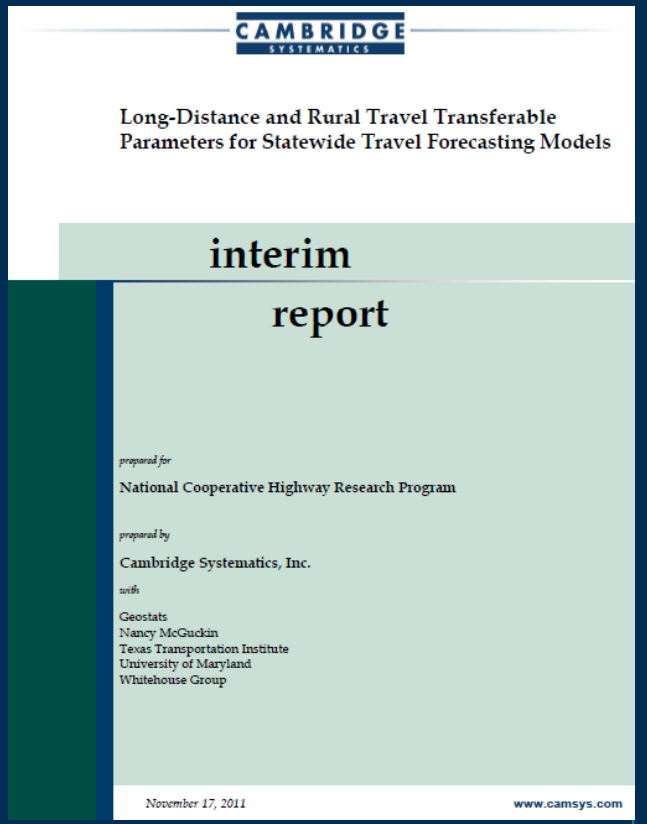
Presentation Outline (Cont'd)

- **NCHRP 8-84, Rural and Long-Distance Transferable Parameters**
  - **Differences in rural and long-distance travel**
  - **Statewide model statistics on rural and long-distance travel**
  - **Transferability of rural and long-distance model parameters**
  - **Consideration of other trip characteristics**
  - **Process for developing model parameters**
  - **Preliminary findings**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Long-Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models

interim report

prepared for
National Cooperative Highway Research Program

prepared by
Cambridge Systematics, Inc.

with
Geostats
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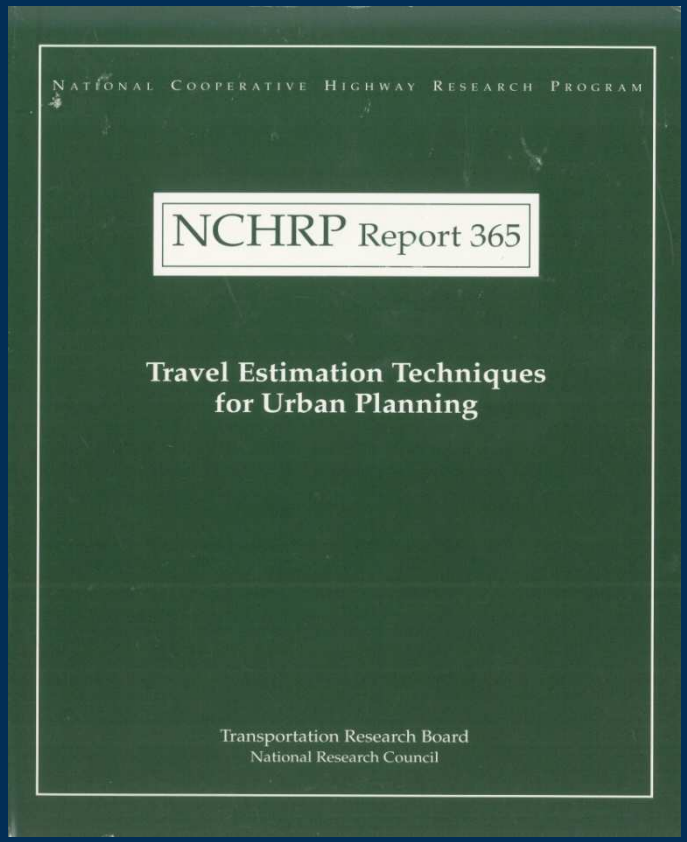
University of Maryland
Whitehouse Group

November 17, 2011 www.camsys.com

Overview of Projects
Background

- **NCHRP 8-61: Urban Parameters**
  - **1978 –NCHRP Report 187**
    - **Quick Response Urban Travel Estimation Techniques and Transferable Parameters**
  - **1998 – NCHRP Report 365**
    - **Travel Estimation Techniques for Urban Planning**
  - **2011 – Project 8-61**
    - **Travel Demand Forecasting: Parameters and Techniques**



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Overview of Projects
Background (Cont'd)

- **NCHRP 8-84: Rural/LD Parameters**
  - **Statewide Model Peer Exchange**
    - **September 2004, Longboat Key, FL**
    - **SWM information exchange**
    - **Identification of problem statements for future funding**
    - **Transportation Research Circular**
  - **Funded problem statements**
    - **National Model Scoping Project**
    - **Validation and Sensitivity Considerations for Statewide Models**
    - **Rural and Long-Distance Travel Parameters**

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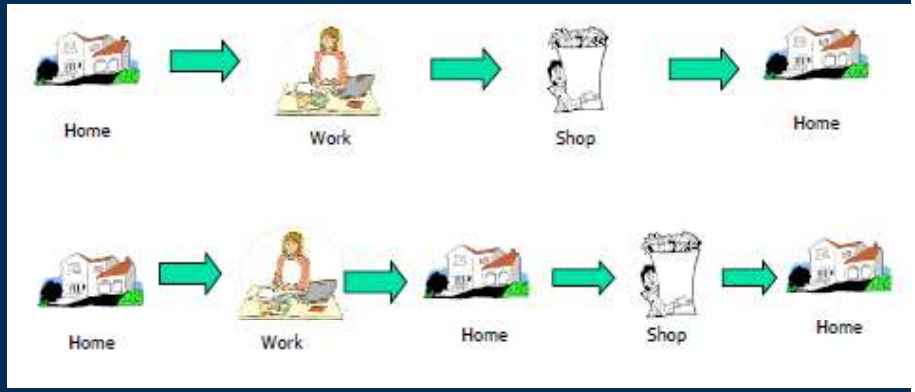
Project Overview: Urban Travel Parameters
Objectives

- **Revise and Update NCHRP Report 365**
  - **Current travel characteristics**
  - **Guidance on forecasting**
    - **Procedures**
    - **Applications**



- **Develop User-Friendly Guidebook**
  - **Range of approaches**
    - **Application of straightforward techniques**
    - **Optional use of default (transferable) parameters**
  - **References to more sophisticated techniques**
  - **Broad range of transportation planning issues**

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Project Overview: Rural/LD Travel Parameters
Objectives (cont'd)

- **NCHRP 8-84 is focused on documenting, obtaining, and analyzing available data sources for rural and long-distance trips**

Project Overview: Rural/LD Travel Parameters
Objectives (cont'd)

- **Long-Distance travel surveys**
  - **1995 American Travel Survey (ATS)**
  - **2001 National Household Travel Survey (NHTS) – *includes large sample of long-distance trips***
  - **Statewide household surveys (Michigan, Ohio, Oregon)**
  - **Recent GPS HHTS data collection (Denver, Atlanta, Chicago, Massachusetts)**
  - **Tourism surveys (Florida, Hawaii, Oregon)**
  - **National and State Park surveys**

Table 2.1 Preliminary Comparative Statistics from ATS and NHTS

Parameter Summary	1995 ATS More Than 100 Miles	2001 NHTS More Than 100 Miles*
Percent of Trips by Mode		
Private Vehicle	78.51	87.13
Air	18.02	9.23
Other	3.47	3.64
Percent of Trips by Purpose		
Business and Bus/Pleasure	22.42	25.69
Visit Friends/Relatives	32.58	26.31
Leisure	30.53	26.21
Personal/Family or Medical	11.93	9.56
Other	2.54	12.22
Overall Mean Trip Length in Miles (One-Way All Modes)[b]	411.88	457.57
Mean Trip Length – Air	1,003.21	2,088.78[a]
Mean Trip Length – Private Vehicle	276.53	301.54
Mean Trip Length – All Other	404.02	482.02
Mean Trip Length by Purpose in Miles (One-Way All Modes)		
Business and Bus/Pleasure	467.89	480.93
Visit Friends/Relatives	398.77	478.60
Leisure	406.70	516.44
Personal/Family or Medical	376.05	409.80
Other	316.03	276.28
Overall Travel Party Size (All Modes)	3.10	N/A
Travel Party Size – Air	2.98	N/A
Travel Party Size – Private Vehicle	2.42	N/A
Travel Party Size – All Other	9.34	N/A
Travel Party Size by Purpose		
Business and Bus/Pleasure	2.12	N/A
Visit Friends/Relatives	2.81	N/A
Leisure	3.93	N/A
Personal/Family or Medical	2.91	N/A
Other	6.34	N/A

* NHTS 2001 includes trips of 50 miles and more. For this analysis only trips of 100 miles and longer one-way were included.

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Analysis of NHTS Data: Urban Parameters
Process

- Information developed for four variables of interest
  - Person trip production rates
    - Per household by trip purpose
  - Reported average trip durations
    - By mode and trip purpose
  - Time of day of travel distributions
    - By trip purpose
  - Vehicle occupancy
    - By trip purpose

Table 4.16. Average daily vehicle occupancy by trip purpose by time period.

Vehicle Occupancy—Time Period	Trip Purpose					
	Home-Based Work	Home-Based Nonwork	Home-Based School	Home-Based Other (Excluding School)	Nonhome Based	All Trips
All Auto Modes—daily	1.10	1.72	1.14	1.75	1.66	1.55
Carpool 2 Plus Only—daily	2.42	2.71	2.35	2.71	2.75	2.72
Carpool 3 Plus Only—daily	3.60	3.81	3.46	3.81	3.79	3.80
All Auto Modes—a.m. peak	1.09	1.66	*	*	1.43	1.34
Carpool 2 Plus Only—a.m. peak	2.36	2.65	*	*	2.65	2.61
Carpool 3 Plus Only—a.m. peak	3.42	3.57	*	*	3.68	3.64
All Auto Modes—p.m. peak	1.11	1.66	*	*	1.65	1.50
Carpool 2 Plus Only—p.m. peak	2.45	2.62	*	*	2.72	2.65
Carpool 3 Plus Only—p.m. peak	3.63	3.66	*	*	3.75	3.70

*Use daily parameters; NHTS data insufficient to estimate.

Source: 2009 NHTS.

- Variables selected based on potential for transferability

Analysis of NHTS Data: Urban Parameters
Classifications

- Trip purposes used for data summaries
  - Home based work
  - Home based school
  - Home based other
  - Home based non-work
  - Non-home based
- Urban area population classifications (from 2009 NHTS)
  - 1 million + with subway/rail; 1 million + without subway/rail
  - 500k to 1 million
  - 200k to 500k
  - 50k to 200k
  - Not in urban area

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Analysis of NHTS Data: Urban Parameters
Sample Tabulations

- **Sample trip production tabulation (2009)**
  Home based work - MSA population less than 250,000

	Workers				
Autos	0	1	2	3+	Avg
0	0.0	1.2	2.3	1.6	**0.6**
1	0.0	1.0	1.7	4.7	**0.7**
2	0.0	1.3	2.5	2.8	**1.7**
3+	0.0	1.2	2.5	3.7	**2.3**
Avg	**0.0**	**1.1**	**2.4**	**3.6**	**1.5**

Analysis of NHTS Data: Urban Parameters
Sample Tabulations

- **Sample trip length tabulation (2009)**
  Home based work – Average travel time in minutes

MSA Population18	Auto	Transit	Non-Motorized	All Modes
Greater than 3 million	29	56	18	31
Between 1 and 3 million	24	48	19	25
Between 500,000 and 1 million	24	53	14	24
Between 250,000 and 500,000	21	30	11	21
Less than 250,000	20	59	11	20
Not in MSA	21	57	8	21
All trips	25	55	15	26

Data from Existing MPO Models: Urban Parameters Process

- **Information from over 70 MPOs**
  - **Small, medium, large**
  - **Direct contact or publicly available reports**
  - **Information collected**
    - **Model parameters**
      - ♦ Trip attraction rates
      - ♦ Friction factor parameters
      - ♦ Mode choice parameters
      - ♦ Volume-delay function parameters
      - ♦ …
    - **Model methods used**

Table 4.4. Trip attraction rates from selected MPOs (person trips per unit).

	Number of MPO Models Summarized	Households[a]	School Enrollment[b]	Employment			
				Basic[c]	Retail[d]	Service[e]	Total
All Person Trips							
Home-Based Work							
Model 1	16						1.2
Home-Based Nonwork							
Model 1	2	1.2	1.4	0.2	8.1	1.5	
Model 2	8	2.4	1.1		7.7	0.7	
Model 3	2	0.7		0.7	8.4	3.5	
Nonhome Based							
Model 1	5	0.6		0.5	4.7	1.4	
Model 2	8	1.4			6.9	0.9	
Motorized Person Trips							
Home-Based Work							
Model 1	8						1.2
Home-Based Nonwork							
Model 1	1	0.4	1.1	0.6	4.4	2.5	
Model 3	4	1.0		0.3	5.9	2.3	
Nonhome Based							
Model 1	6	0.6		0.7	2.6	1.0	

[a] The number of households in a zone.
[b] The number of elementary, high school, or college/university students in a zone.
[c] Employment primarily in two-digit North American Industry Classification System (NAICS) codes 1–42 and 48–51 [Standard Industrial Classification (SIC) codes 1–51].
[d] Employment primarily in two-digit NAICS codes 44–45 (SIC codes 52–59).
[e] Employment primarily in two-digit NAICS codes 52–92 (SIC codes 60–97).

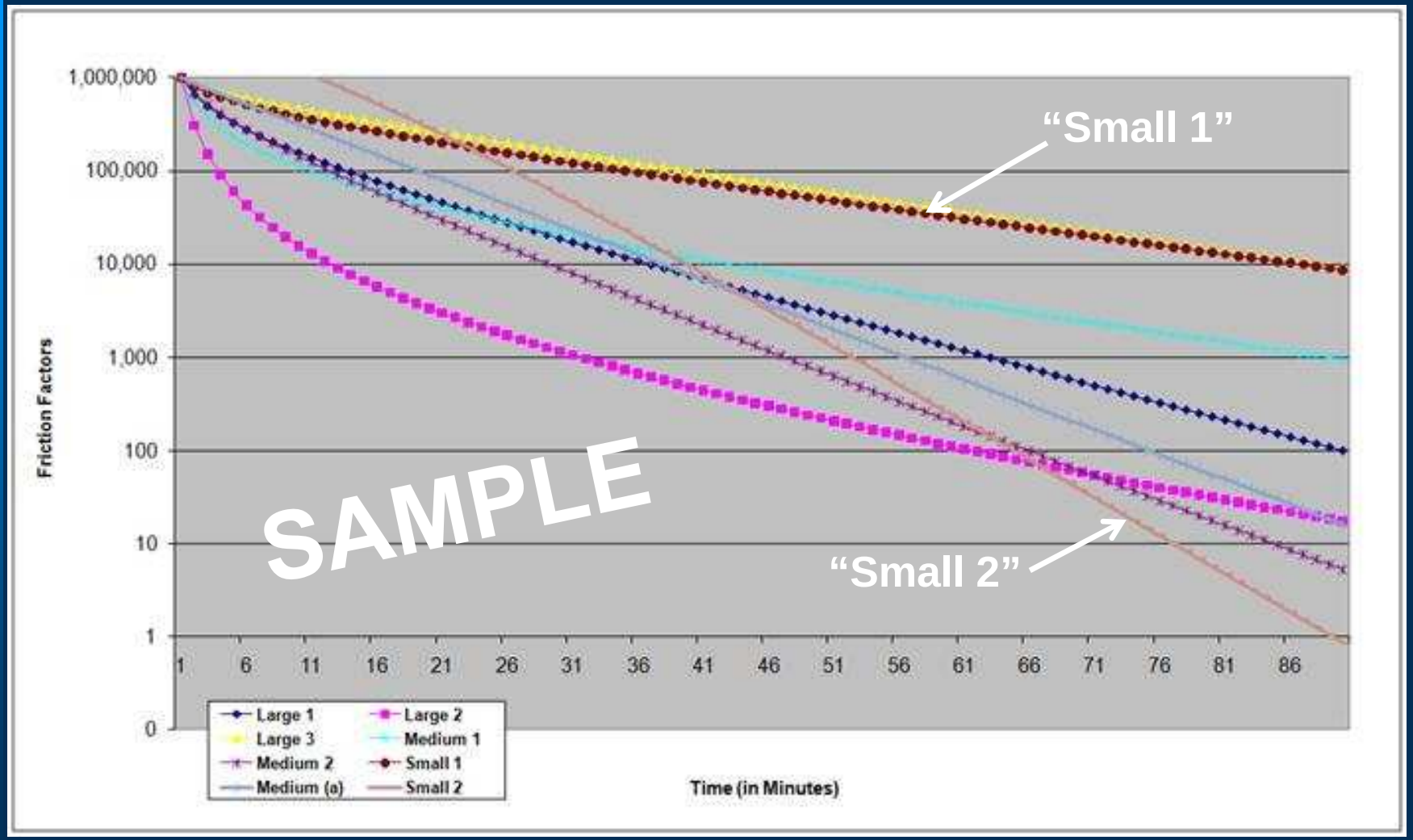
Source: MPO Documentation Database.

Data from Existing MPO Models: Urban
Sample Tabulation

- **Sample gamma function gravity model parameters (home based work)**

	"b"	"c"
Large MPO 1	0.503	-0.078
Large MPO 2	-1.650	-0.040
Large MPO 3	-0.156	-0.045
Medium MPO 1	-0.812	-0.037
Medium MPO 2	-0.388	-0.117
Medium MPO 3	-0.020	-0.123
Small MPO 1	-0.265	-0.040
Small MPO 2	0.850	-0.200

Data from Existing MPO Models: Urban
Sample Gamma Function Comparison (Home Based Work)



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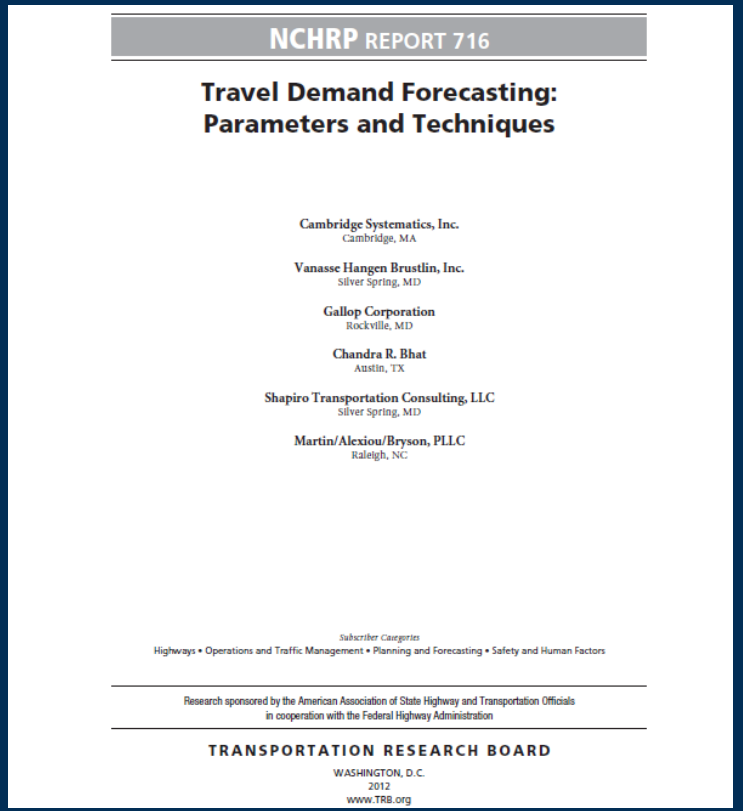
What's in Report 716 on Urban Parameters?

- Chapter 1. Introduction
  - Purpose, objectives, and roadmap
  - Summary of modeling process
  - How parameters used
- Chapter 2. Planning Applications Context
  - Planning context affect on model
  - Examples from urban areas



NCHRP REPORT 716

Travel Demand Forecasting:
Parameters and Techniques

Cambridge Systematics, Inc.
Cambridge, MA

Vanasse Hangen Brustlin, Inc.
Silver Spring, MD

Gallop Corporation
Rockville, MD

Chandra R. Bhat
Austin, TX

Shapiro Transportation Consulting, LLC
Silver Spring, MD

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What's in Report 716 on Urban Parameters? (cont'd)

- **Chapter 3. Development of Data**
  - **Purposes**
    - **Model development**
    - **Model validation**
    - **Model application**
  - **Considerations**
    - **Limitations of typical data**
    - **Primary and secondary data sources**
    - **Conversion of data from secondary sources**
    - **Network coding procedures**

Table 3.2 ACS Data Releases

Data Product	Population Threshold	Geographic Threshold	Planned Year of Release 2010	2011	2012	2013
1-year Estimates	65,000+	PUMAs, counties, large cities	2009	2010	2011	2012
3-year Estimates	20,000+	Counties, large cities	2007-2009	2008-2010	2009-2011	2010-2012
5-year Estimates	All areas*	Census tracts, block groups in summary file format	2005-2009	2006-2010	2007-2011	2008-2012

Source: U.S. Census Bureau.

*Five-year estimates will be available for areas as small as census tracts and block groups.

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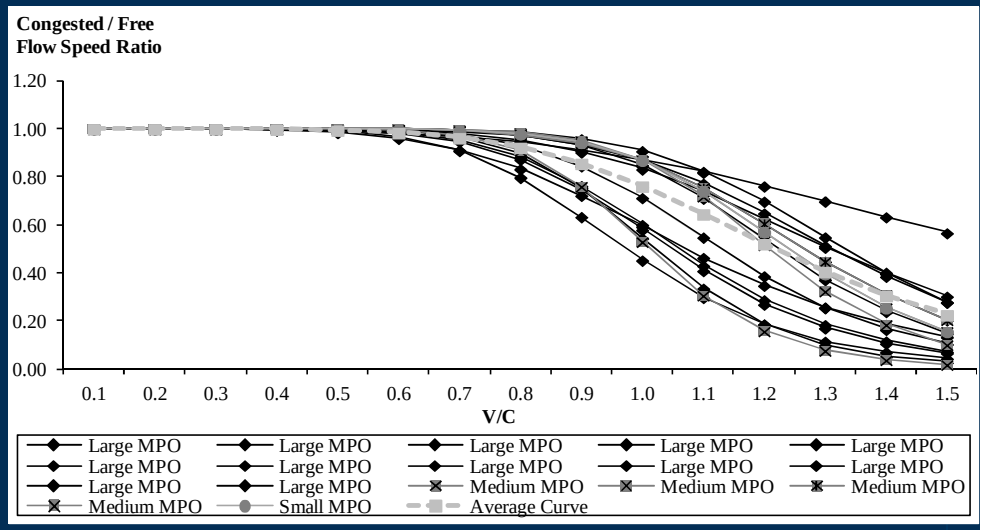
What's in Report 716 on Urban Parameters? (cont'd)

- **Chapter 4. Model Components**
  - **Discusses each model component**
  - **Each subsection presents:**
    - **A brief description of best practice(s)**
    - **Basis for development of parameters**
    - **Parameters classified by urban area category**
    - **Explanations of use in model**
      - Estimation
      - Validation
    - **Parameter transfer**



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What's in Report 716 on Urban Parameters? (cont'd)

Chapter 4 subsections

- Vehicle Availability
- Trip Generation
- Trip Distribution
- External Travel
- Mode Choice
- Automobile Occupancy
- Time-of-Day Characteristics
- Truck/Freight Modeling
- Highway Assignment
- Transit Assignment

What's in Report 716 on Urban Parameters? (conti'd)

Chapter 4 appendices

- % of HHs by number of vehicles by U.S. metro area
- Coefficients for logit vehicle availability models
  - 1 vehicle HHs
  - 2 vehicle HHs
  - 3+ vehicle HHs
- Mean trip length in minutes by purpose and mode by population range
- Trip production rates by population size and purpose:
  - HBW
  - HBNW
  - NHB
  - HBSC
  - HBO (nonwork, nonschool)
- Time-of-day distributions by purpose and direction

What's in Report 716 on Urban Parameters? (cont'd)

- **Chapter 5. Model Validation Process**
  - **Validation overview**
    - **Consistent with other sources**
    - **Appropriate out-references**
    - **Not duplication of existing references**
  - **Basic guidance**
    - **Focus on information in the guidebook**

Table 5.8 Comparison of Shares of Trips by Trip Purpose

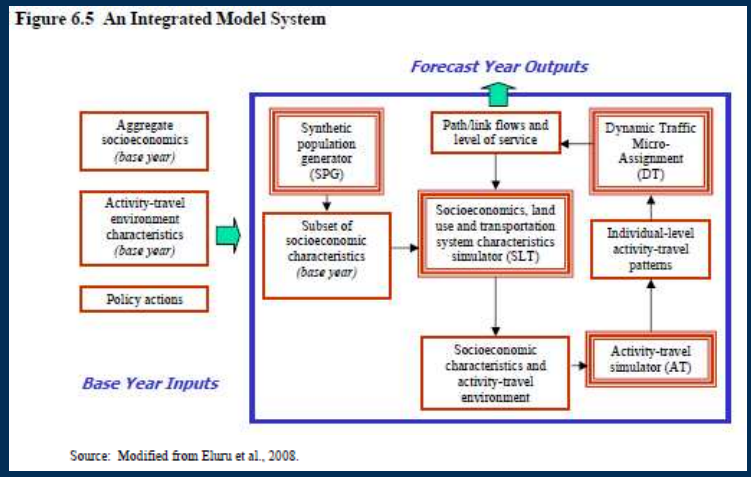
Urbanized Area Population	Percents of Daily Person Trips by Trip Purpose								
	NCHRP Report 187[a] (Published 1978)			NCHRP Report 365[a] (Published 1998)			2009 NHTS Data[b]		
	HBW	HBNW	NHB	HBW	HBNW	NHB	HBW	HBNW	NHB
50,000 to 100,000	16	61	23[c]	20[c]	57[c]	23[c]	15	54	31
100,000 to 200,000	20	57	23[c]	20[c]	57[c]	23[c]	15	54	31
200,000 to 500,000	20	55	25[c]	21[c]	56[c]	23[c]	15	54	31
500,000 to 1,000,000	25	54	21[c]	22	56[c]	22[c]	14	56	30
1,000,000 to 3,000,000	25	54	21[c]	22[c]	56[c]	22[c]	14	56	30
More than 3,000,000	25	54	21[c]	22[c]	56[c]	22[c]	14	56	30

Notes: a. Shares by purpose are based on person trips in motorized vehicles.
b. Shares by purpose are based on person trips by all modes.
c. Because of differences between urban area categories in the three reports, the rates shown were chosen from the closest matching category.

Sources: NCHRP Report 187, NCHRP Report 365, 2009 NHTS.

What's in Report 716 on Urban Parameters? (cont'd)

- **Chapter 6. Emerging Modeling Practices**
  - Overview
  - Tour and activity based approaches
  - Traffic microsimulation
- **Chapter 7. Case Study Application(s)**
  - Two studies
    - Smaller urban area with little transit
    - Larger area with transit
  - Illustrate use of the information from Chapters 4 and 5
  - Draw on concepts presented guidebook
    - Similar to approach in NCHRP Report 365



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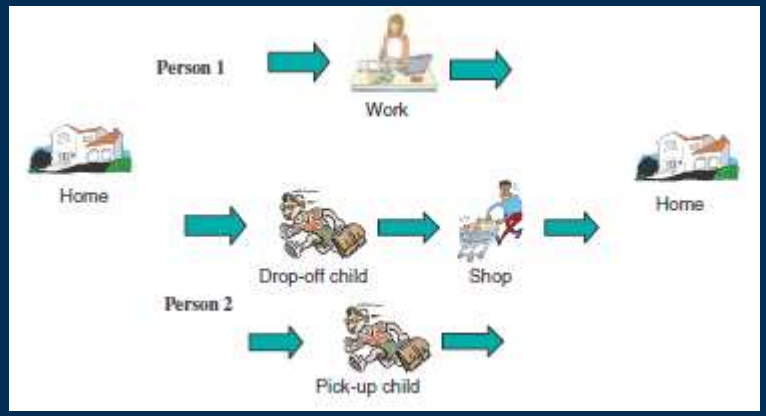
Emerging Modeling Practices (cont'd)

- ABM parameters were outside the scope of NCHRP 8-65
- That said, Chapter 6 of Report 716 includes discussion of this topic



- Transferability of ABMs may be valid in at least some limited circumstances…
- But what those limits are is somewhat unknown (lack of research/guidance)
- Transferability is asserted through SHRP C-10A (Sacramento-Jax-Tampa); should learn lessons from this effort

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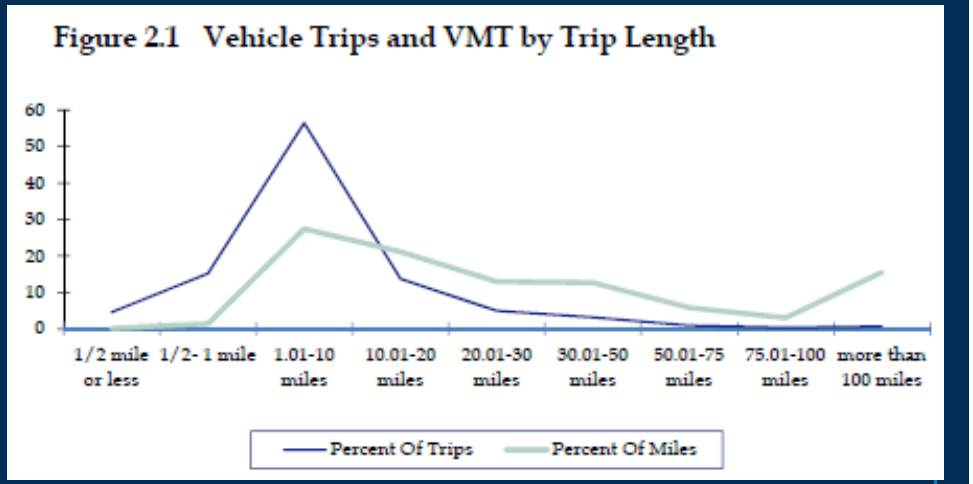
Differences in Rural and Long-Distance Travel vs. Urban Trips

- **Rural/long-distance trips have small impact on *most** urban models but great impact on statewide/national models**
- **While the greatest percent of trips occurs within urban model geography, percent of miles extends way beyond**

however, long-distance and rural travelers have a significant impact on Florida's regional models; use of these transferable parameters could enhance our regional models



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Differences in Rural and Long-Distance Travel (Cont'd)

- Long-distance travel surveys
  - 1995 ATS + 2001 NHTS
  - Statewide household surveys
  - Recent GPS HHTS data collection

Figure 2.8 Long-Distance Trip Travel Modes from Ohio Long-Distance Travel Survey

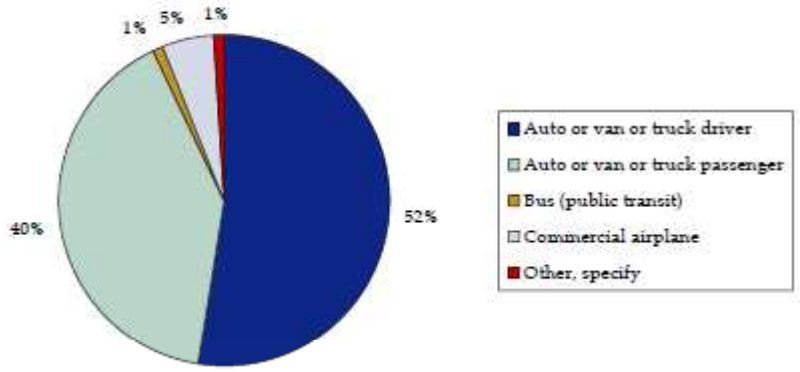


Figure 2.10 Michigan Travel Counts
Long-Distance Travel Mode

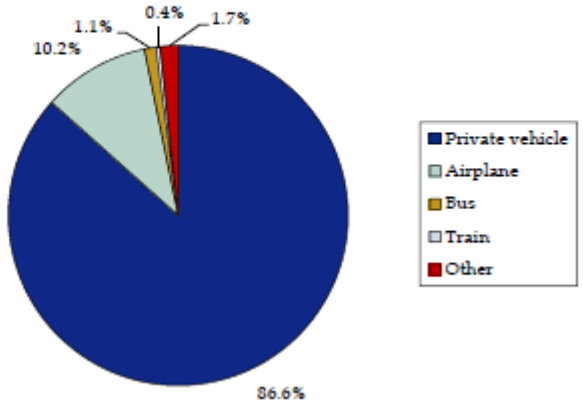
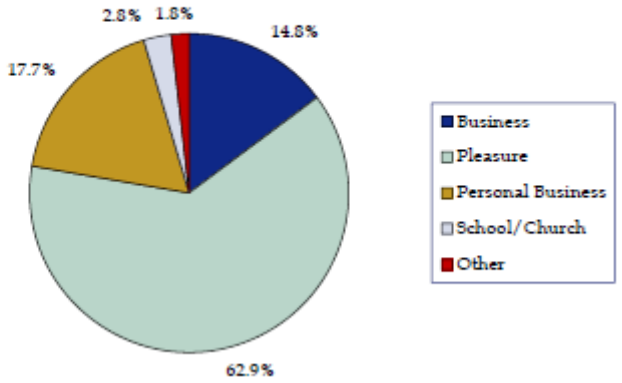


Figure 2.9 Michigan Travel Counts
Long-Distance Trip Purpose



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Differences in Rural and Long-Distance Travel (Cont'd)

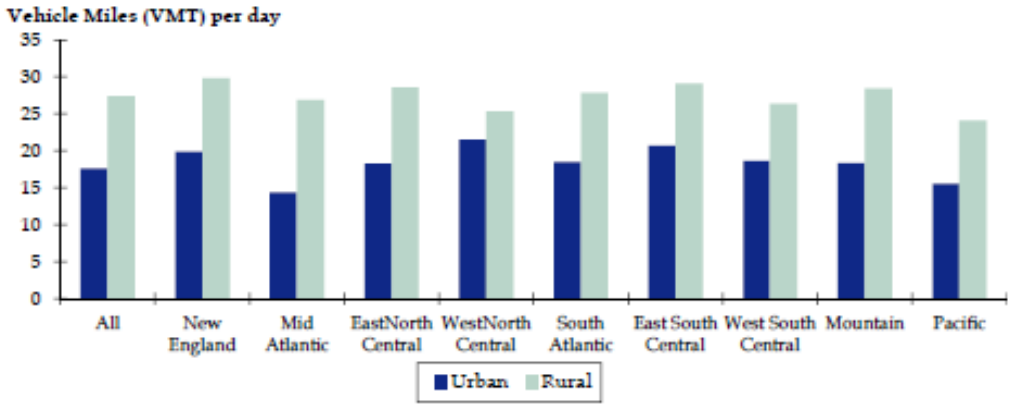
- Rural travel surveys
  - 2009 NHTS
  - Statewide household surveys
  - Recent GPS HHTS data collection

Table 2.2 NHTS 2009 Sample of Rural Households

Item	Rural Samples*
All Rural (National)	43,583
New England	1,560
Mid-Atlantic	5,721
East North Central	2,355
West North Central	2,684
South Atlantic	19,293
East South Central	1,570
West South Central	6,228
Mountain	1,727
Pacific	2,445

* Includes Add-on samples.

Figure 2.3 VMT per Person for Urban and Rural Households by Census Division



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Statewide Model Statistics on Rural/LD Travel

- SWM statistics on rural and long-distance travel
  - Fill data gaps
  - Identify long-distance trip thresholds used
  - Assess reasonableness of survey analysis

Table 3.2 Average Trip Length of Long-Distance Trips in Statewide Models

	Average Trip Length				
	By Purpose (Minutes or Miles[a])				
	Business	Tourist	Other	Total Minutes	Total Miles
Arizona (Passenger)	–	–	–	213	206
Arizona (Truck)	–	–	–	228	257
Florida	–	–	–	127	–
Georgia	–	–	–	131	–
Indiana	–	–	–	121	–
Louisiana	–	–	–	168	–
Texas (Miles)	200	–	199	–	200
Utah	89	–	81	85	–
Virginia (Interstate)	284	308	318	303	–
Virginia (Intrastate)	127	124	126	126	136

[a] Listed in minutes unless indicated otherwise.

Table 3.3 Auto Occupancy Rates in Statewide Models

	Auto Occupancy Rates			
	By Purpose (Minutes or Miles)			
	Business	Tourist	Other	Average
California	–	–	–	1.34
Florida	1.10	2.60		1.85
Indiana	–	–	–	3.06
Louisiana	1.86	3.44	2.64	2.65
Mississippi (Interstate)	1.39	2.55	2.05	2.00
Mississippi (Intrastate)	1.50	2.55	2.26	2.10
Utah	1.33	–	2.06	1.70
Virginia	1.82	2.69	2.69	1.82

Transferability of Rural/LD Parameters

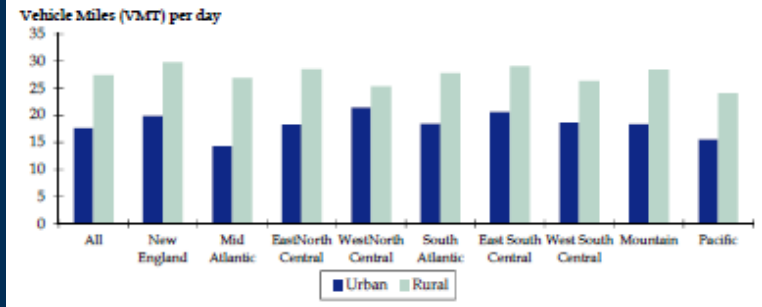
- **Conditions conducive to transferability**
  - **Population densities**
  - **Median income**
  - **Available transportation modes**
  - **Key employment types/ industries**
  - **Proximity to tourist destinations**
  - **Source of model parameters relative to where being used**

Table 2.3 Travel Parameters for Urban and Rural Households by Census Division, 2009 NHTS

	Person Trips per Person		Average Vehicle Trip Length (Miles)		VMT per Household		VMT per Person	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
All	3.8	3.6	8.0	12.0	43.5	72.1	17.6	27.4
New England	3.8	3.9	9.0	11.7	47.7	79.5	19.9	29.8
Mid-Atlantic	3.8	3.7	7.7	11.6	35.6	70.9	14.3	26.9
East North Central	4.0	3.6	7.7	11.8	43.2	75.9	18.3	28.6
West North Central	4.1	3.6	8.2	10.6	48.3	68.2	21.5	25.3
South Atlantic	3.7	3.6	8.3	12.6	44.4	72.0	18.5	27.8
East South Central	3.8	3.4	8.7	13.3	46.7	75.0	20.7	29.1
West South Central	3.8	3.7	8.2	12.3	47.0	72.6	18.6	26.3
Mountain	4.0	3.8	7.6	12.0	46.0	76.6	18.3	28.5
Pacific	3.8	3.7	7.4	10.6	42.1	64.6	15.6	24.1

Source: Author's analysis of 2009 NHTS, includes travel on weekends and holidays.

Figure 2.3 VMT per Person for Urban and Rural Households by Census Division



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Transferability of Rural/LD Parameters (Cont'd)

- Parameters considered for transferability
  - Daily rural trip rates per HH by rural trip purpose
  - Annual long-distance trips per HH by long-distance trip type/purpose
  - Friction factors for rural and long-distance purposes
  - Auto occupancy rates by rural trip purposes
  - Party size by long-distance types/purposes
- Reasonableness values/benchmarks
  - Percent rural trips by purpose
  - Percent long-distance trips by type
  - Average trip length by mode and rural trip purpose
  - Average trip length by mode and LD trip type
  - Percent of rural and LD trips by mode and travel distance

Table 3.7 2001 Long-Distance Trips by Purpose and Mode

LD Purpose	Percent by Purpose	Percent Trips by Mode				
		Personal Vehicle	Air	Bus	Train	Other
Pleasure	55.5%	90.4%	6.7%	2.2%	0.5%	0.2%
Business	15.9%	79.3%	17.8%	0.8%	1.6%	0.5%
Commuting	12.6%	96.4%	1.5%	0.5%	1.7%	0.0%
Personal Business	12.6%	89.3%	4.7%	5.6%	0.3%	0.1%
Other	3.4%	96.6%	1.9%	0.5%	0.0%	1.0%
Total	100.0%	89.5%	7.4%	2.1%	0.8%	0.2%

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Consideration of Other Rural/LD Trip Characteristics

- Temporal analysis considerations
  - Seasonal variations
  - Daily, monthly, or annually (for long-distance trips)
  - AADT (include weekends) vs. PSWADT (exclude weekends)
  - Time-of-day
- Other aspects of trip definition
  - Person vs. vehicle
  - Per capita vs. Household
  - Long-distance thresholds
  - Dealing with intermediate stops
  - Tours vs. trips

Table 3.8 2001 Long-Distance Trips by Trip Distance

Distance	Trips
50-499 Miles	90.0%
500-900 Miles	5.0%
More Than 1,000 Miles	5.0%

Table 3.9 2001 Long-Distance Trips by Geography and Mode

	Personal Vehicle	Air	Other Modes
Urban	87.0%	9.0%	4.0%
Rural	95.0%	3.0%	2.0%

Table 3.11 2001 Long-Distance Trips by Income and Mode

Income	Personal Vehicle	Air	Bus[a]
Less Than $75,000	91.0%	5.0%	4.0%
More Than $75,000	84.0%	14.0%	2.0%

[a] Income ranges of less than $25,000 and more than $25,000 were used for bus trips.

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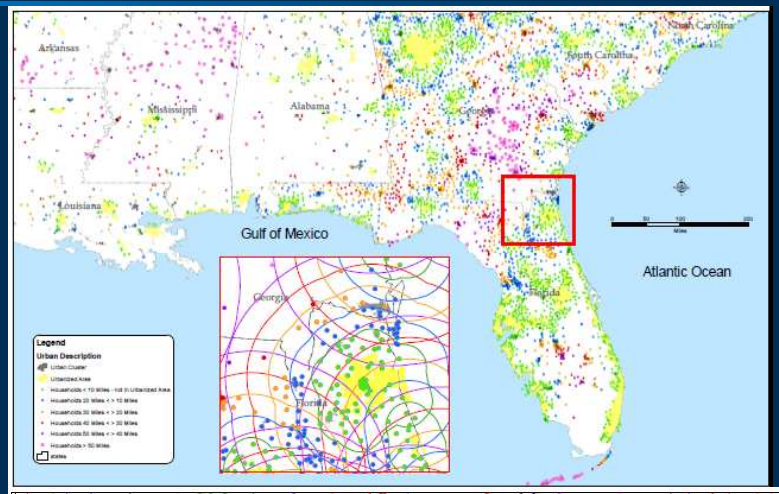
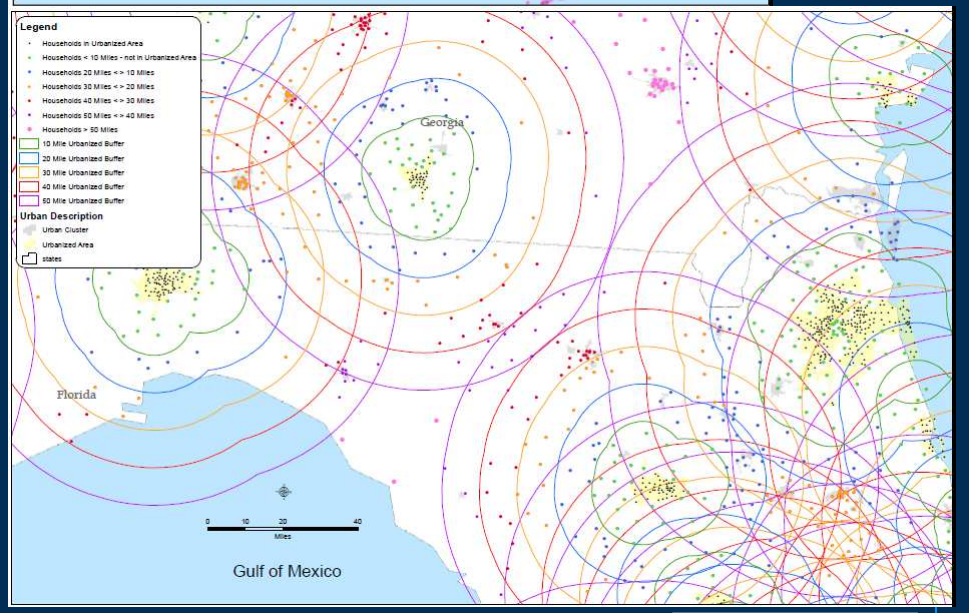
Process for Developing Rural/LD Parameters

- Process for developing transferable parameters
  - Comparisons – rural vs. urban vs. long-distance
  - Typologies – household characteristics, density, proximity, purpose/type, length of trip
  - Geographies – proximity to urbanized areas, small urban vs. agrarian, tourist, etc.
  - Time periods – weekday vs. weekend, daily vs. annual





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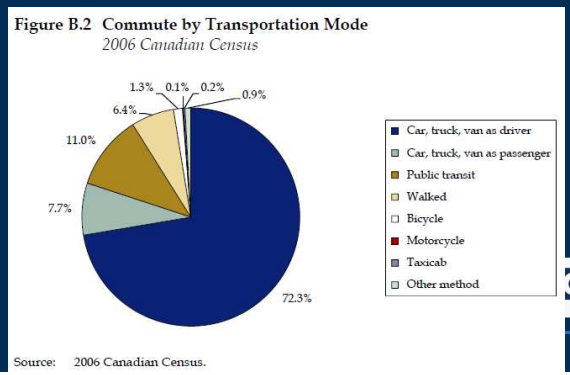
Process for Developing Rural/LD Parameters (Cont'd)

- Limitations of datasets – ATS, NHTS 2001, NHTS 2009, Michigan, Ohio, GPS surveys
- Minimum amount of local data required – comparisons against statistics from statewide models, local surveys
- Next steps (*in progress or recently completed*)
  - Refine statistical analysis for each survey
  - Refine preliminary findings/recommendations
  - Prepare Guidebook/Final Report



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Preliminary Findings… *some might be obvious*

- **Long distance trip rates are generally consistent among different databases; *pleasure trips land in the middle***
- **Long distance trips are generally longer for business and shortest for personal business**
- **Auto occupancy rates are considerably higher for long-distance trips than urban or rural travel**
- **Auto is the primary mode for long distance trips, especially within a 300 mile range. Air travel begins to increase significantly over 300 miles**

Preliminary Findings (Cont'd)

- Rural trip rates vary somewhat among different sources; statewide HH survey trip rates (e.g., OH, MI) are generally lower than 2009 NHTS trip rates
- Rural trip rates are generally lower than suburban area trip rates but otherwise not that different from urban rates
- Rural work trips are a smaller percentage than found in most urban settings
- Auto occupancy rates for rural areas are generally higher than small-to-medium sized urbanized areas, but lower than the largest metropolitan areas

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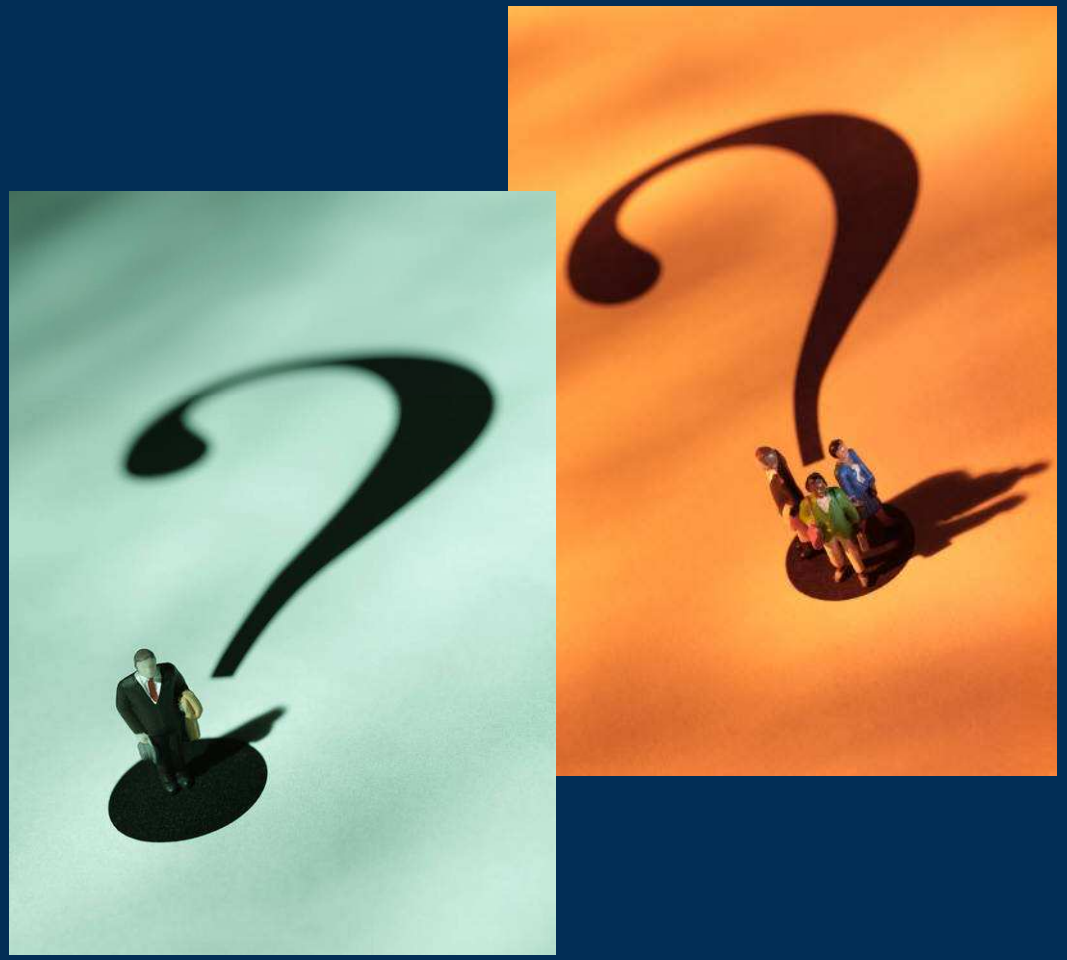
Transferable Model Parameters: NCHRP 8-61 and NCHRP 8-84

- ***Questions?***



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