

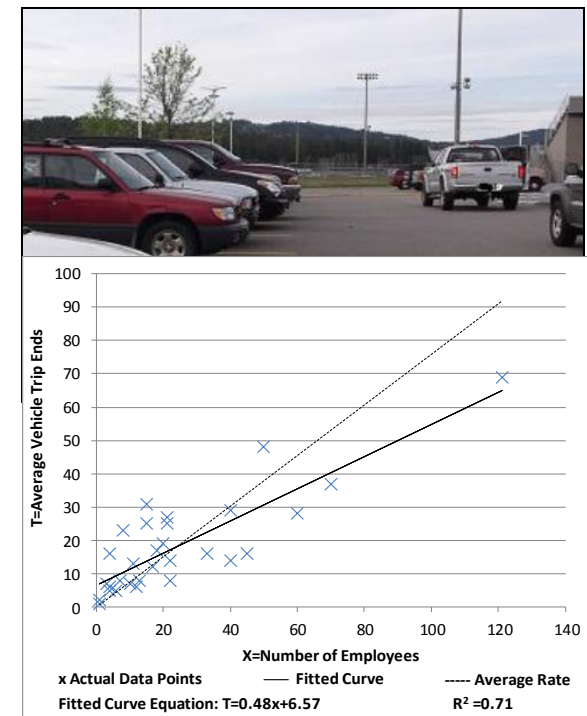
RMC Project 6760



Improved Trip Generation Data for Texas Using Workplace and Special Generator Surveys

Task 8: Half-Day Workshop
Presented by TTI and CTR

TTI Austin Office
August 18, 2014



Module 1

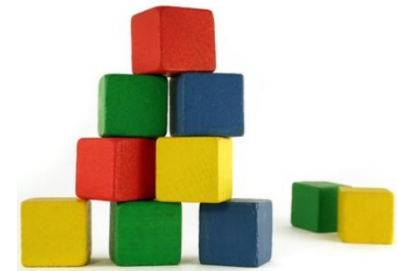
- Welcome and Introductions
- Workshop Objectives
- Workshop Agenda
- Overview of 6760 Project Tasks

Welcome and Introductions

- Project Director, Wade Odell
- RMC 6760 Project Team
 - TTI Researchers
 - CTR Researchers
- Project Management Committee
- Guests

Workshop Objectives

- Present Texas Trip Generation Manual
 - How developed
 - How it can be used, built upon
 - Provide examples and discuss
- Present Generic WP Attraction Rates
- Review Trip Attractions and Advanced Models



Workshop Agenda

Module	TOPICS
1 10:00 – 10:30	Welcome and Introductions <ul style="list-style-type: none"> • Workshop Objectives • Today's Agenda • Overview of Project Tasks
2 10:30-12:00	Texas Trip Generation Manual <ul style="list-style-type: none"> • How Developed • Criteria Used
	BREAK 11:00 – 11:10
	<ul style="list-style-type: none"> • Data Plots and Statistics • How to Use • Examples/Discussion
LUNCH 12:00 – 1:00 (to be brought in)	
3 1:00-1:45	Generic Attraction Rates for Modeling <ul style="list-style-type: none"> • Master Database Assembly • Area Sizes, Types and Trip Purposes • Attraction Rates and Variability
BREAK 1:45 – 1:55	
4 1:55-2:40	Trip Attractions for Advanced Models <ul style="list-style-type: none"> • TA Models for non-commercial and commercial vehicles • TA models for different purposes and modes • Applications of TAs in advanced models
5 2:40-3:00	Wrap-up and Closing <ul style="list-style-type: none"> • Recommendations, Discussion, Direction

Project Objectives

- Utilize TxDOT's rich source of workplace survey data
- Focus on 'attractions' instead of 'productions'
- Develop generic attraction rates for modeling
- Develop Trip Generation Manual for Texas with 'local data' for land development
- Research the use of trip attraction data in advanced models
- Improve travel demand modeling process

Project 6760: Task Overview

- Task 1:** Literature Review, Review of Previous Work
- Task 2:** Review Work Place/Special Generator Survey Design and Methods
- Task 3:** Compile and Analyze Data to Develop Trip Attraction Rates for Modeling
- Task 4:** Conduct Analysis to Develop Trip Generation Rates for Land Development
- Task 5:** Evaluate Models and Potential Explanatory Variables

Project 6760: Task Overview

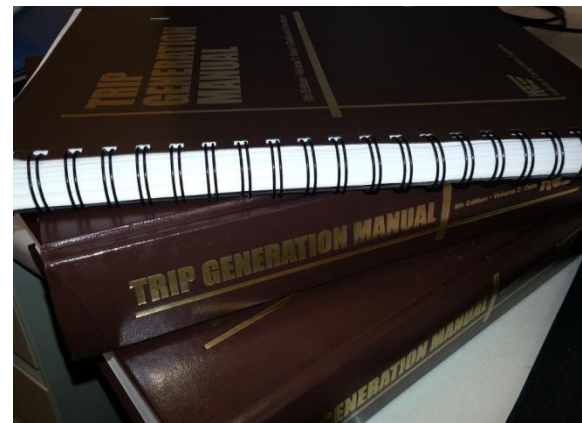
- Task 6:** Establish Criteria for Texas Trip Generation Manual
- Task 7:** Prepare Draft Texas Trip Generation Manual and User Guide
- Task 8:** Conduct Workshop to Present Manual and User Guide
- Task 9:** Prepare Research and Summary Reports

Module 2

- Methods/Analyses to Develop Trip Generation (TG) Rates
- TG Rate Calculations
- Criteria for Texas TG Manual (for land development)
- Overview of Manual and User Guide
- Instructions for Using Manual
- Examples and Discussion

Methods/Analysis to Develop TG Rates

- **Initial Site Screening**
 - Availability of vehicle counts or person counts
 - Availability of hourly or 15-minute count data
 - Availability of complete data from region
- **Identification of Institute of Transportation Engineers Land Use Code (ITE LUC)**
 - 172 ITE LUCs exist
 - 34 LUCs included in the Texas TG Manual



Methods/Analysis to Develop TG Rates

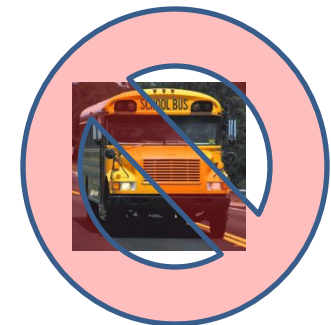


- **Independent Variable Data Collection**

- Number of employees
- Other data obtained through appraisal district, visual inspection, websites
- Discarded sites where independent variable data not obtained with reasonable confidence

- **Finalizing Sample Size for Analysis**

- Discarded all schools
- Only included LUCs with 3+ sites
- Resulted in 390 establishments, 34 unique land uses



Texas TG Rate Calculations

- **Time Periods**

- A.M./P.M. Peak Hour of Adjacent Street Traffic
- A.M./P.M. Peak Hour of the Generator
- Weekday

- **Independent Variables**

- Number of Employees
- Size of the Development
- “Special” Variables

- **Items Calculated**

- Weighted Average Trip Generation Rate, Standard Deviation
- Weighted Average Percent Entering Trips
- Average Independent Variable Size (unweighted)
- Range of calculated trip generation rates (unweighted)

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4	5	6	7



Criteria in Developing the Texas TG Manual

- Elements of Workplace data to include
- Time periods to present
- Classifications to use in displaying results
- Independent variables
- Methodology for analyzing the data
- Minimum required sample size
- Manual form
- Distribution method
- How frequently to update
- Guidelines for outside source contribution

TG Manual Development

Elements Used

- Land Use
- ITE Land Use Code
- Independent Variable
- Analysis Time Period
- Weighted Trip Generation Weight
- Range of Trip Rates for Different Study Locations

TG Manual Development (con't)

Elements Used

- Standard Deviation of TG Rates at Different Studies
- Graph Section
 - Independent Variable, x-axis
 - Dependent Variable, y-axis
- Coefficient of Determination
- Best Fit Regression Equation

TG Manual Development (con't)

- Time Periods
 - Weekday
 - Weekday A.M. Peak Hour of Adjacent Street Traffic
 - Weekday P.M. Peak Hour of Adjacent Street Traffic
 - Weekday A.M Peak Hour of Generator
 - Weekday P.M. Peak Hour of Generator
- Classifications
 - Institute of Transportation Land Use Codes (ITE LUCs)
 - 34 LUCs included in this draft of the Texas Manual

TG Manual Development (con't)

- Independent Variables
 - Number of Employees
 - 1,000 Square Foot Gross Floor Area
 - Others (Acres, Rooms, Fueling Positions, etc.)
- Methodology
 - Weighted Average Trip Rate vs. Regression Equation
 - Followed ITE Methodology



TG Manual Development (con't)

- Minimum Required Sample Size
 - 3+ establishments
 - 3-5 establishments, “Caution—Use Carefully—Small Sample Size”
 - 4+ establishments, Provide best fit regression curve if R^2 value greater than or equal to 0.50

TG Manual: Availability and Updates

- Available in summary form (like ITE Manual)
- Available in electronic form: this allows for updates on a more on-going basis
- Updating is partially automated process
- Additional Data
 - Largely in form of data collected as part of surveys
 - Ensure survey specs compatible with Texas TG Manual needs
 - Possible data collection from ITE student chapters, govt. agencies, etc.

User's Guide for TG Manual

Overview

- Included in TG Manual
 - User's Guide includes:
 - Overview of purpose of manual and its uses
 - Definitions of terms
 - Description of database
 - Description of data plots and reported statistics
 - Instructions
 - Update procedures
- *Largely follows ITE *Trip Generation Manual and User's Guide*

TG Manual User's Guide

Introduction

- Describes purpose of manual and basis for development
- Explains how the manual is to be used and how to properly use plots
- Provides background on data and sample used in manual:
 - From 5 WP surveys in Texas conducted between 2010 and 2013
 - Final sample: 390 establishments with 34 ITE LUCs

TG Manual User's Guide

Definitions Provided

- Acre
- Adjacent Street Traffic
- Average Trip Rate
- Average Trip Rate for the Peak Hour of the Adjacent Street Traffic
- The A.M. and P.M. Peak Hour of Volumes of Adjacent Street Traffic
- Average Trip Rate for the Peak Hour of the Generator
- Average Weekday Trip Rate
- Employee
- Gross Floor Area, Leasable Area, Rentable Area
- Independent Variable
- Student
- Trip/Trip End
- Vehicle Fueling Position



Texas TG Manual

Description of Database

- Data is **Vehicular** trip generation
- Data for 34 land uses
 - Classified into 10 major categories
 - Includes 172 land uses in ITE *Trip Generation Manual*
 - Additional land uses may be added in future
- Not much need to worry about temporal variations
- As more data added to Manual dataset, will monitor



Texas TG Manual

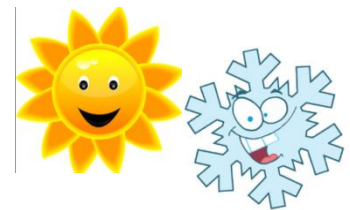
Description of Database

Important Statistics Used to Describe Data Variation

- Range of Rates
- Standard Deviation
- Coefficient of Determination (R^2) Value

Factors that May Contribute Towards Variation

- Small Sample Size
- Individual Marketing of the Site
- Economic Conditions of the Business Market
- Geographic Location of the Sites Studied
- Unique Characteristics of the Specific Site
- Daily and Seasonal Variation



Texas TG Manual

Data Plots and Reported Statistics

Data Plots

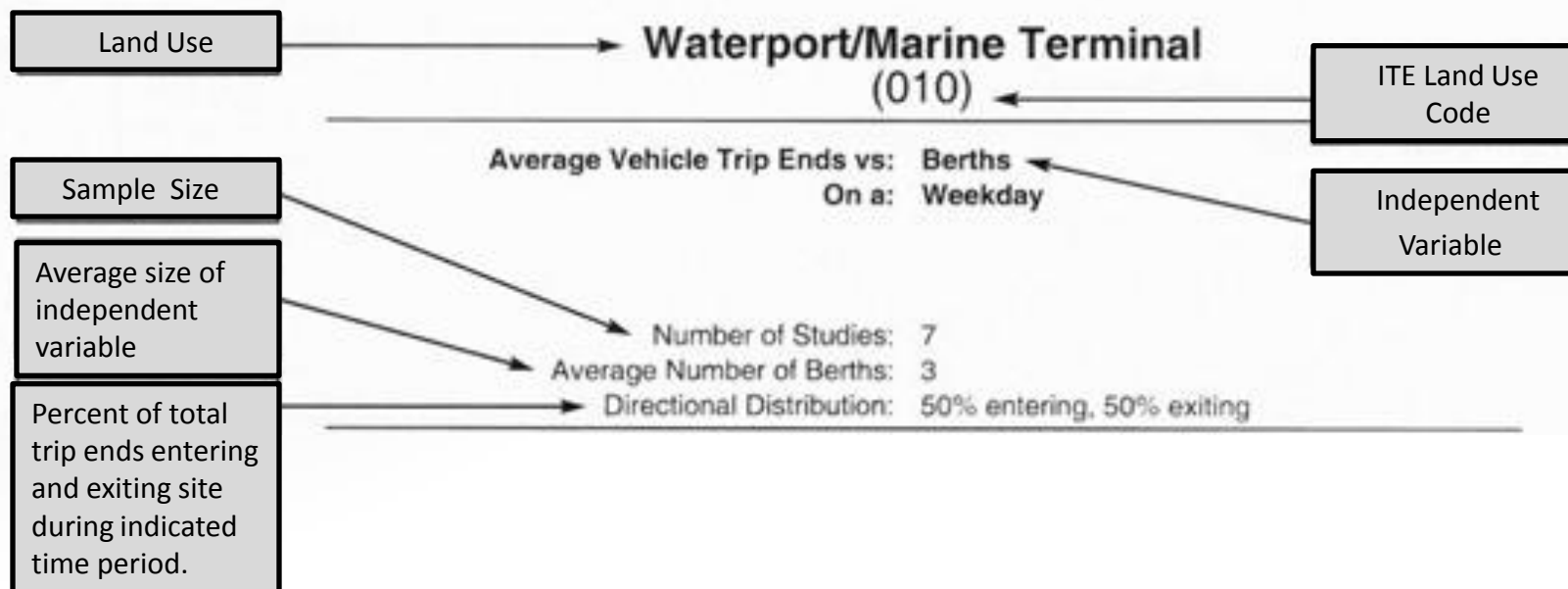
- Examples to follow provide visual of variance
- Each plotted point represents number of trips generated for a given size of the independent variable
- ≤ 5 points, include “Caution—Use Carefully—Small Sample Size”
- Only includes those period/LUC combinations with 3+ sites

Use Caution When:

- Making inferences beyond range of data included within dataset
- Rare instances when tip generation estimate for peak hour of adjacent street traffic exceeds peak hour estimate of generator

Data Plots and Reported Statistics (con't)

Figure V-I: Sample Data Page

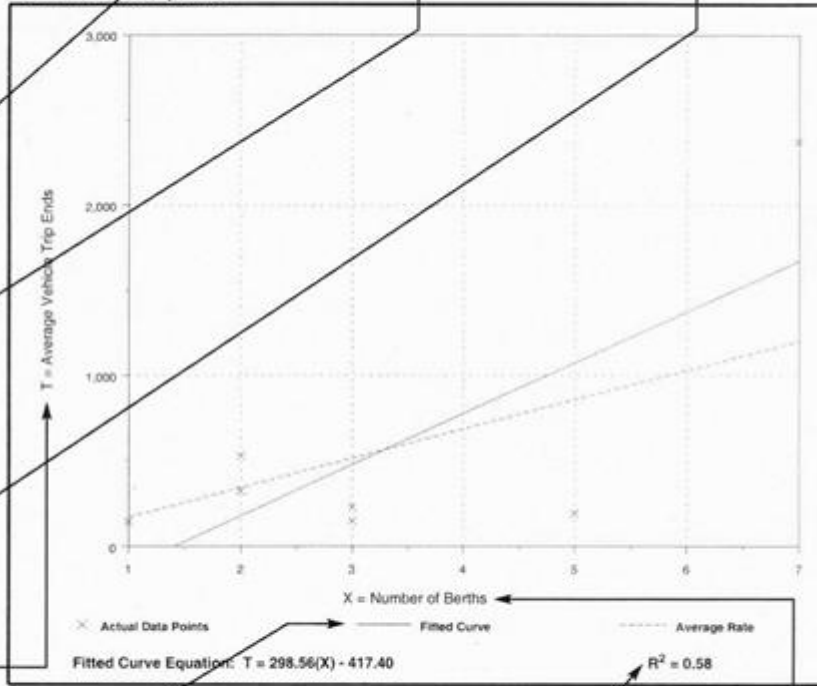


Data Plots and Reported Statistics (con't)

Trip Generation per Berth

Average Rate	Range of Rates	Standard Deviation
171.52	38.60 - 338.57	130.72

Data Plot and Equation



Weighted Trip Generation Rate—The weighted average number of trip ends per one unit of independent variable (in this example, per berth).

Minimum and maximum trip generation rates from the entire range of studies reported.

The standard deviation estimates the difference among trip generation rates in all studies for a land use and independent variable.

Dependent Variable

Best fit regression equation; expresses the optimal mathematical relationship between two or more related variables. If the variables are related linearly, the equation will have the following format: $T=aX + b$. In a logarithmic relationship, the equation will have the following format: $\ln(T)=a\ln(X) + b$.

Measure of correlation between 2 variables, expressed on a scale of 0 to +1. The closer to +1 the R^2 is, the better the correlation between the variables.

Independent Variable

Data Plots and Reported Statistics (con't)

Reported Statistics

- **Average Trip Rate**
 - **Weighted** Average
- **Standard Deviation for the Weighted Average Trip Rate**
 - Measure of the variation
 - Because calculated using weighted average rate, not quite statistically correct

Data Plots and Reported Statistics (con't)

Reported Statistics

Regression Analysis

- Regression equation can be linear or logarithmic
- Following three criteria must be met to display regression equation:
 - R^2 value greater than or equal to 0.50
 - Sample size greater than or equal to 4
 - Number of trips increases as the size of the independent variable increases
- In cases with large y-intercept values associated with regression equation, may produce unrealistic results

Instructions

Understanding the Methodologies

- **Graphic Plot**

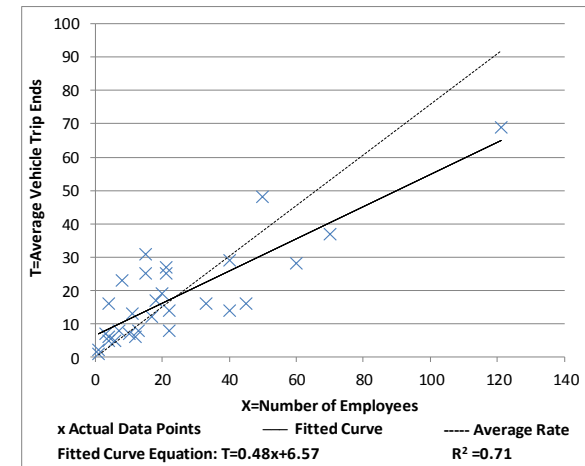
- Total trip ends vs. independent variable
- Interpolation or discarding data may make it difficult to draw meaningful conclusions

- **Weighted Average Trip Rate**

- Assumes linear relationship
- Forced through origin

- **Regression Equation**

- “Best Fit” estimate
- NOT forced through origin
- Linear or Logarithmic (whichever has higher R^2 value)
- Only included if three criteria (specified on previous slide) met



Instructions (con't)

Sample Problem

- Consider land use 110-General Light Industrial with 20 employees, Weekday
- The equations related to the weighted average rate and the regression equation are shown below:
 - Rate: $T=3.86(\text{employees})$
 - Equation: $T=2.50(X)+32.36$

Instructions (con't)

Selecting Method for Estimating Trips

Use Fitted Curve equation when:

- A fitted curve equation is provided; **and**,
- The data plot has at least 20 data points.

OR

- A fitted curve equation is provided;
- The curve has an R^2 of at least 0.75;
- The fitted curve falls within data cluster; **and**,
- The weighted standard deviation is more than 55 percent of the weighted average rate.

Instructions (con't)

Selecting Method for Estimating Trips

Use Weighted Average rate when:

- The data plot has at least three data points (and preferably, six or more);
- The R^2 value for the fitted curve is less than 0.75 or no fitted curve equation is provided;
- The weighted standard deviation for the average rate is less than 55 percent of the weighted average rate; **and**,
- The weighted average rate is within data cluster in plot.

Instructions (con't)

Selecting Method for Estimating Trips

- **Collect Local Data when:**
 - Study site is not compatible with ITE land use code definition;
 - Data plot has only one or two data points (and preferably, when five or fewer);
 - Independent variable value is not within range of data; **or**,
 - Neither weighted average rate line nor fitted curve is within data cluster at size of study site.

Instructions (con't)

Steps in Selecting Method for Estimating Trips

*Largely taken from ITE *Trip Generation Handbook*, p. 29-31

Step 1: Is the study site consistent with the LUC description and with presumed characteristics of development sites of provided data points?

Step 2: Is the size of study site (in terms of independent variable) in the range of data shown in the data plot?

Step 3: How many data points are in the sample reported in the Manual?

Step 4: Is a fitted curve equation provided?

Instructions (con't)

Steps in Selecting Method for Estimating Trips (con't)

*Largely taken from *ITE Trip Generation Handbook*, p. 29-31

Step 5: Is the weighted standard deviation less than or equal to 55 percent of weighted average?

Step 6: Is the line that corresponds to the weighted average rate within a cluster of data points near the size of the study site?

Step 7: Are there at least 20 data points distributed over the range of values typically found for the independent variable? Is the line corresponding to the fitted curve equation within the cluster of data points near the size of the study site?

Step 8: What are the answers to Questions 8A and 8B?

Examples of Recommended Process

Example 1

Estimate TG for LUC 110 (General Light Industrial) on a Weekday as a function of Employees. Assume site has 25 employees.


Step 2: Site size is within range of data

Step 3: Sufficient number of data points

Step 4: Fitted curve equation provided

Step 7: More than 20 data points; and line corresponding to fitted survey equation within cluster of data points near size of study site (or at least for slightly smaller and slightly larger sites)

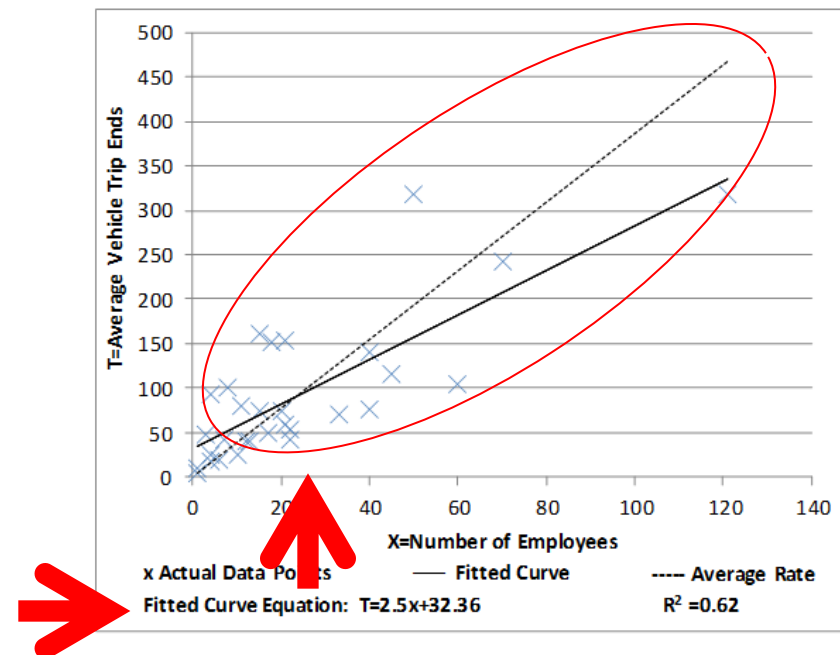
Use Fitted Curve Equation

General Light Industrial (110)		
Average Vehicle Trip Ends vs: Employees On a: Weekday		
Number of Studies:	30	
Average Number of Employees:	23.8	
Directional Distribution:	50% entering, 50% exiting	

Trip Generation per Employees

Average Rate	Range of Rates	Standard Deviation
3.86	1.73-23.50	2.87

Data Plot and Equation



Example 2

Estimate TG for LUC 150 (Warehousing) on a Weekday, Peak Hour of Adjacent Street Traffic, One Hour Between 4 and 6 p.m. as a function of Employees. Assume site has 25 employees.

Step 2: Site size is within range of data

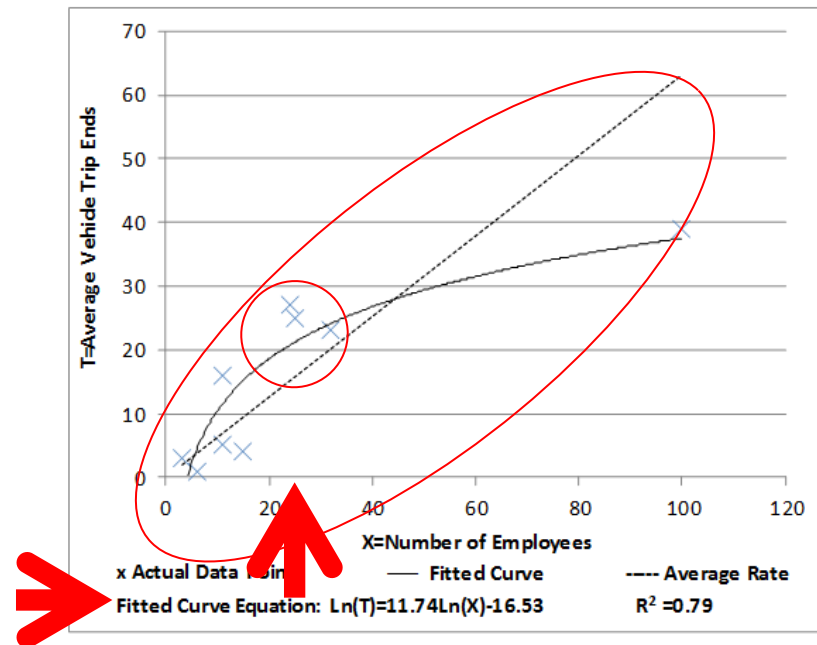
Step 3: Sufficient data points (9)

Step 4: Fitted curve equation provided

Step 7: NOT at least 20 data points distributed over the typical range of the independent variable; but line corresponding to fitted curve equation within cluster of data points near size of the study site

Warehousing (150)		
Average Vehicle Trip Ends vs: Employees		
On a: Weekday, Peak Hour of Adjacent Street Traffic, One Hour Between 4 and 6 p.m.		
Number of Studies:	9	
Average Number of Employees:	25.2	
Directional Distribution: 32% entering, 68% exiting		
Trip Generation per Employees		
Average Rate	Range of Rates	Standard Deviation
0.63	0.17-1.45	0.40

Data Plot and Equation



Example 2 (con't)

Estimate TG for LUC 150 (Warehousing)

Question 8A: R^2 for fitted curve equation (0.79) greater than or equal to 0.75; and line corresponding to fitted curve equation within the cluster of data points at study site size

*Answer is yes

Question 8B: Weighted standard deviation (0.40) NOT less than or equal to 55 percent of weighted average rate ($0.55 \times 0.63 = 0.35$); line corresponding to weighted average rate somewhat within cluster of data points at size of study site

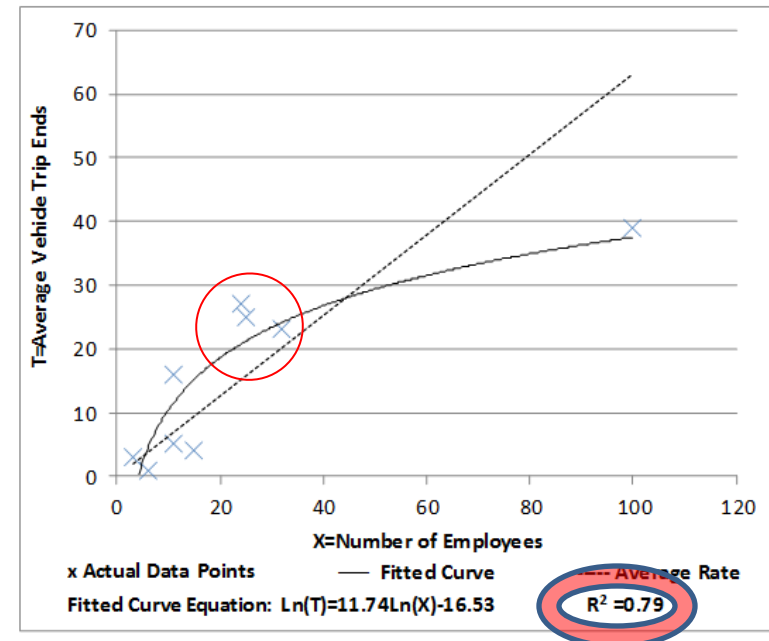
*Answer is no

Warehousing (150)	
Average Vehicle Trip Ends vs:	Employees
On a:	Weekday, Peak Hour of Adjacent Street Traffic, One Hour Between 4 and 6 p.m.
Number of Studies:	9
Average Number of Employees:	25.2
Directional Distribution:	32% entering, 68% exiting

Trip Generation per Employees

Average Rate	Range of Rates	Standard Deviation
0.63	0.17-1.45	0.40

Data Plot and Equation



Example 2 (con't)

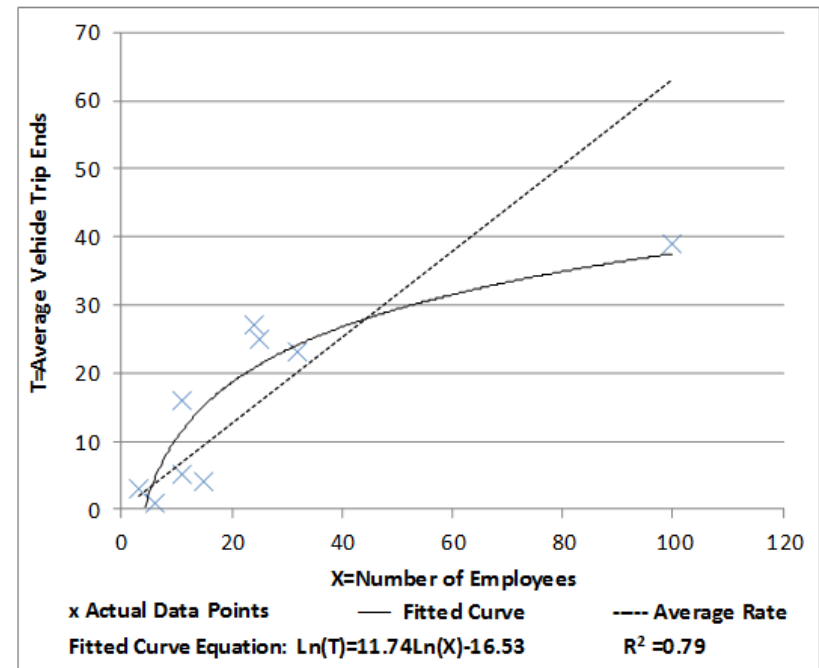
Estimate TG for LUC 150 (Warehousing)

Step 8: Answer to Question 8A is **yes**, and answer to Question 8B is **no**

Use the Fitted Curve Equation

Warehousing (150)		
Average Vehicle Trip Ends vs: Employees		
On a: Weekday, Peak Hour of Adjacent Street Traffic, One Hour Between 4 and 6 p.m.		
Number of Studies: 9		
Average Number of Employees: 25.2		
Directional Distribution: 32% entering, 68% exiting		
Trip Generation per Employees		
Average Rate	Range of Rates	Standard Deviation
0.63	0.17-1.45	0.40

Data Plot and Equation



Example 3

Estimate TG for *LUC 853 (Convenience Market with Gasoline Pumps)* on a *Weekday* as a function of 1000 Sq. Feet Gross Floor Area. Assume the site will have a gross floor area of 3000 square feet.

Convenience Market with Gasoline Pumps (853)

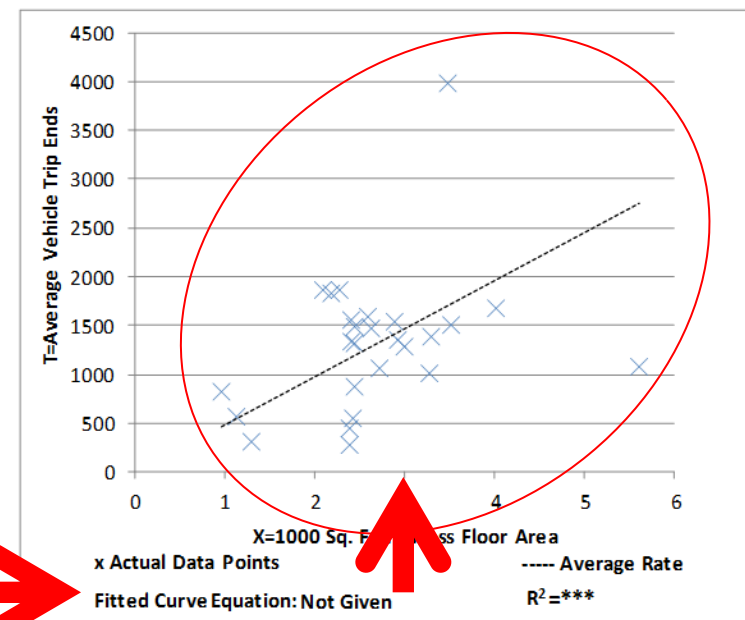
Average Vehicle Trip Ends vs: 1000 Sq. Feet Gross Floor Area
On a: Weekday

Number of Studies: 26
Average Number of 1000 Sq. Feet Gross Floor Area: 2.7
Directional Distribution: 50% entering, 50% exiting

Trip Generation per 1000 Sq. Feet Gross Floor Area

Average Rate	Range of Rates	Standard Devia
491.80	115.13-1,149.37	251.82

Data Plot and Equation



Step 2: Size of site is within the range of data

Step 3: Sufficient number of data points (26)

Step 4: Fitted curve equation NOT provided

Example 3 (con't)

Estimate trip generation for Land Use Code 853 (Convenience Market with Gasoline Pumps) on a Weekday as a function of 1000 Sq. Feet Gross Floor Area. Assume the site will have a gross floor area of 3,000 square feet.

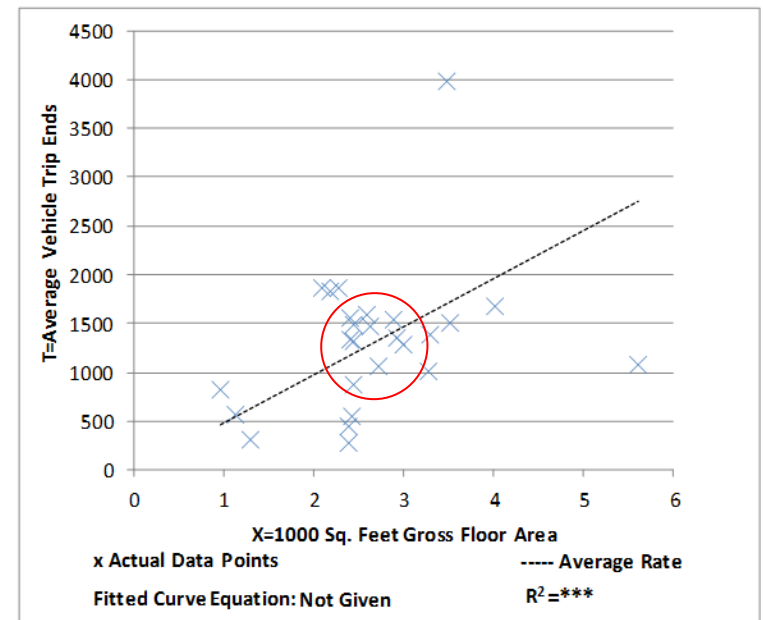
Step 5: Weighted standard deviation (251.82) less than or equal to 55 percent of weighted average rate ($0.55 \times 491.80 = 270.49$)

Step 6: Line corresponding to weighted average rate within a cluster of data points near study site size

Use the Weighted Average Rate

Convenience Market with Gasoline Pumps (853)		
Average Vehicle Trip Ends vs: 1000 Sq. Feet Gross Floor Area		
On a: Weekday		
Number of Studies: 26		
Average Number of 1000 Sq. Feet Gross Floor Area: 2.7		
Directional Distribution: 50% entering, 50% exiting		
Trip Generation per 1000 Sq. Feet Gross Floor Area		
Average Rate	Range of Rates	Standard Deviation
491.80	115.13-1,149.37	251.82

Data Plot and Equation



Example 4

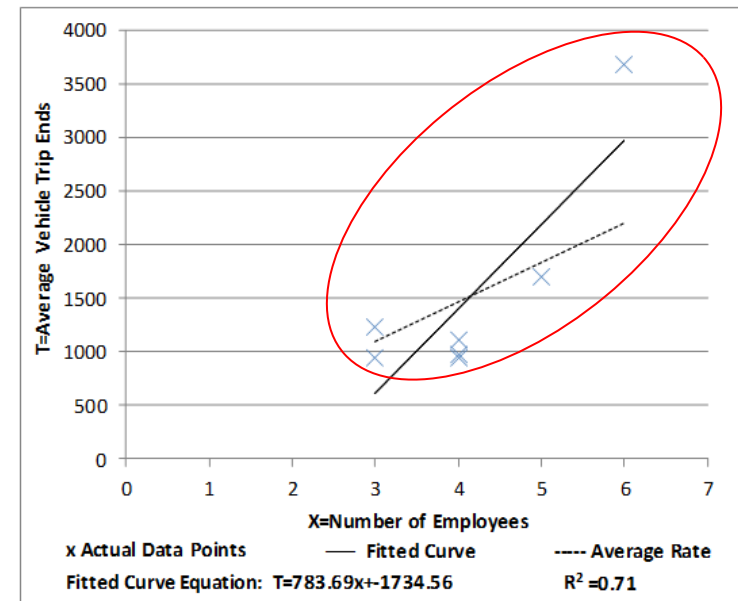
Estimate trip generation
for **Land Use Code 944**
(**Gasoline/Service Station**)
on a **Weekday** as a
function of **Employees**.
Assume the site will have
10 employees.

Step 2: Size of site is NOT within the
range of data (highest the range goes is 6
employees)

**Collect Local Data (or consider the use
of a different independent variable and
its associated data pages)**

Gasoline/Service Station (944)		
Average Vehicle Trip Ends vs: Employees On a: Weekday		
Number of Studies: 7		
Average Number of Employees: 4.1		
Directional Distribution: 50% entering, 50% exiting		
Trip Generation per Employees		
Average Rate	Range of Rates	Standard Deviation
365.00	237.50-613.33	148.33

Data Plot and Equation



Instructions (con't)

Choice of Day and Time Period

- Most interested in time period (and associated day) with peak traffic flow of site and adjacent street combined
- Often (but not always), site and adjacent street peak at same time
- Some data collection and assessment may be needed to determine when site generates maximum impact

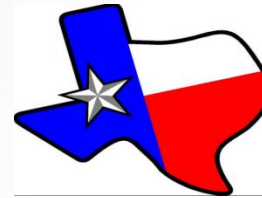


Manual Update Procedure +



- Data contained in original version of the Texas Trip Generation Manual taken from WSG surveys, TTSP
- Anticipated that additional data added as become available
- Results will be made available electronically
- TTI will continue to add TTSP data to the Manual
- TTI also welcomes collection of addition data
- With TxDOT permission, data may be shared with ITE

Comparison of Texas TG Rates to ITE Trip Generation Rates



VS



- Statistical and Practical Significance
- 256 of the 400 Texas rates could be compared to ITE rates
- Texas rates often lower than national rates
- “Based on the results of the analysis there **are differences in the trip generation characteristics of Texas establishments compared to national averages**. Therefore, the continued production of a Texas-specific trip generation manual as part of project RMC-0-6760 is justified (Task 4 memo, p. 13).”

Module 3

Generic Attraction Rates for Modelling

- Database Development
- Area Sizes, Types, and Trip Purposes
- Rates and Variability
- Application and Discussion

Task 3: Compile and Analyze Data to Develop Trip Attraction Rates for Modeling (Critical Components)

- Development of a comprehensive **database of WSG surveys**
- Development and review of **area types and density criteria** for use in developing attraction rates
- Development and review of **NAICS employment types**
- Preliminary development of **standardized attraction rates** for use in Texas travel demand models
- Preliminary review of **variation in attraction rates**

Database Development Key Points

Data Normalization

- Common NAICs to BSR attribution
- Converting geographic codes (study area, county, etc.) unique to surveys to unique for data set (i.e. assigning FIPS codes for counties)
- Establishing common data set of density values and assigned area types

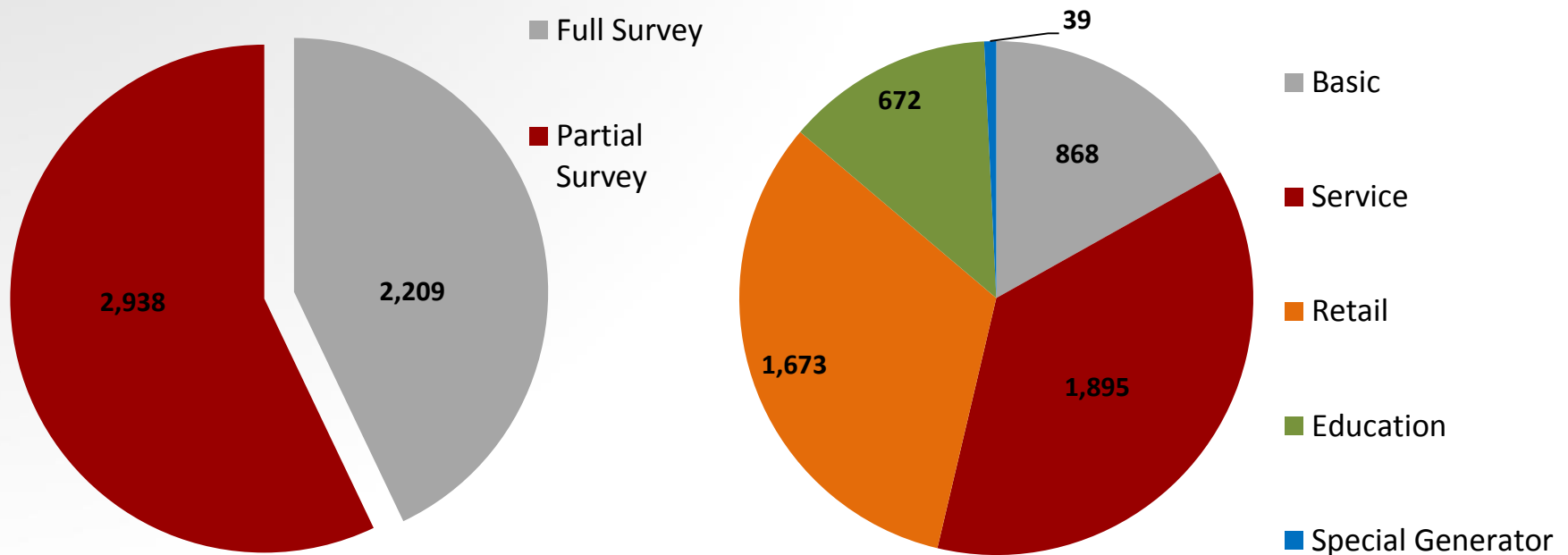
Database Development Key Points

Data Normalization (con't)

- Establishing common data set of skims using urban models and SAM
- Establishing common trip purposes
- Establishing common modes
- Database designed to be scalable as more recent surveys are available (Dallas, Bryan-College Station etc.)

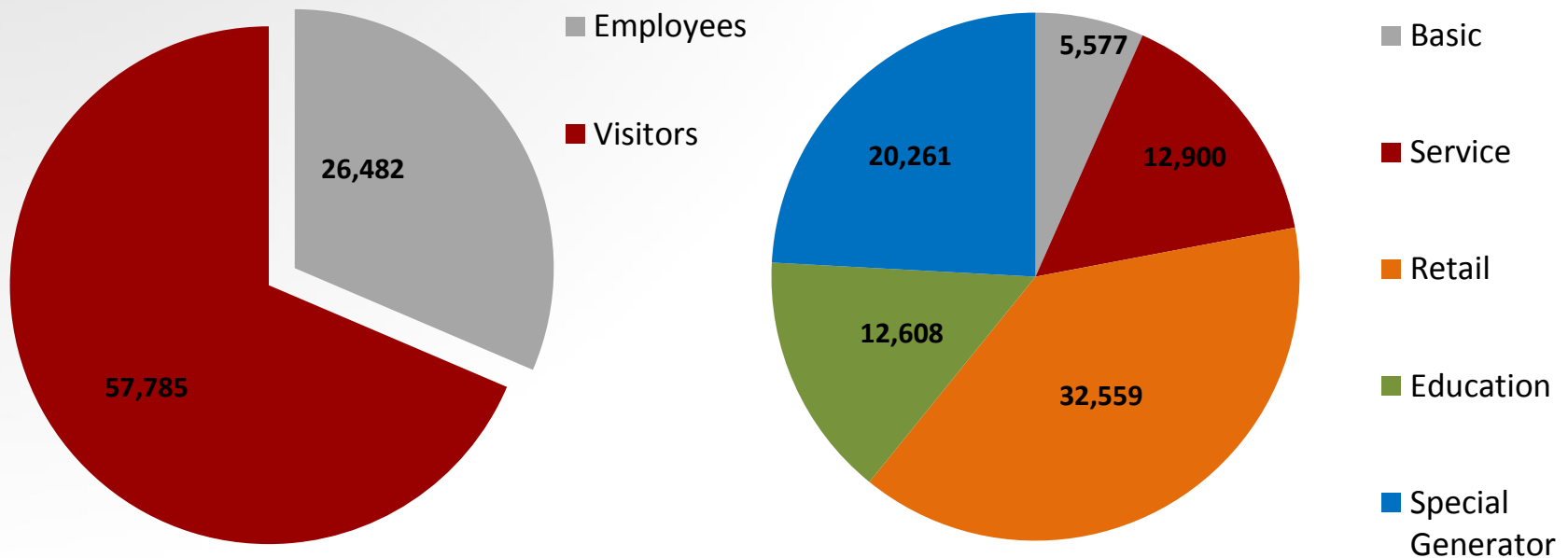
Establishment Surveys

- Establishment database includes 5,147 WP



Intercept Surveys

- Intercept database includes 84,267 surveys



Area Type

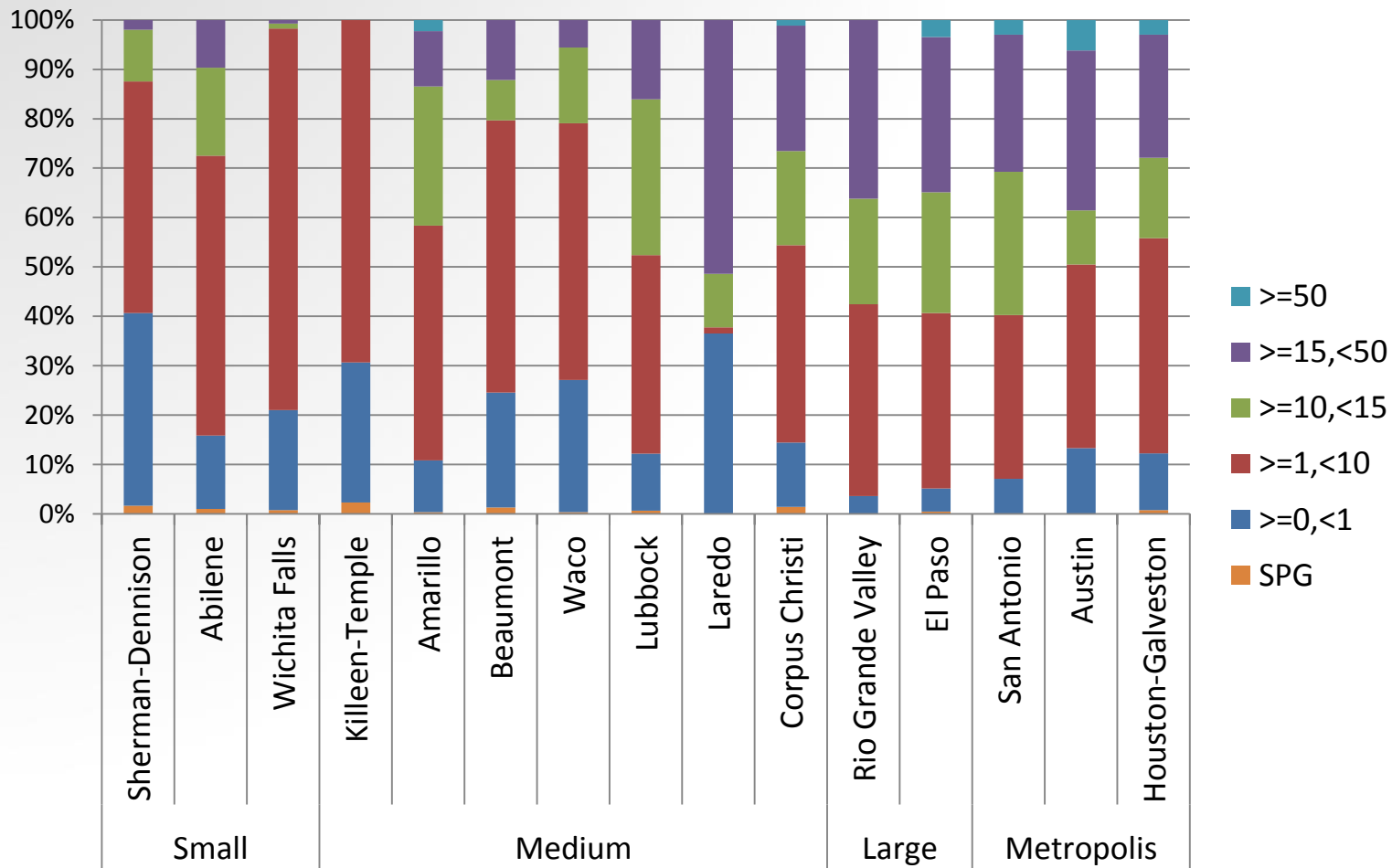
- Area Type for each establishment is assigned using consistent methodology based on population/employment density; area types include:
 - ≥ 0 and < 1 – Rural
 - ≥ 1 and < 10 – Suburban
 - ≥ 10 and < 15 – Urban
 - ≥ 15 and < 50 – CBD Fringe
 - ≥ 50 – Generally CBD
 - Special Generator

(all values are population/employment per acre)

Study Area Grouping

- Study Areas are grouped into 5 categories based on population
- Categories are based on NCHRP 365 and are:
 - **Small** -> Population 50,000 - 199,999:
Abilene, Sherman-Denison, Wichita Falls
 - **Medium** -> Population 200,000 - 499,999:
Beaumont, Killeen-Temple, Corpus Christi, Lubbock, Laredo, Waco, Amarillo
 - **Large** -> Population 500,000 – 1,199,999:
Rio Grande Valley, El Paso
 - **Metropolis** -> Population 1,200,000+:
Houston-Galveston, San Antonio, Austin

Percent of Establishments by Study Area Grouping and Area Type



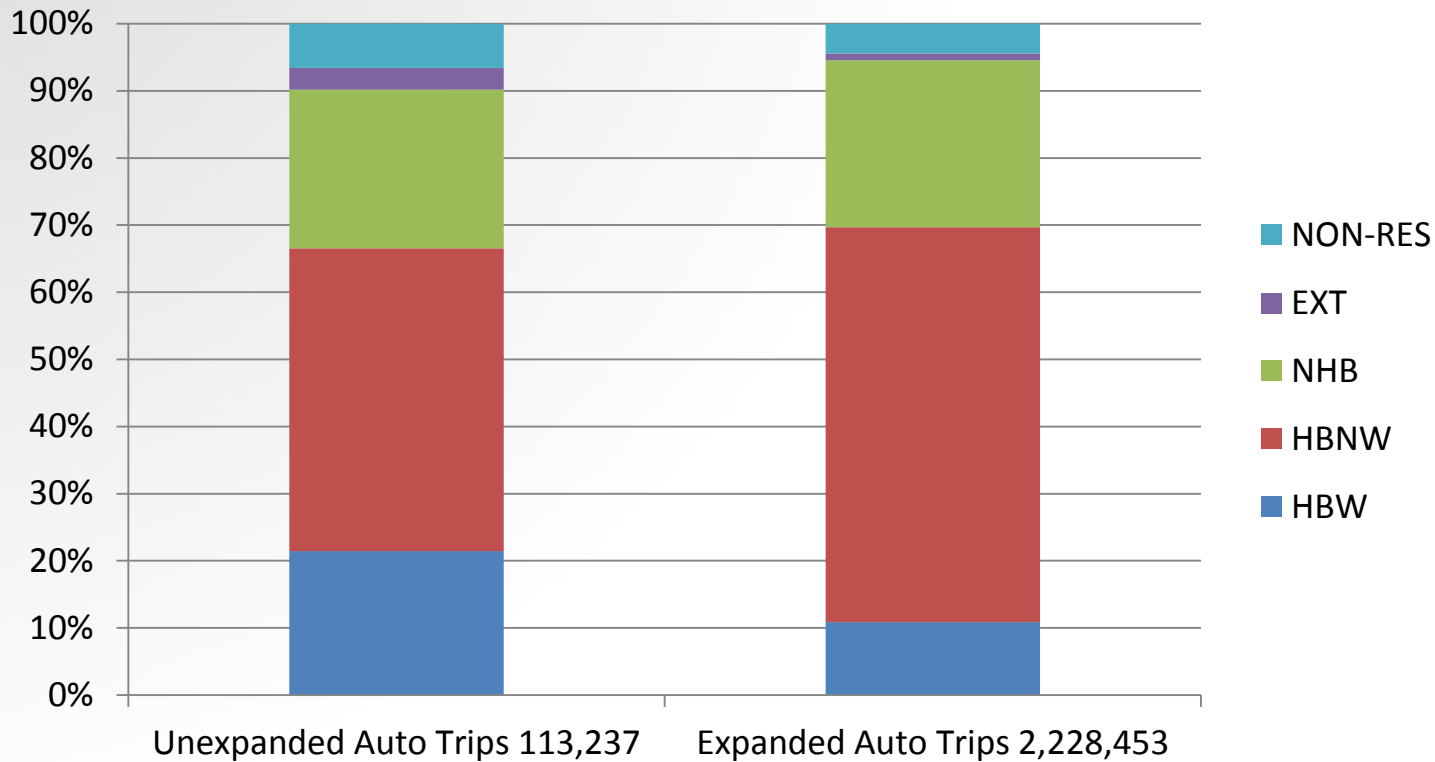
Data Expansion

- Intercept surveys expanded and trip purposes assigned using established TxDOT/TTI methodology
- Expansion is either to traffic or person counts
- Expansion for full survey sites is based on intercepts
- Expansion for partial survey sites is imputed from full survey sites

Trip Purpose

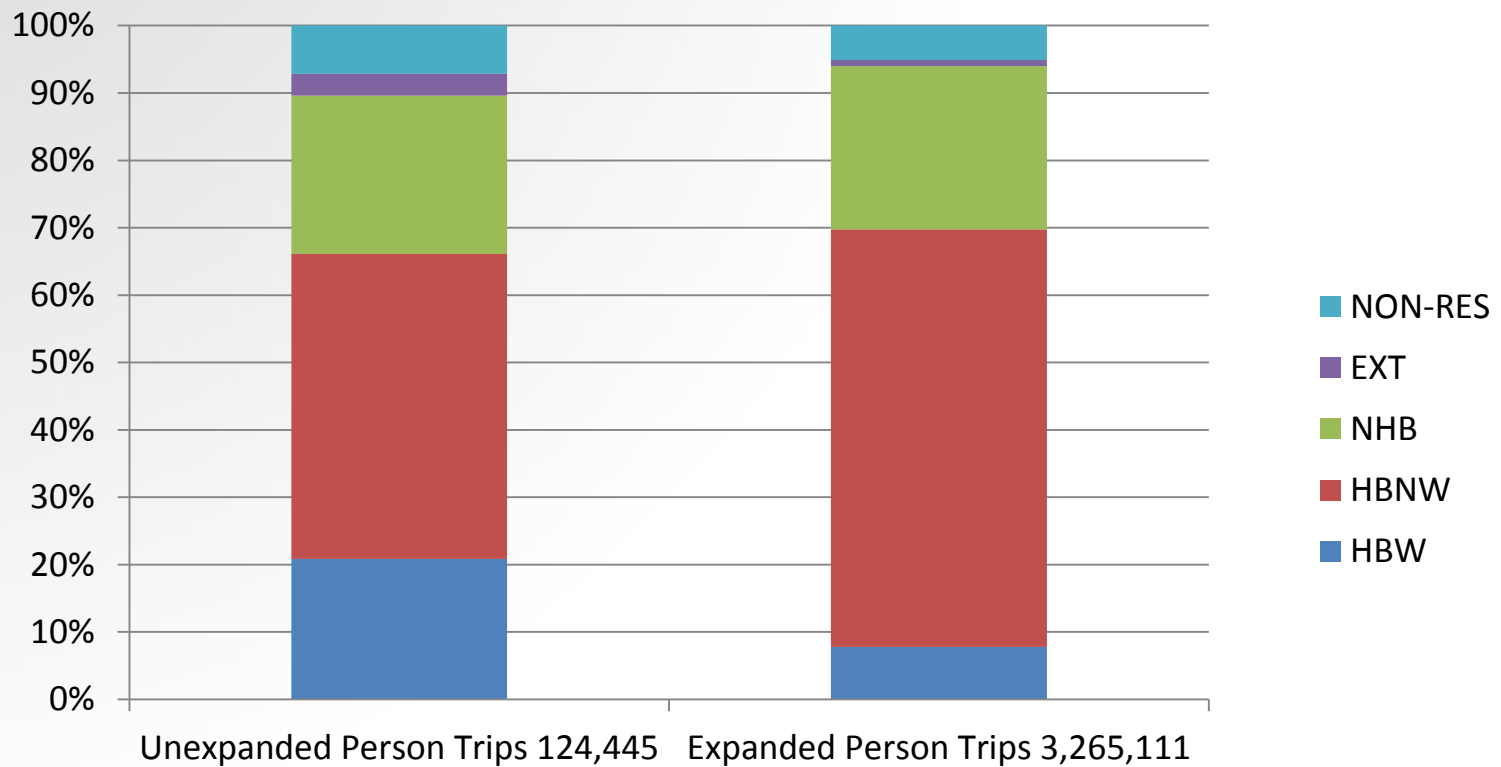
- Standard Trip Purposes Include:
 - Home-based work (HBW)
 - Home-based non-work (HBNW)
 - Non home-based destination (NHB-D)
 - Non home-based origin (NHB-O)
 - External trip origin (EXT-O)
 - External trip destination (EXT-D)

Unexpanded and Expanded Vehicle Trips



Excludes special generator, excluded establishments, and non-free standing establishments not the first store visited trips.

Unexpanded and Expanded Person Trips

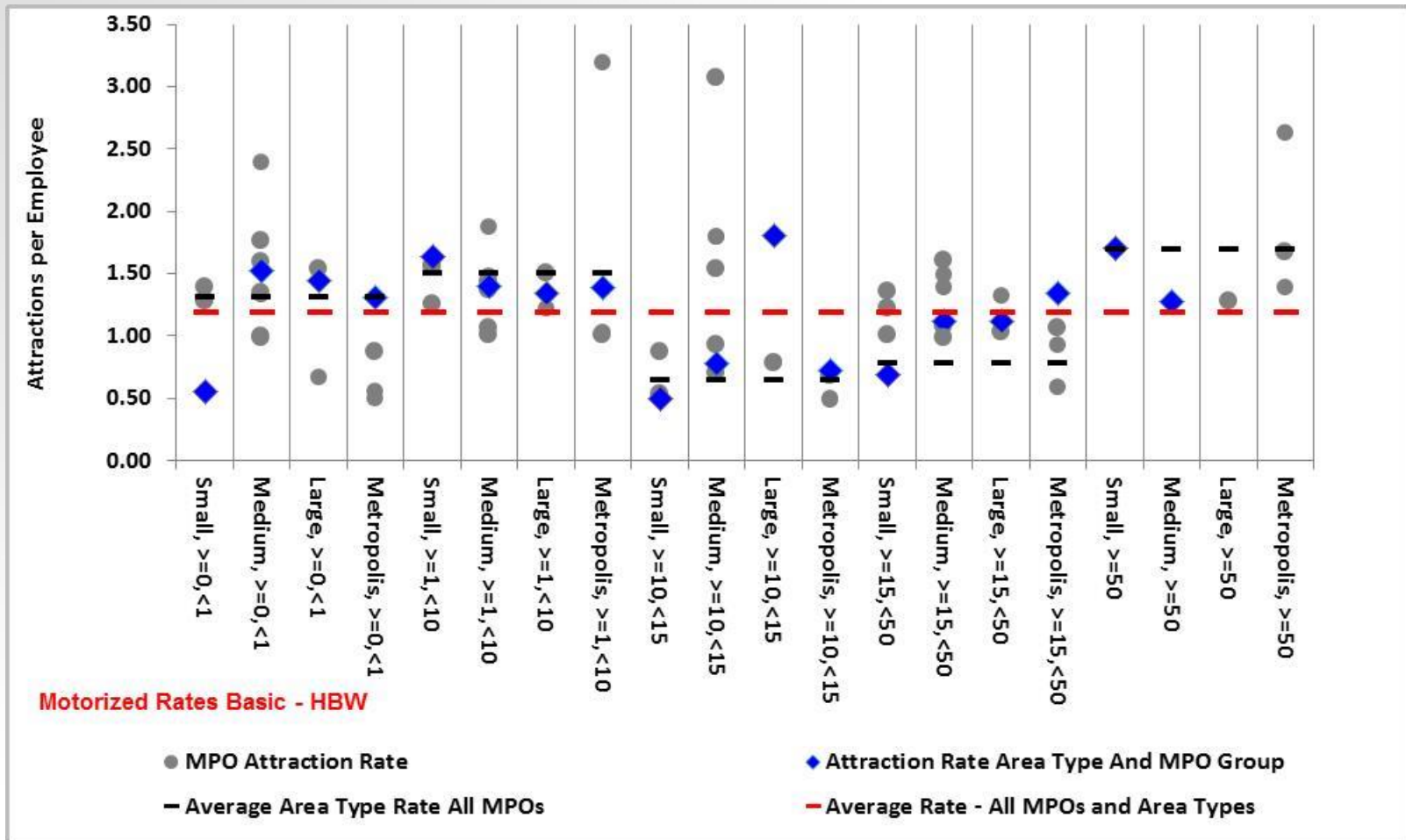


Excludes special generator, excluded establishments, and non-free standing establishments not the first store visited trips.

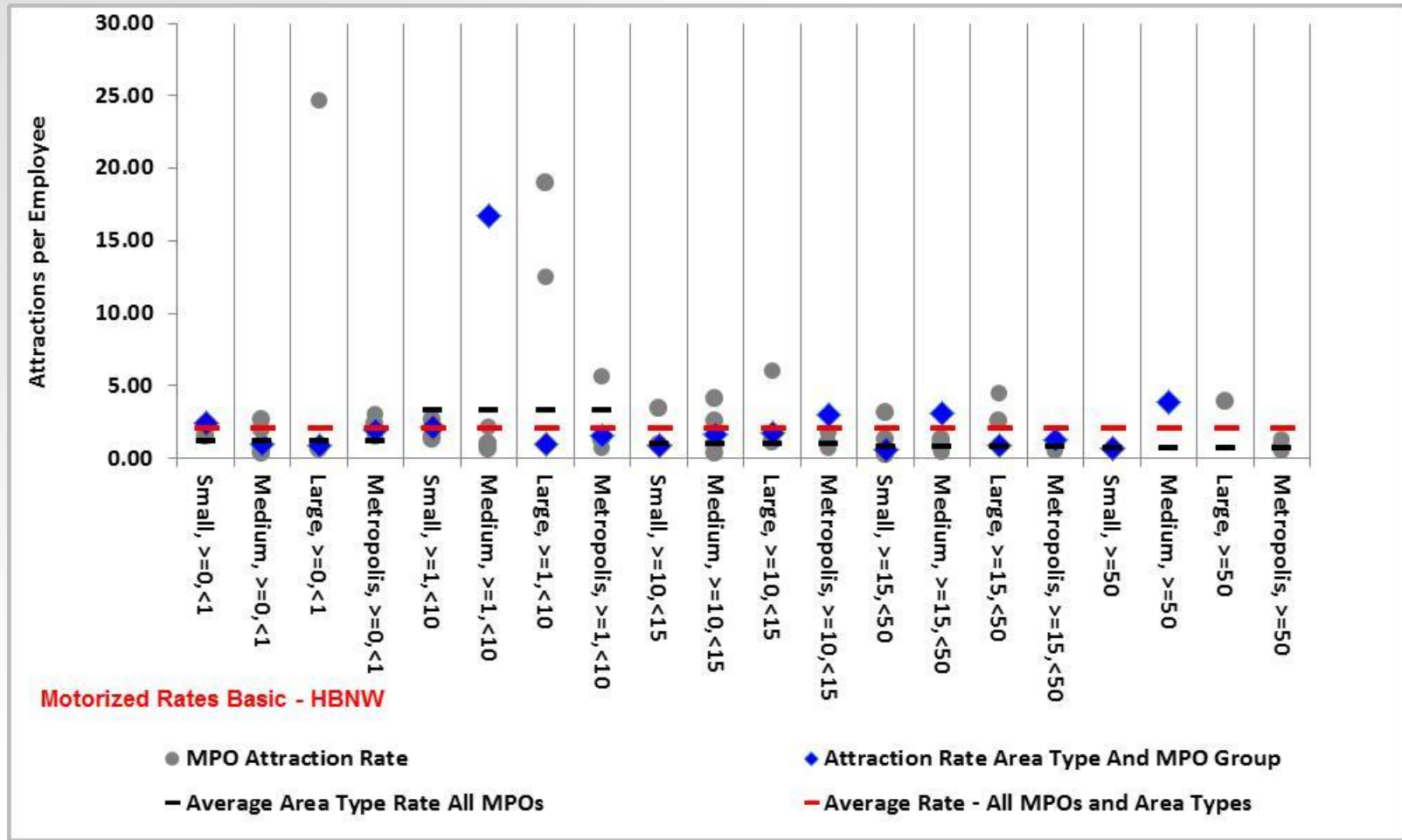
Base Attraction Rates vs Final Attraction Rates for Modeling

- “Base” Attraction rates are developed solely from the expanded data set
- “Final” Attraction rates are post processed to:
 - Balance to Production Rates based on analysis of Household surveys from the same region
 - Smoothed to be harmonious between trip purpose categories

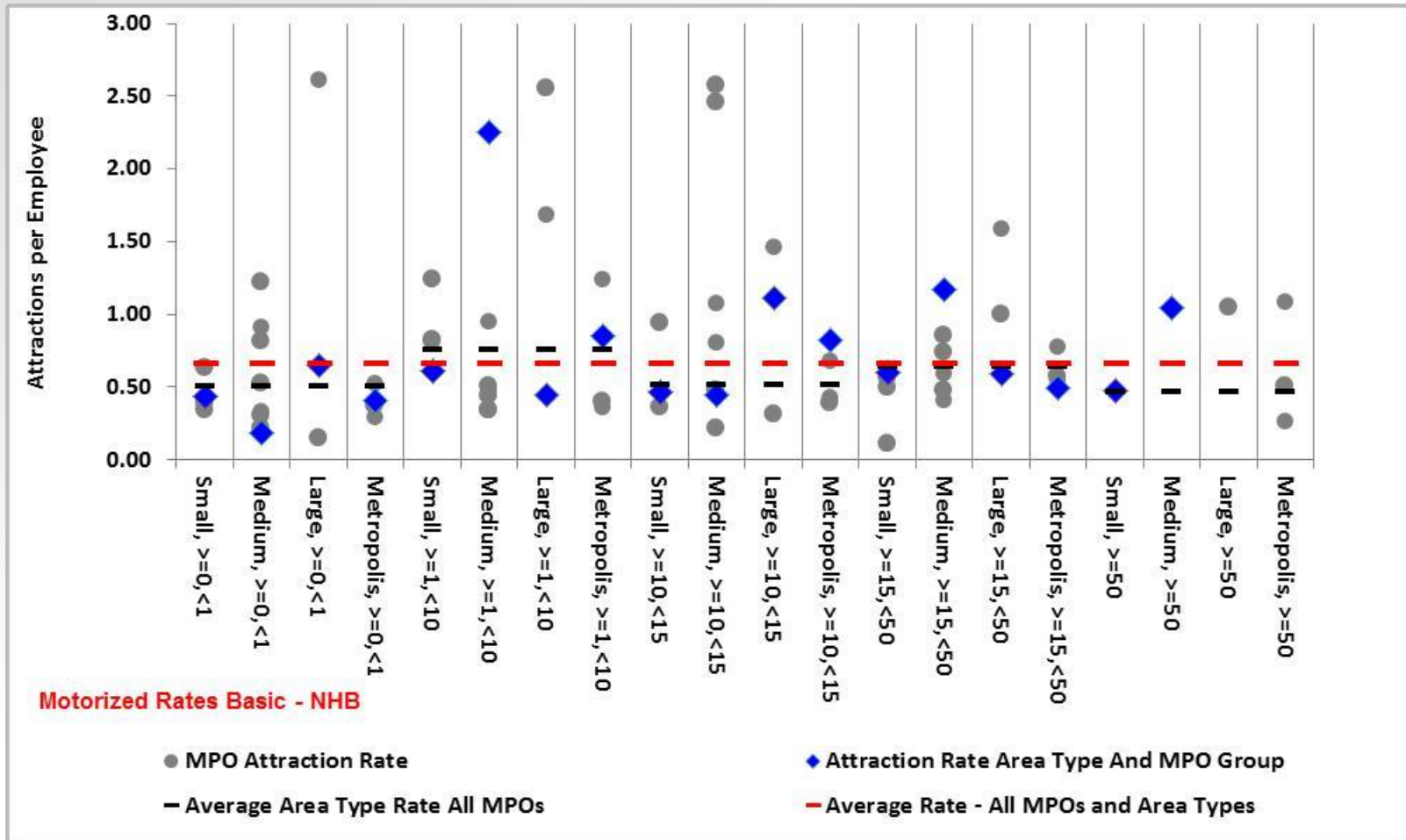
Basic Vehicle Attraction Rates



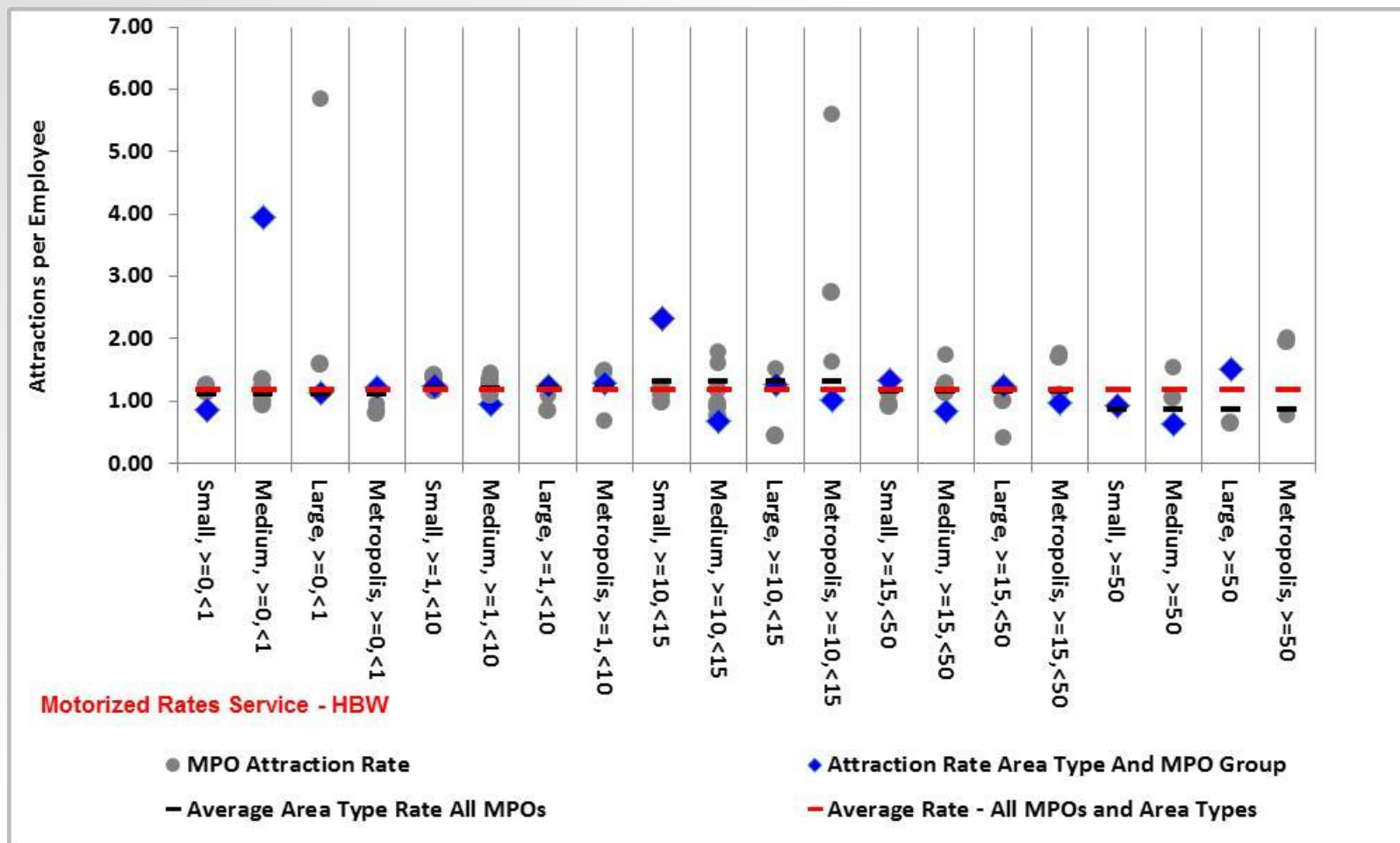
Basic Vehicle Attraction Rates



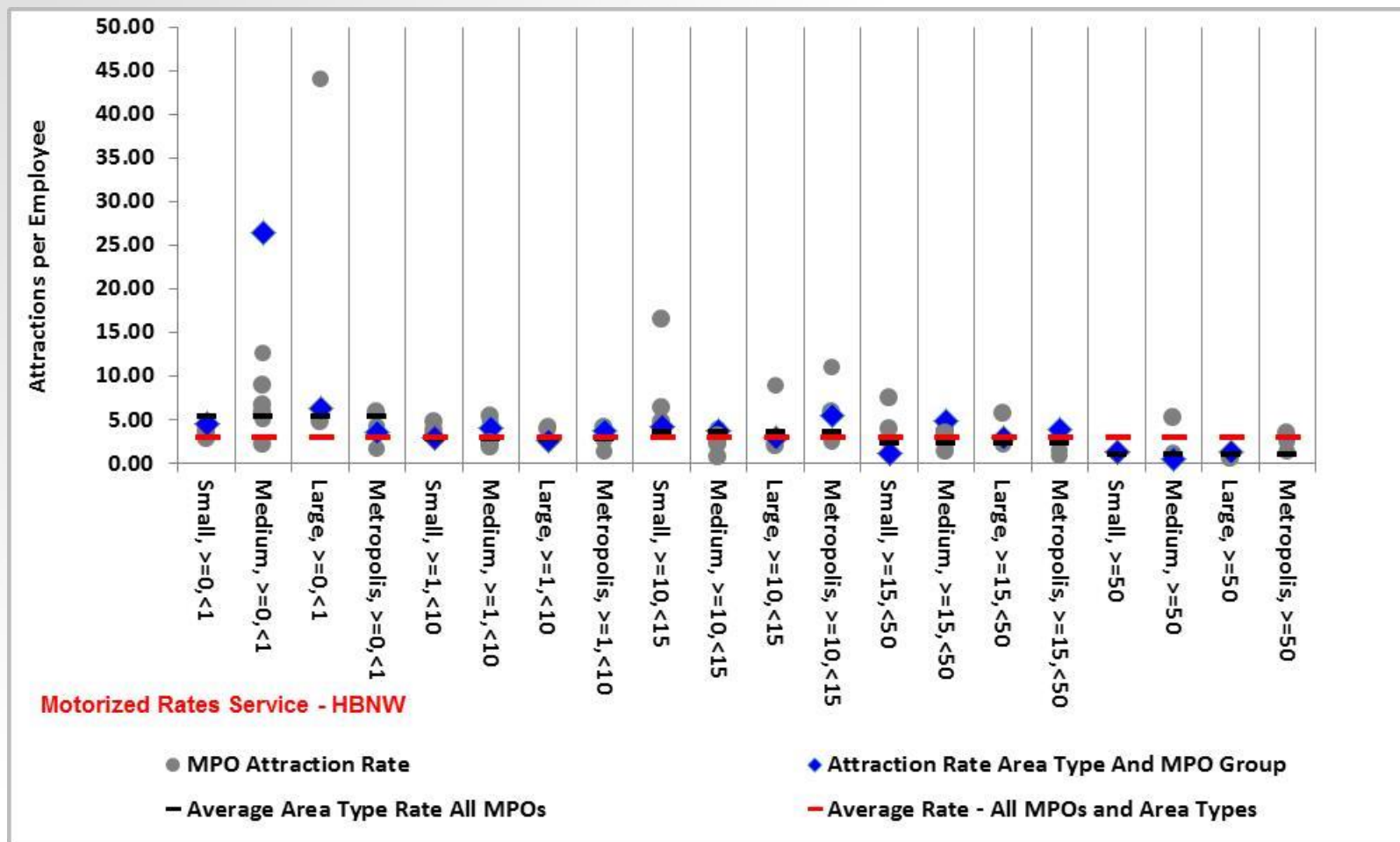
Basic Vehicle Attraction Rates



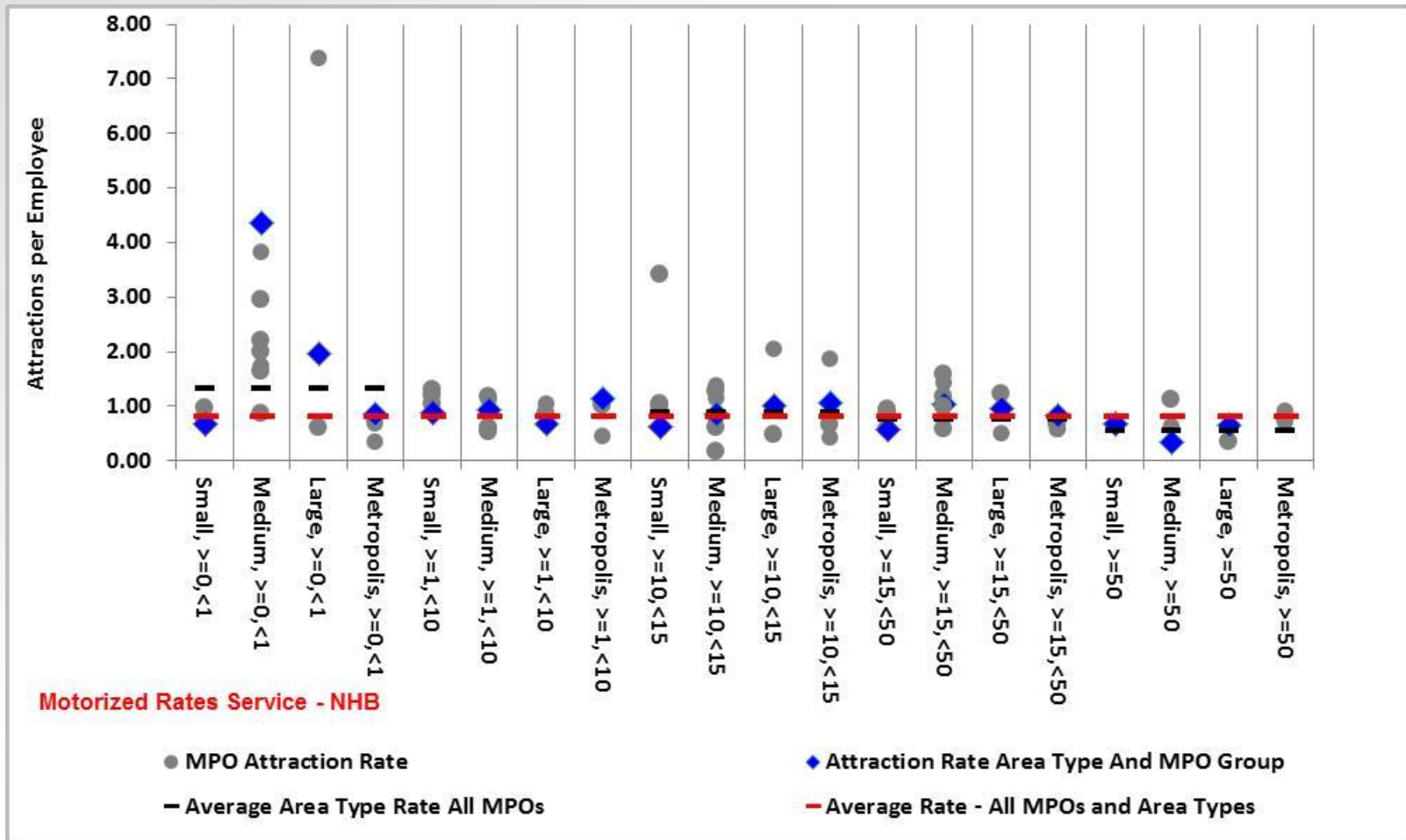
Service Vehicle Attraction Rates



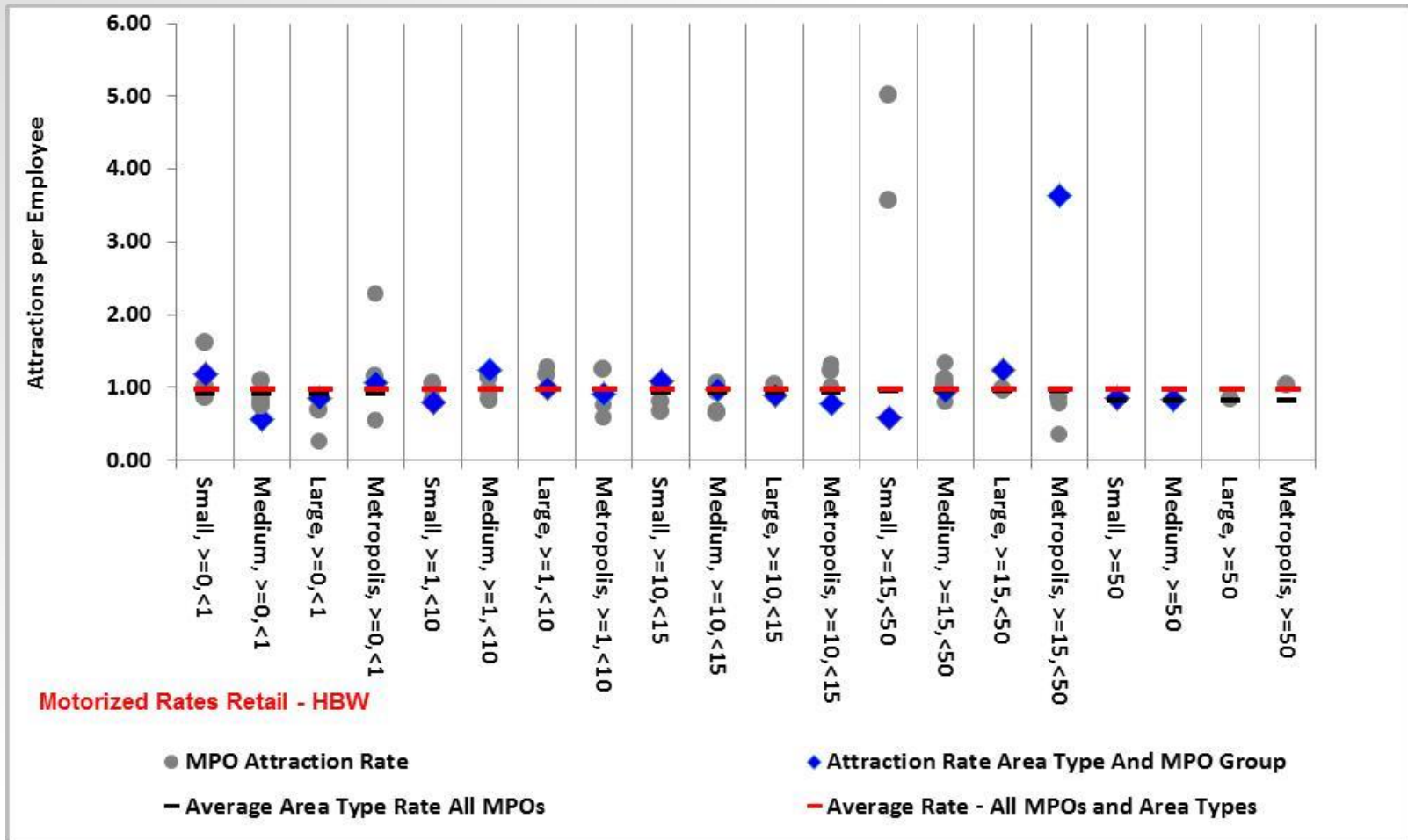
Service Vehicle Attraction Rates



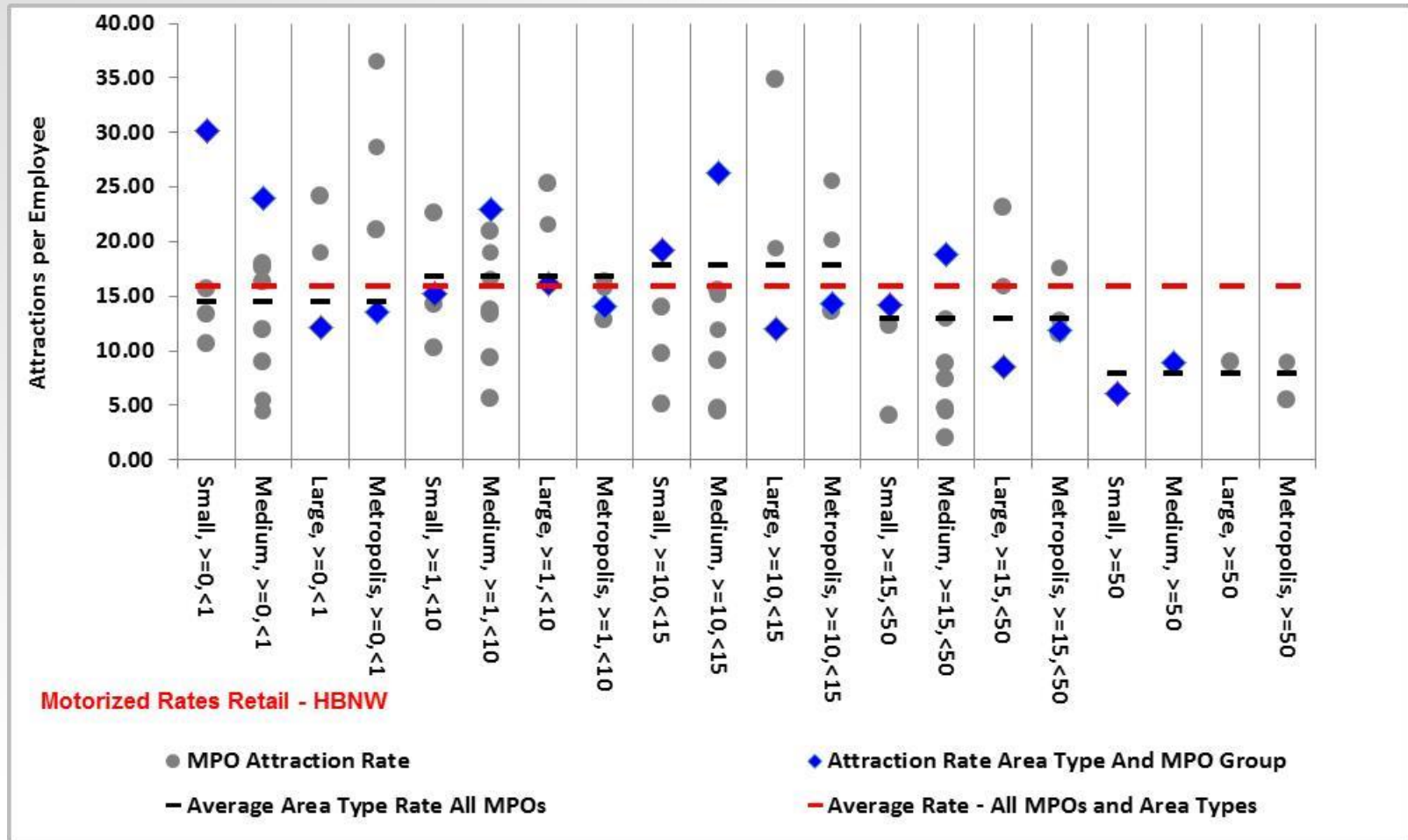
Service Vehicle Attraction Rates



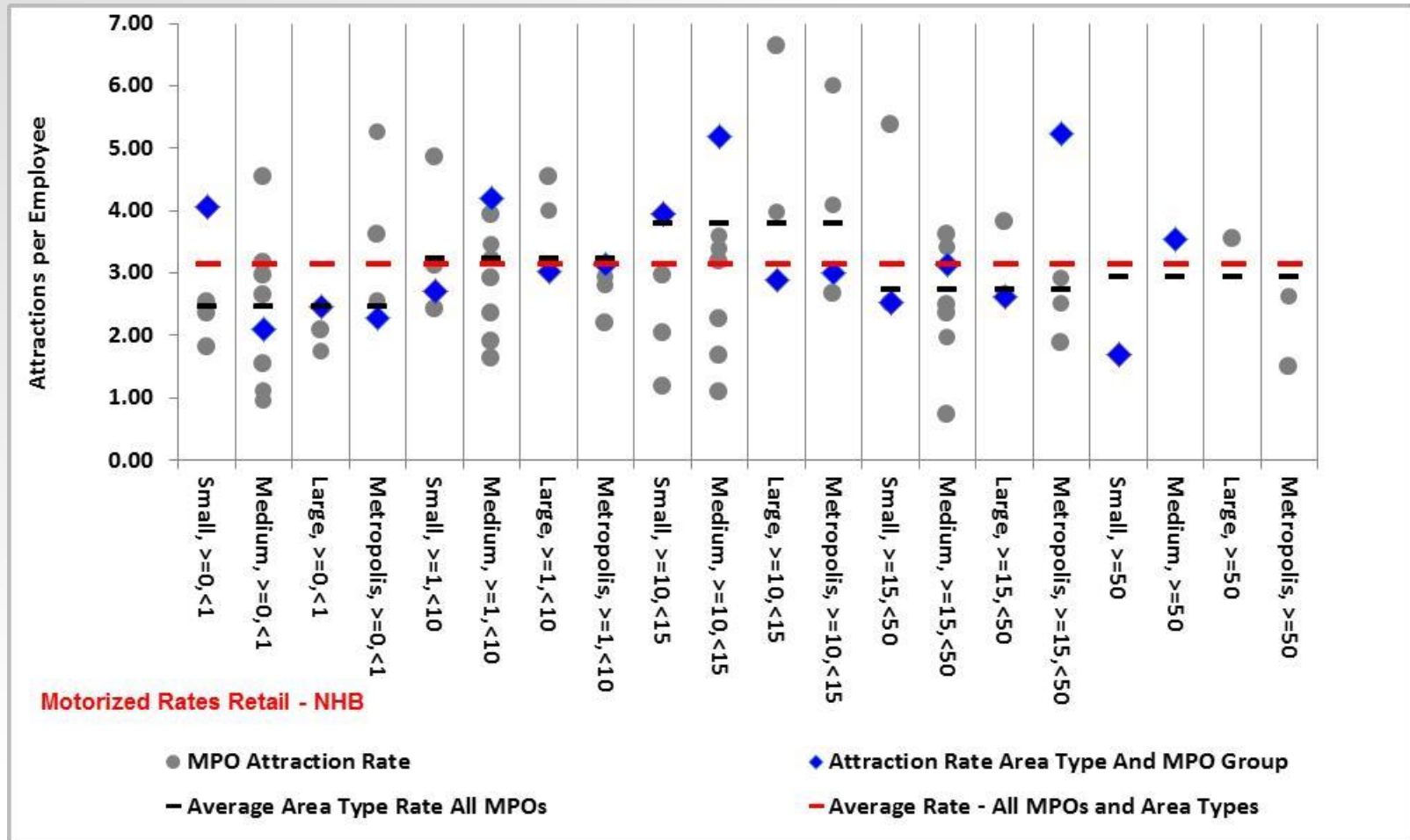
Retail Vehicle Attraction Rates



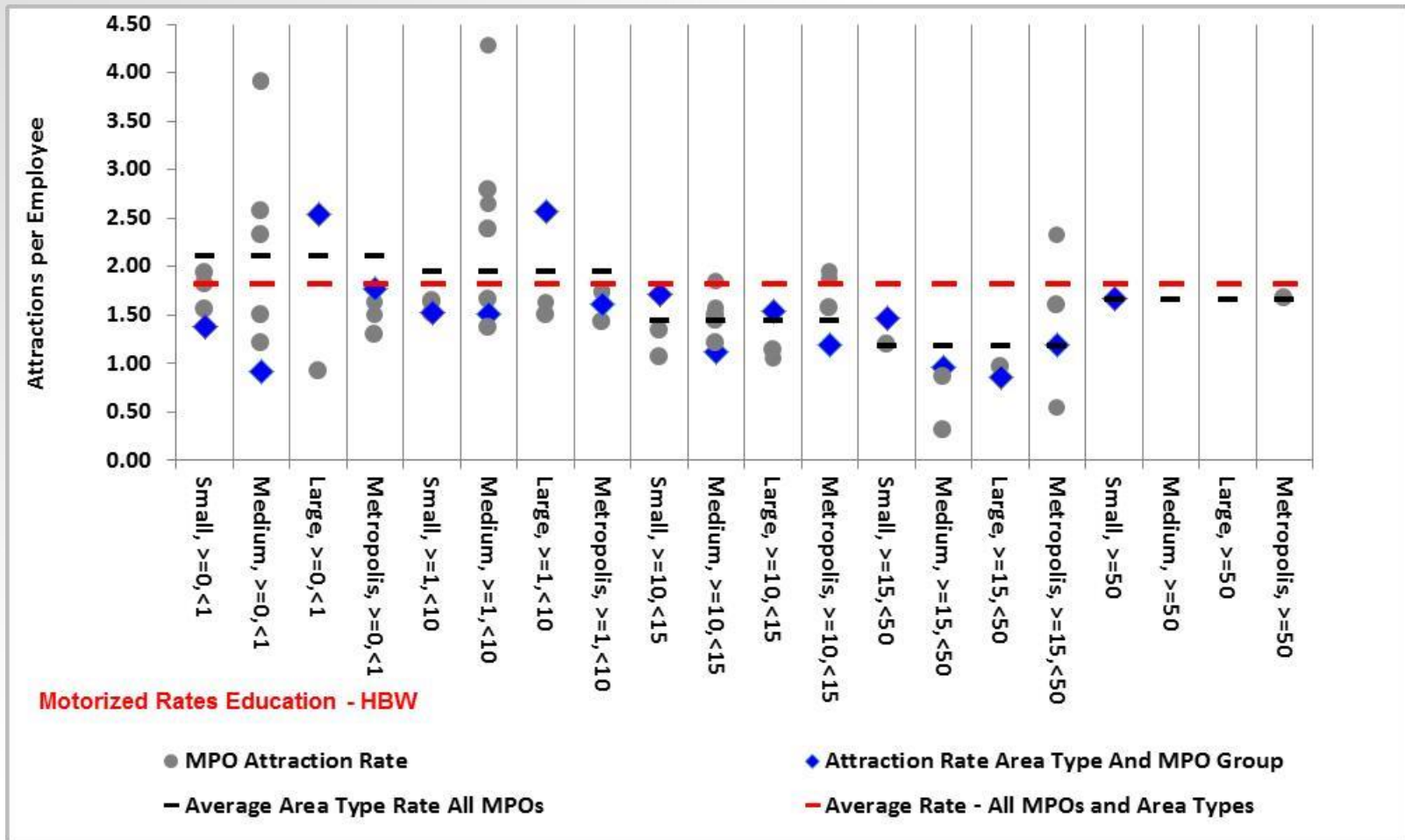
Retail Vehicle Attraction Rates



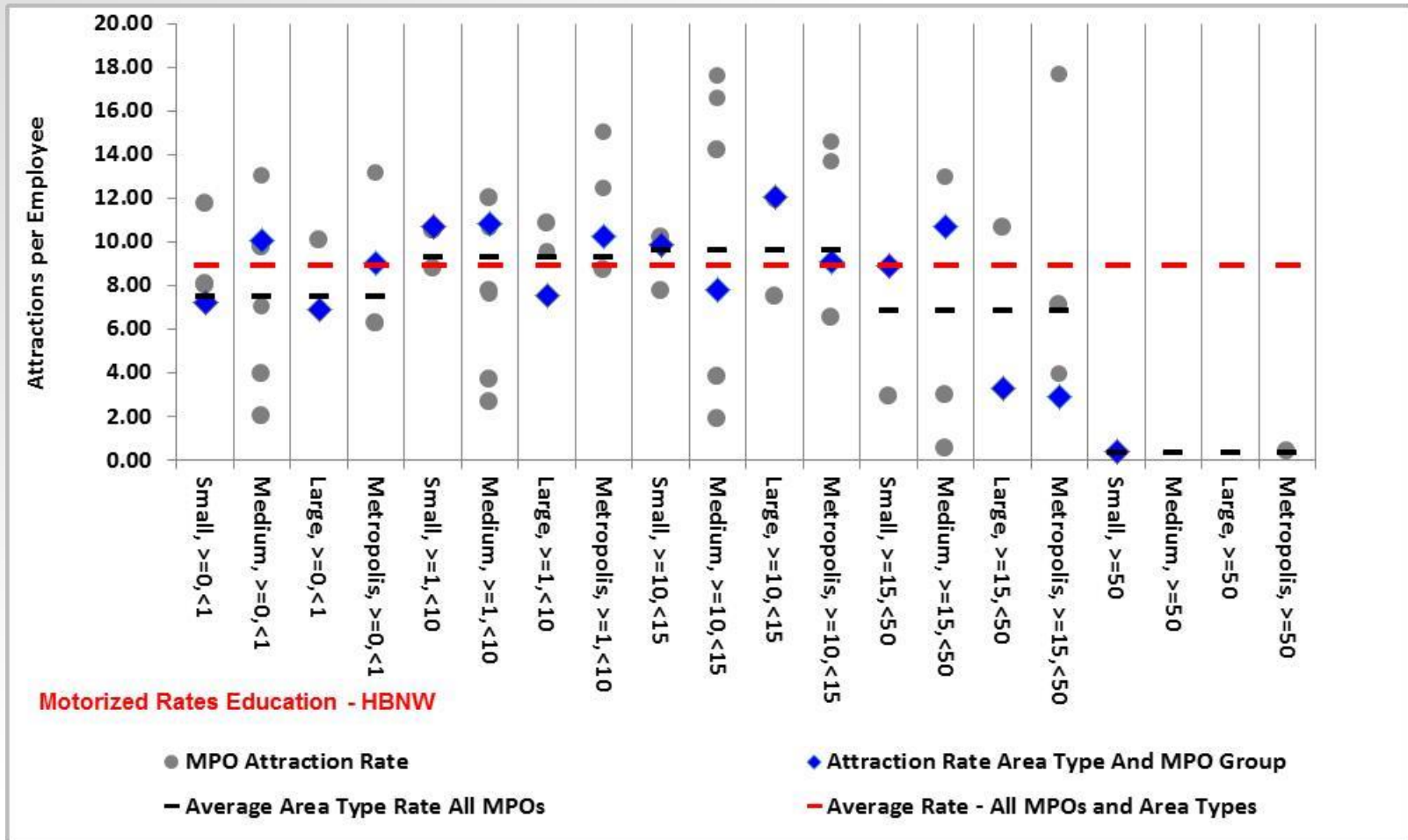
Retail Vehicle Attraction Rates



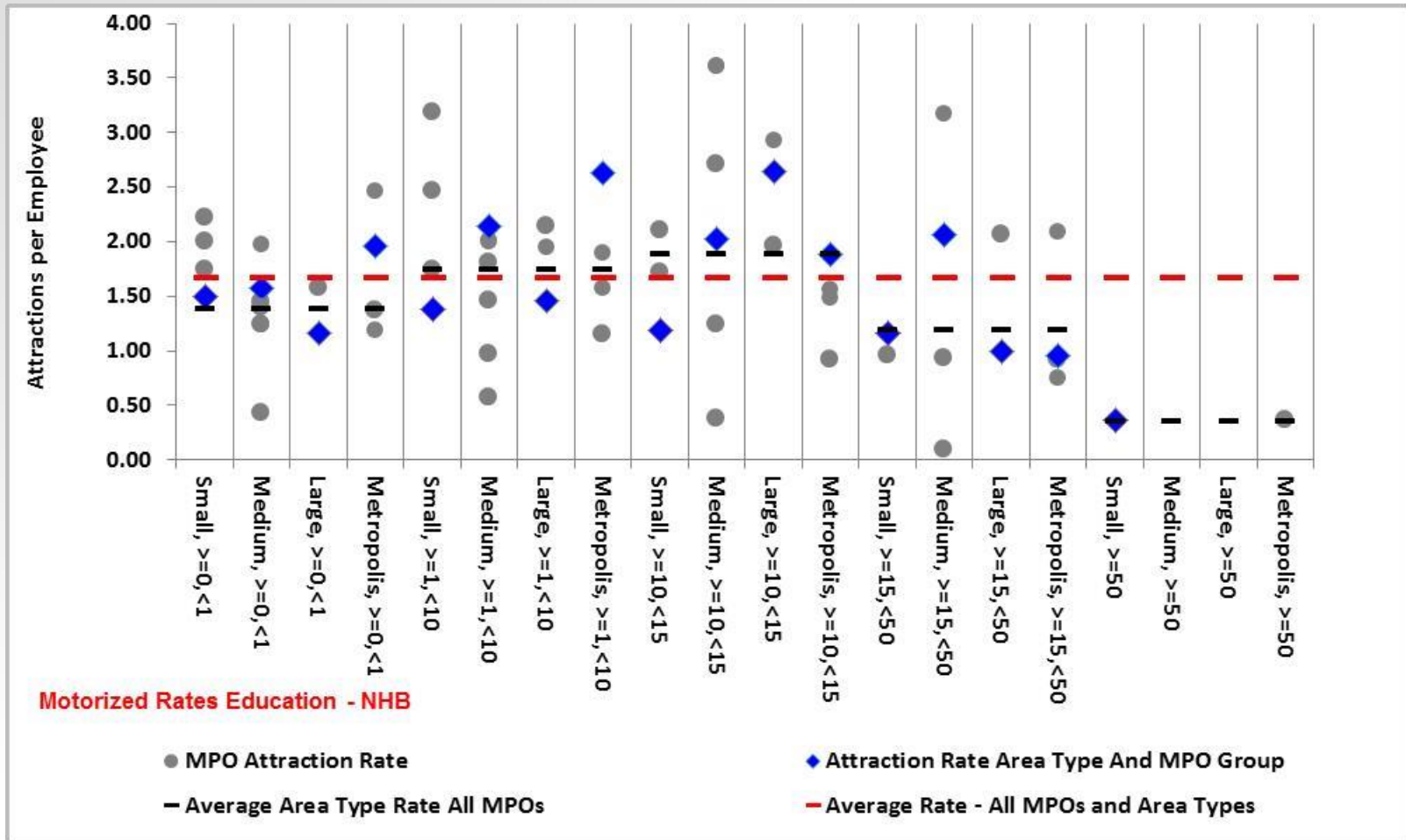
Education Vehicle Attraction Rates



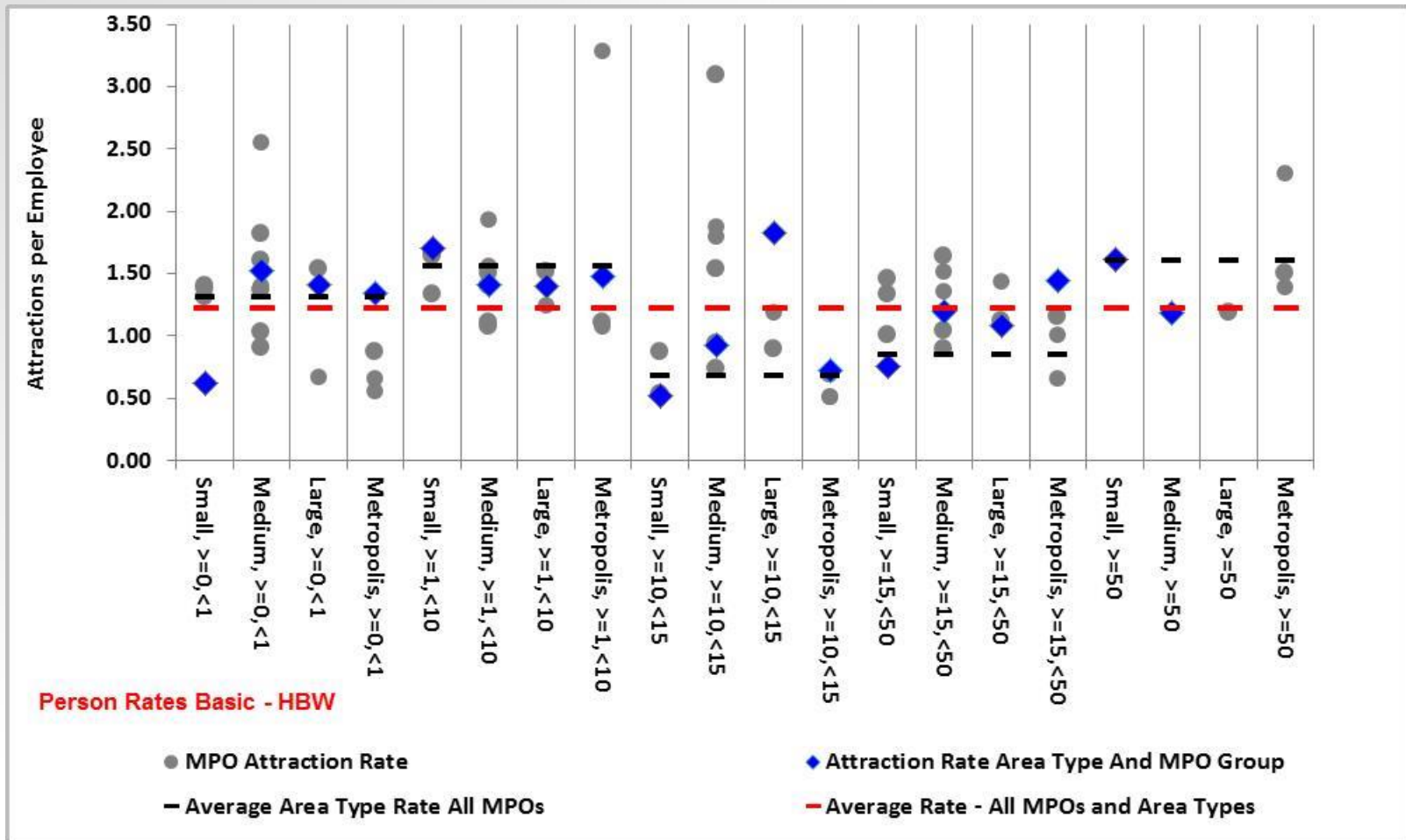
Education Vehicle Attraction Rates



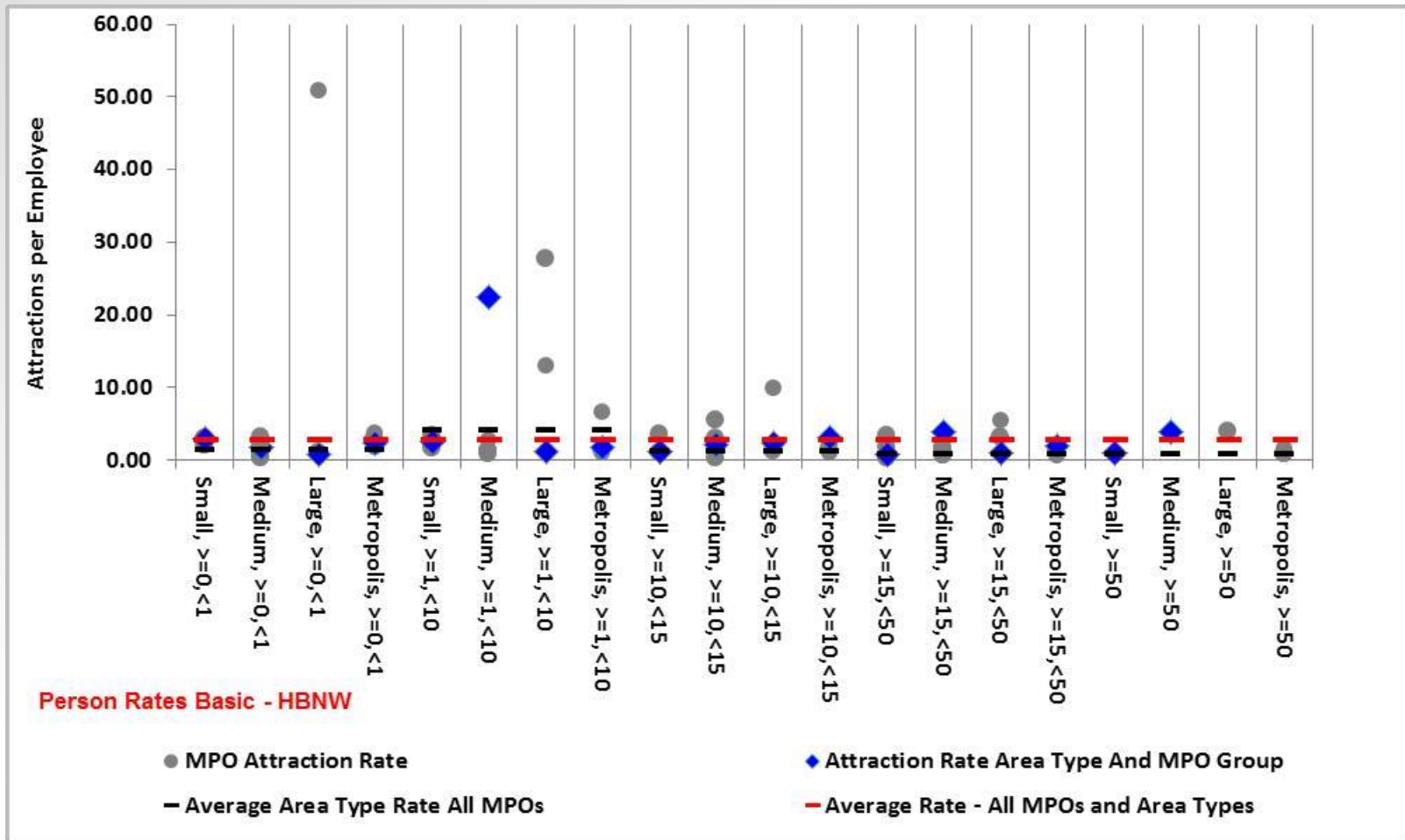
Education Vehicle Attraction Rates



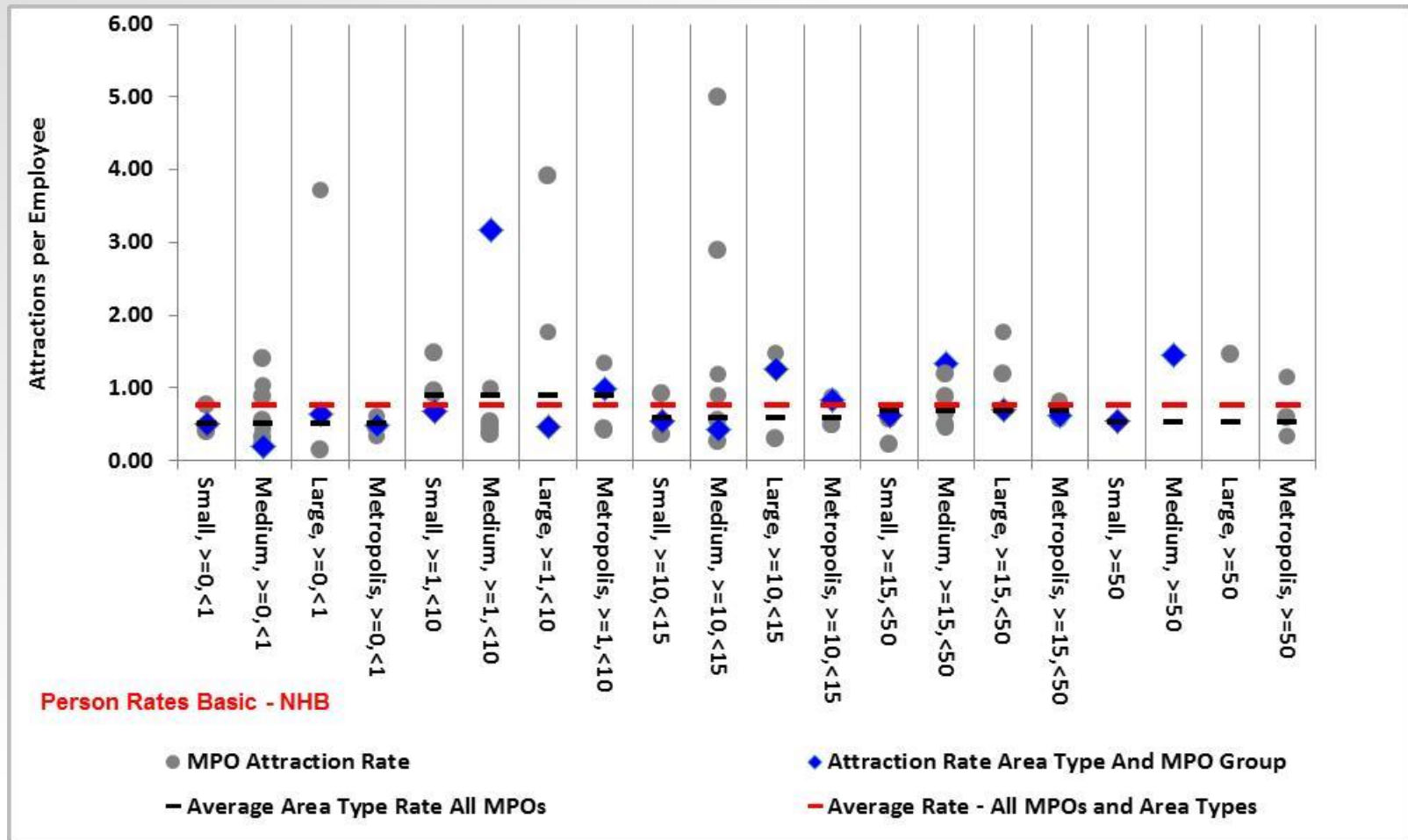
Basic Person Attraction Rates



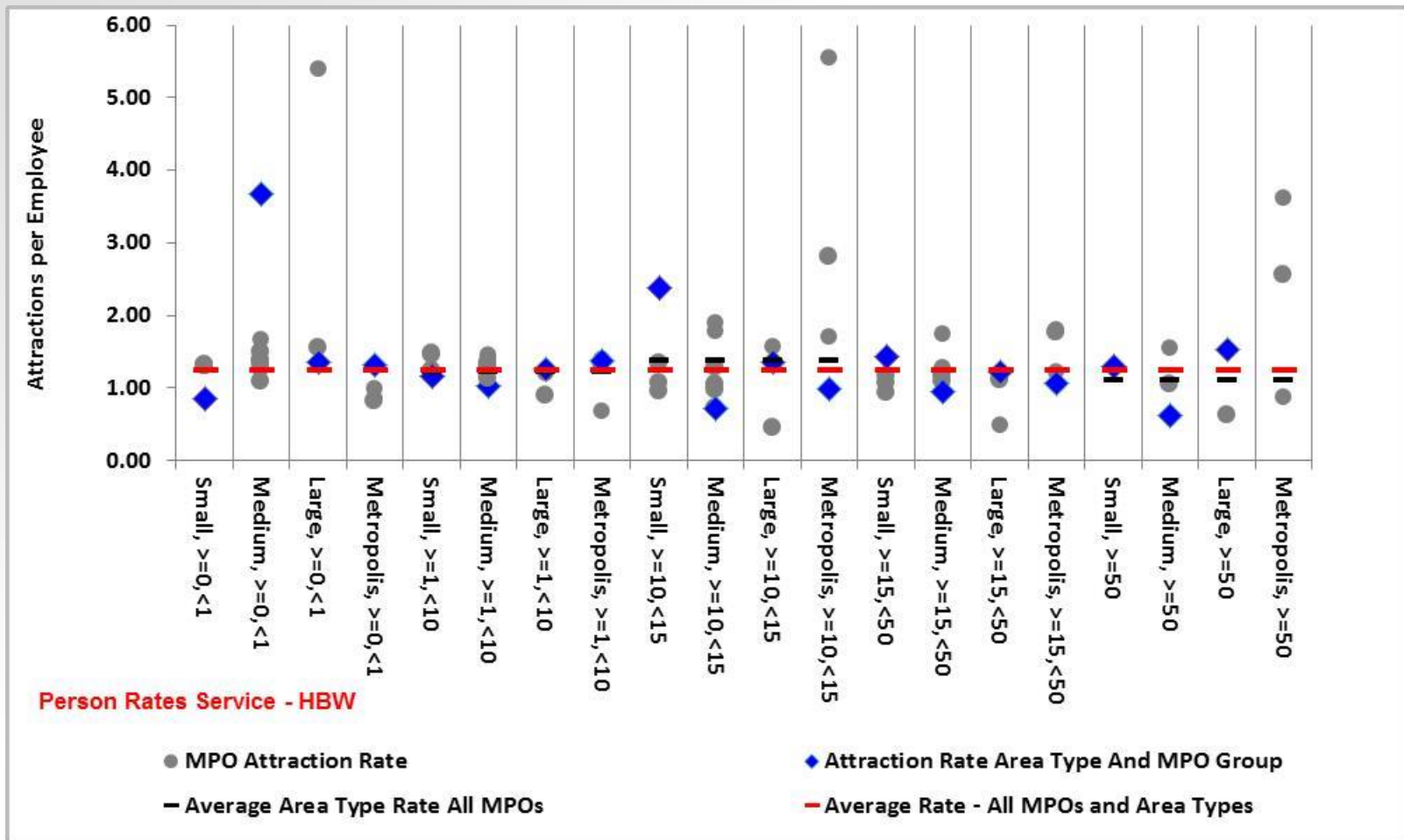
Basic Person Attraction Rates



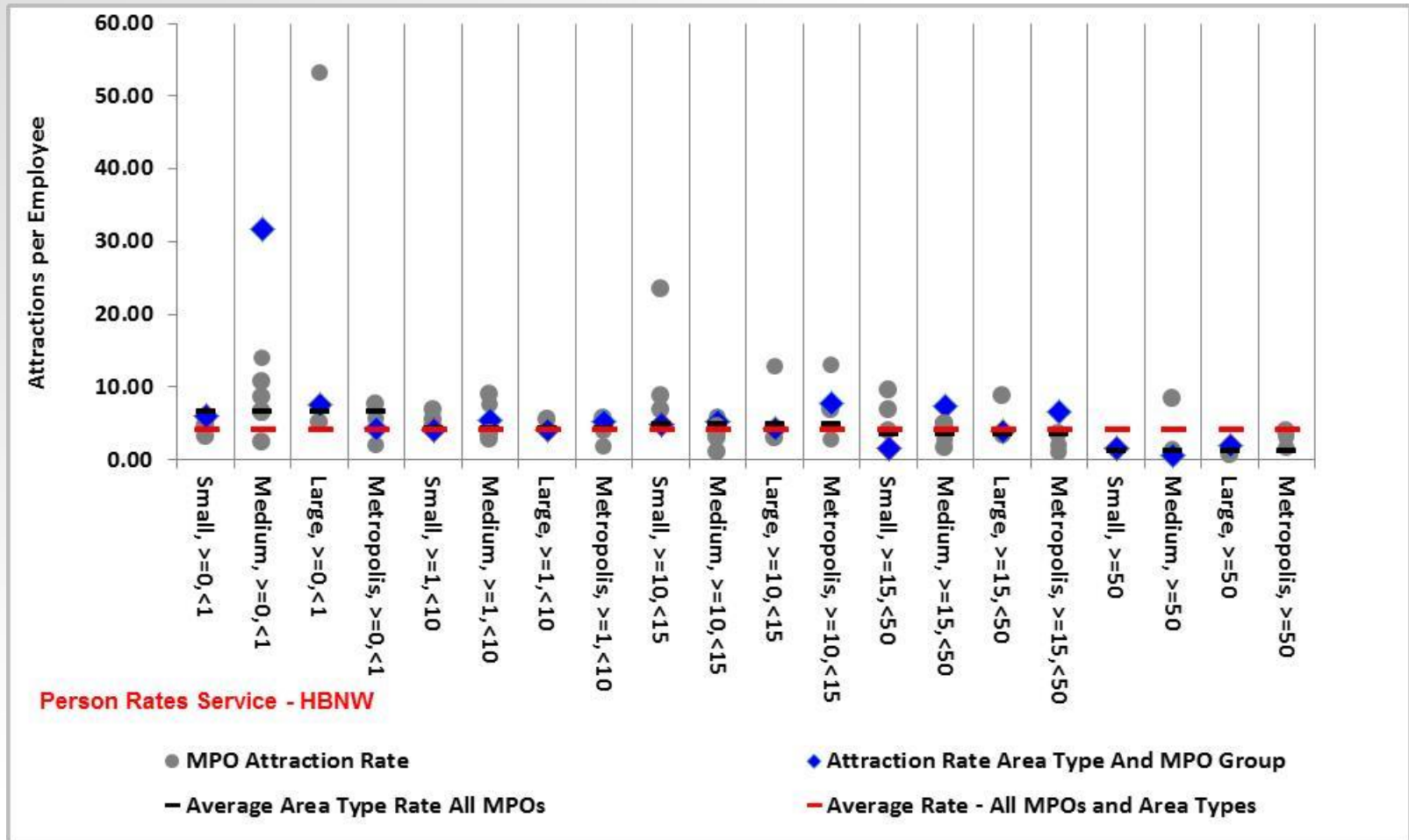
Basic Person Attraction Rates



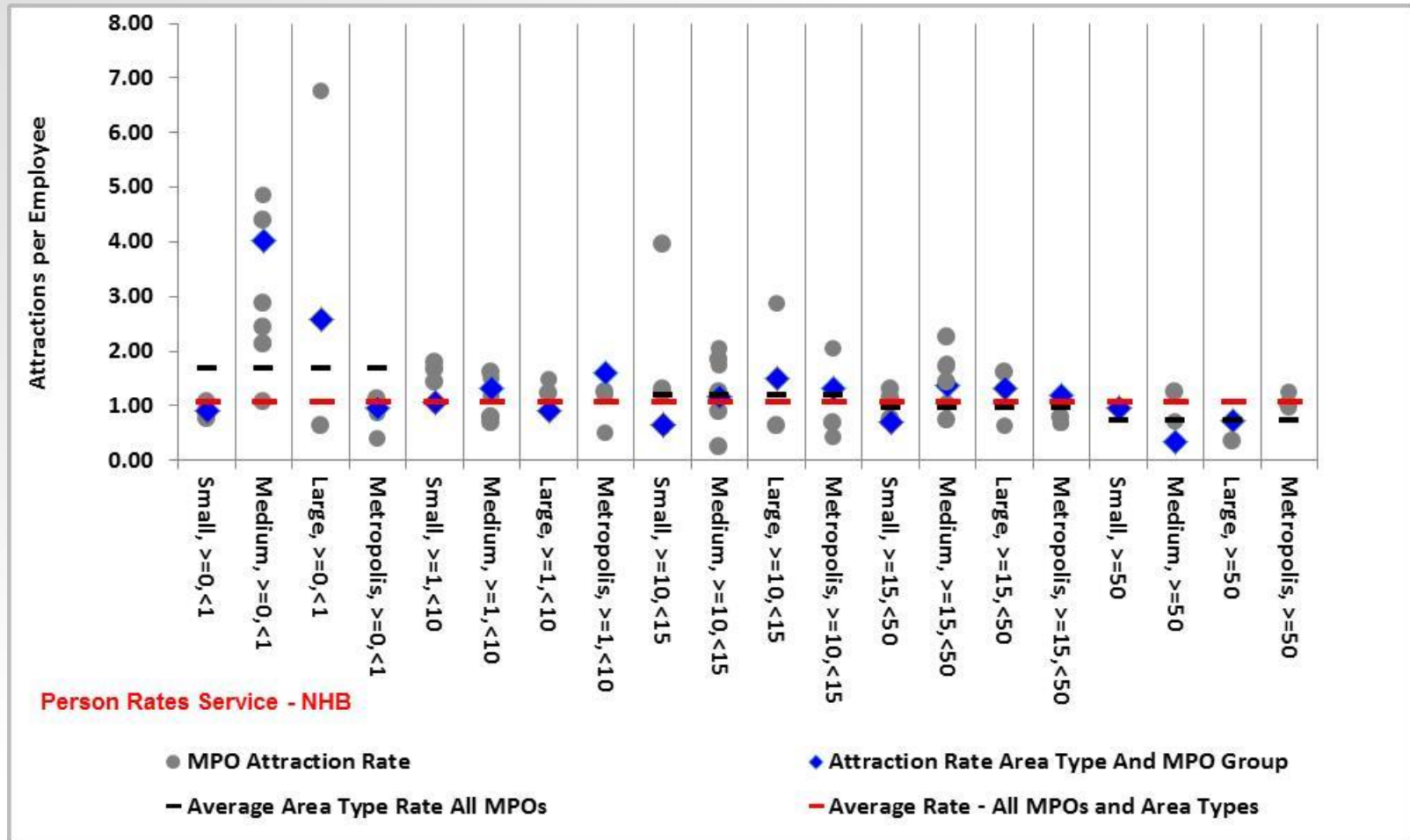
Service Person Attraction Rates



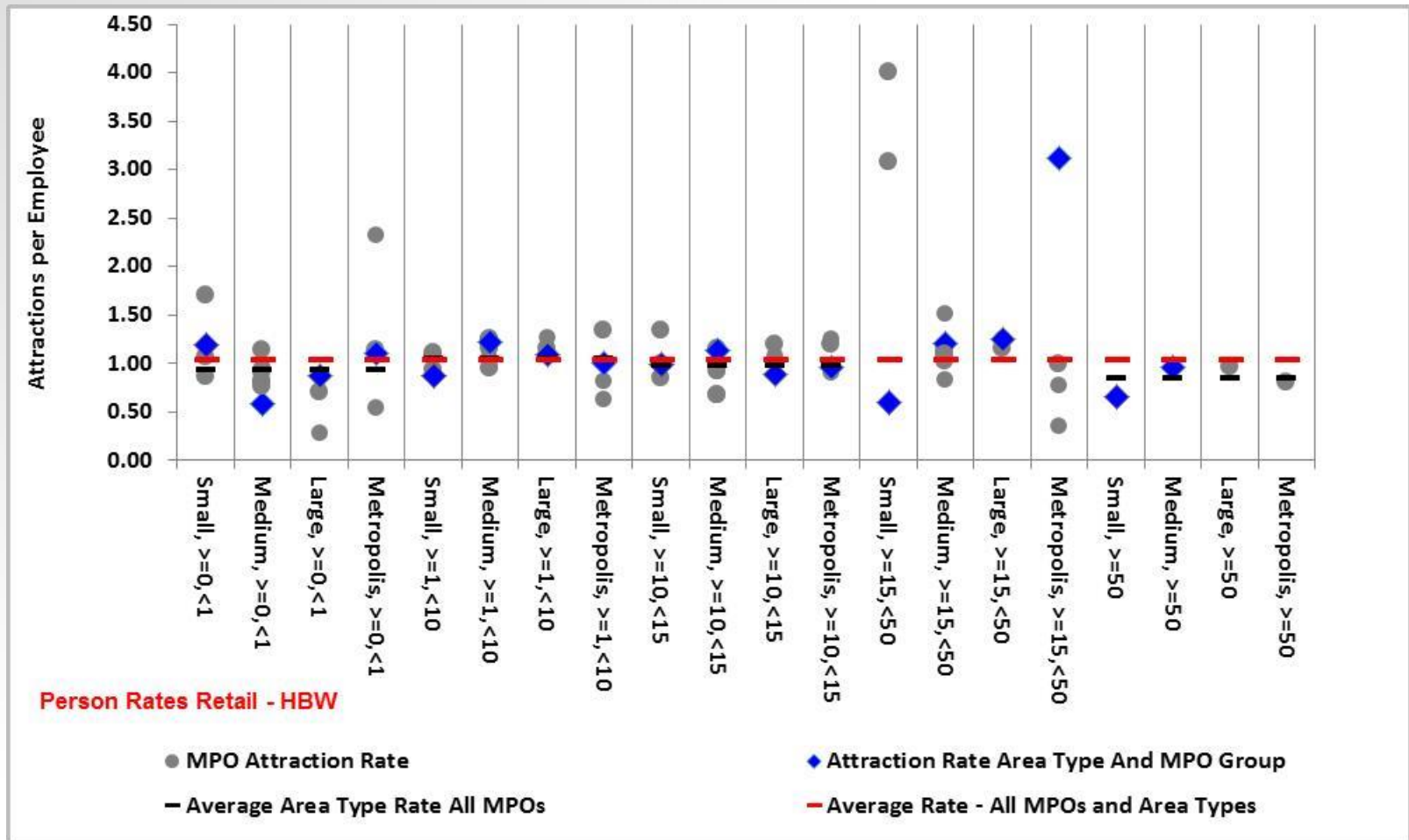
Service Person Attraction Rates



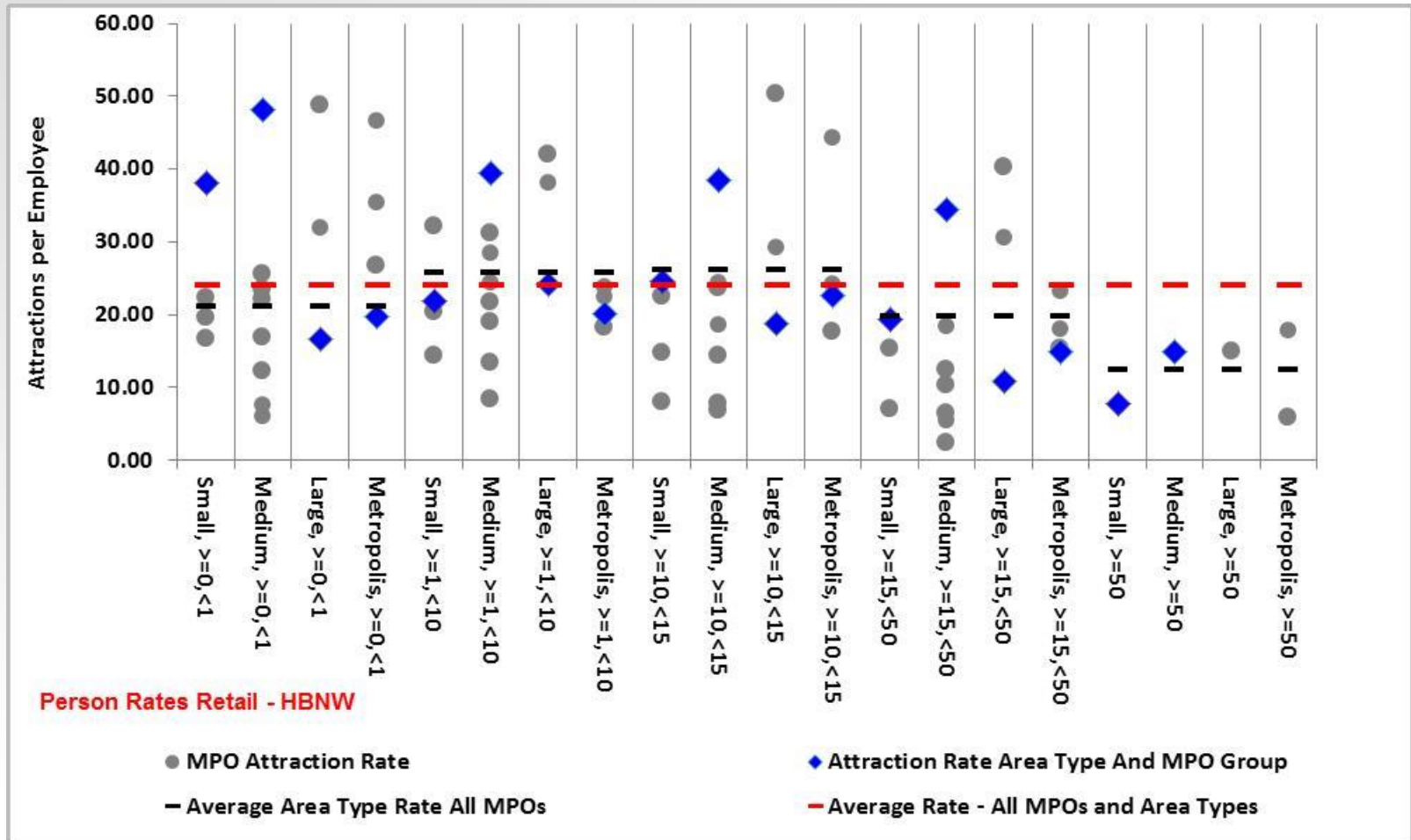
Service Person Attraction Rates



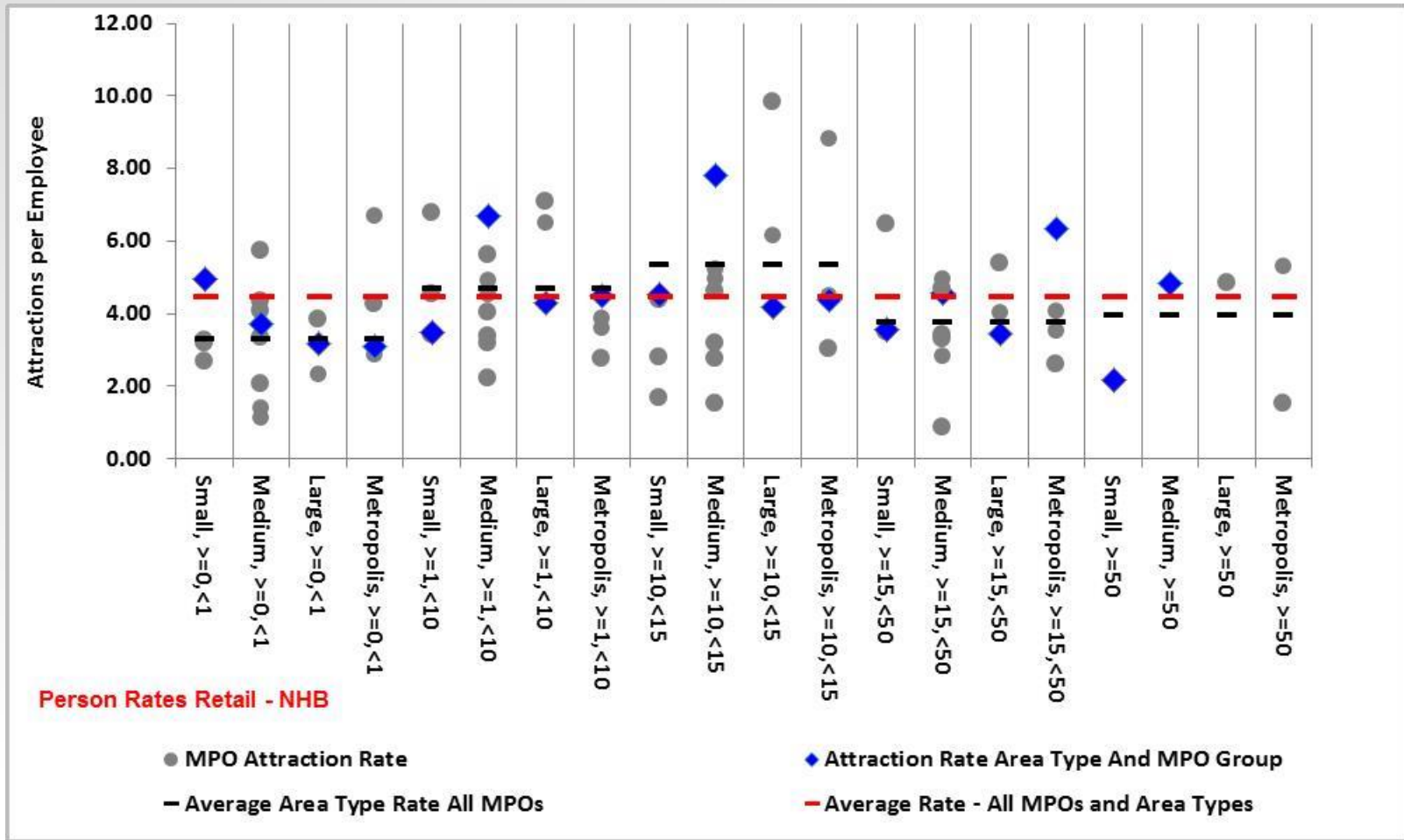
Retail Person Attraction Rates



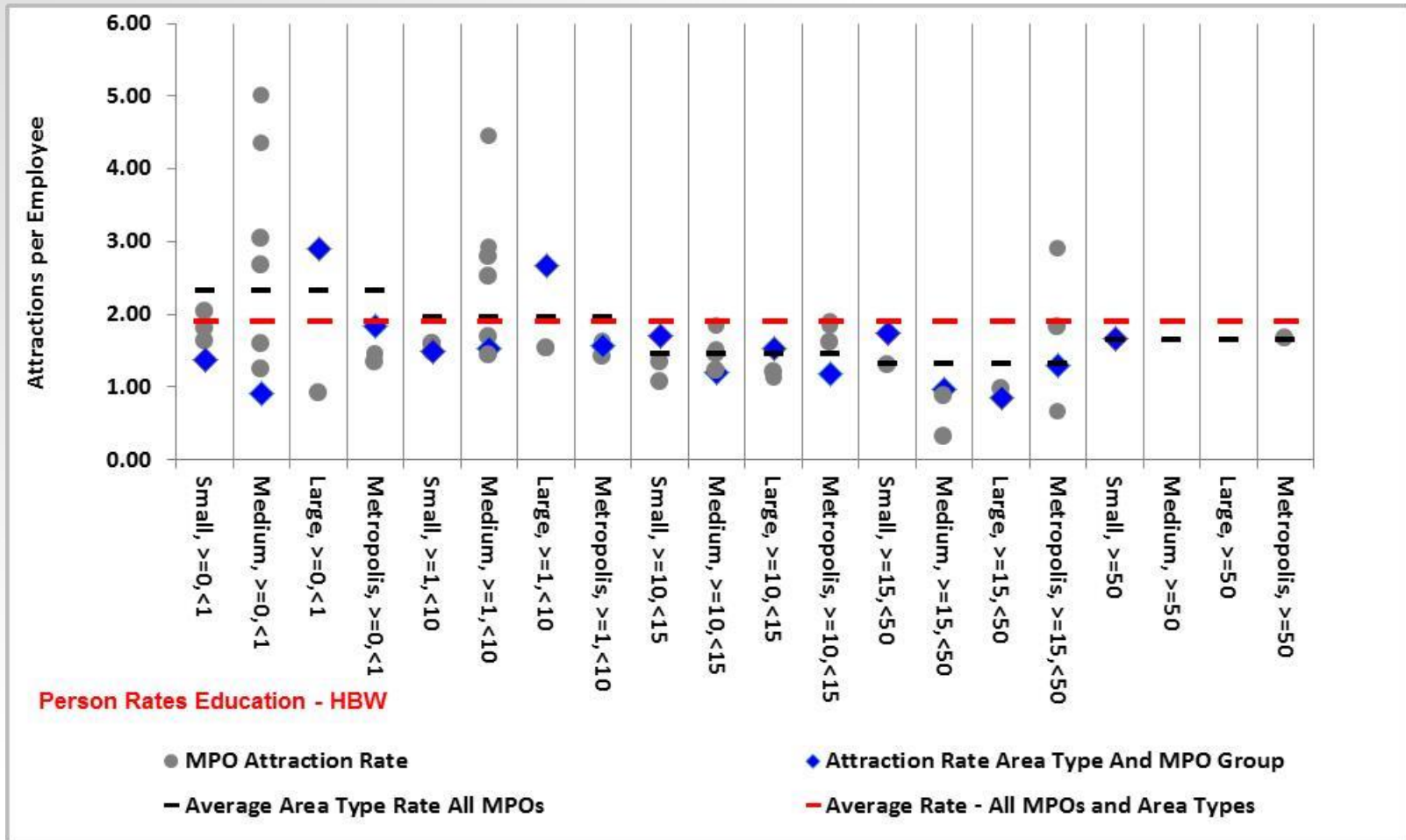
Retail Person Attraction Rates



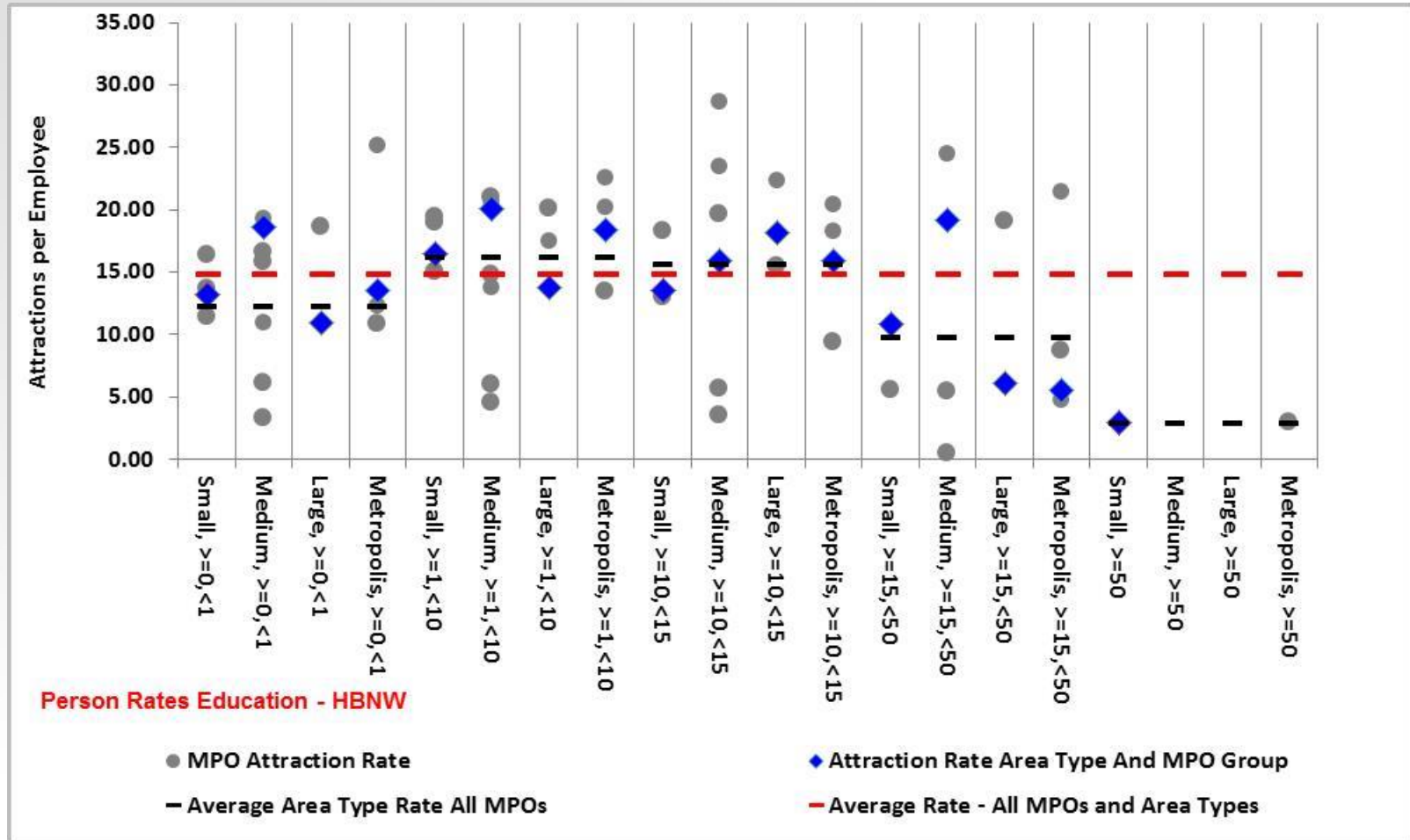
Retail Person Attraction Rates



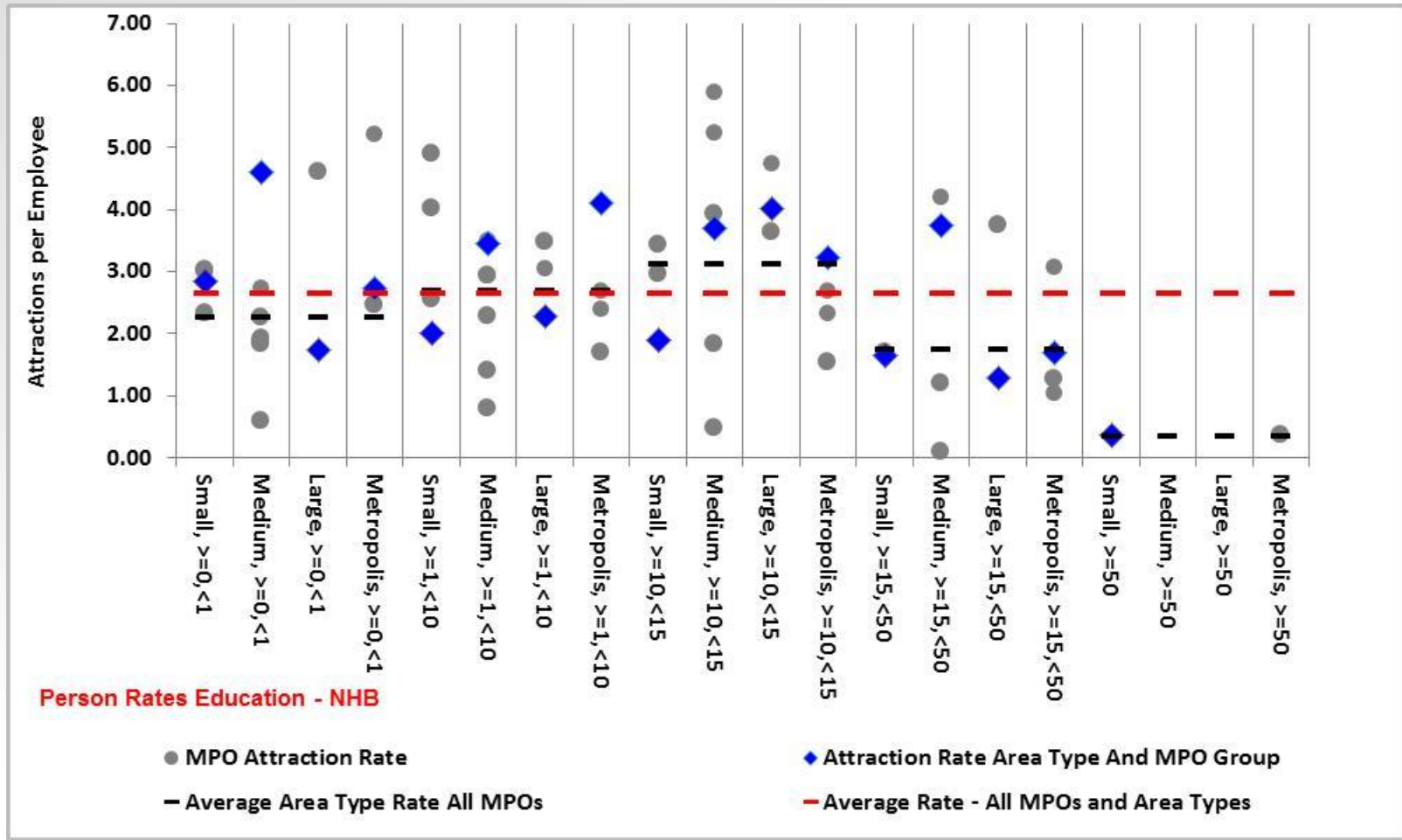
Education Person Attraction Rates



Education Person Attraction Rates



Education Person Attraction Rates



Application and Discussion

- Rates are not smoothed and balanced – so different than current applications
- Standardize Area Type Criteria (re. CBD and density breaks)?
- Potential Limitations of transferability?

Module 4

Trip Attraction (TA) Rates for Modelling

- TA Models for non-commercial and commercial vehicles
- TA Models for Different Purposes and Modes
- Application and Discussion

Employment Sector Classification

- North American Industry Classification System (NAICS) **vs** The Institute of Transportation Engineers Landuse Classification System (ITE-LUCS).
- NAICS is well established.
- Most businesses in the US are classified as per NAICS.
- At the aggregate level, it classifies establishments into 20 sectors.
- At the disaggregate level, it classifies establishments into more than 1,000 categories.
- ITE-LUCS classification is based on characteristics of the establishment, which may affect amount of traffic attracted to a particular establishment.
- The current study uses NAICS for employment classification.

Employment Sector Specific TA Rates

Employment Sector	# of sites	Average attraction rate (per employee)	# of sites	Average attraction rate (per employee)
	Commercial vehicles		Non-commercial vehicles	
Agriculture, Forestry, Fishing & Hunting, Mining & Quarrying (AGR)	26	0.117 (0.196)	29	1.558 (3.054)
Construction (CONST)	106	0.292 (0.655)	119	2.410 (3.779)
Manufacturing (MANF)	103	0.489 (1.101)	114	2.186 (3.744)
Wholesale Trade (WHTR)	119	0.510 (1.165)	136	3.145 (5.633)
Retail Trade (RETR)	639	0.595 (1.844)	713	29.264 (71.670)
Transportation & Warehousing (TRWA)	43	0.777 (1.056)	44	29.713 (64.098)
Information Sector (INFOMS)	15	0.131 (0.296)	17	1.672 (2.945)
Finance, Insurance, Real Estate (FINC)	248	0.346 (1.478)	273	6.949 (16.651)
Professional, Scientific, Management, Administrative, & Waste Management Service (PROFS)	193	0.342 (1.527)	224	2.325 (5.606)
Educational Sector (EDUSC)	481	0.297 (0.402)	512	13.003 (9.259)
Health Care (HECA)	273	0.250 (0.447)	313	2.994 (5.632)

Employment Sector Specific TA Rates

Employment Sector	# of sites	Average attraction rate (per employee)	# of sites	Average attraction rate (per employee)
	Commercial vehicles		Non-commercial vehicles	
Arts, Entertainment, Recreation, Accommodation & Food Services (ARTSC)	278	0.127 (0.237)	326	10.457 (18.989)
Public Administration and Other Services (ADMIN)	100	0.478 (0.999)	114	4.339 (7.520)
Utilities (UTIL)	11	0.348 (0.907)	14	5.188 (6.450)
Total	2635		2948	

TA Rates Across Vehicle Type and Employment Sectors

- Are they different or same?

Commercial vs Non-commercial Vehicle Trips

Employment Sector	p-value
Agriculture, Forestry, Fishing & Hunting, Mining & Quarrying	0.0427
Construction	0.0211
Manufacturing	0.0588
Wholesale Trade	0.1166
Retail Trade	0.2230
Transportation & Warehousing	0.2742
Information Sector	0.1793
Finance, Insurance, Real Estate	0.3036
Professional, Scientific, Management, Administrative, & Waste Management Service	0.1308
Educational Sector	0.0000
Health Care	0.0261
Arts, Entertainment, Recreation, Accommodation & Food Services	0.2580
Public Administration and Other Services	0.1791
Utilities	0.3098

Sector Specific Commercial Vehicle Trip Rate Variation

- Commercial Vehicle Trips : Are they different or same across employment sectors?

P-value of difference

	AGR	CONST	MANF	WHTR	RETR	TRWA	INFOMS	FINC	PROFS	EDUSC	HECA	ARTSC	ADMIN	UTIL
AGR		0.3791	0.409	0.3906	0.4882	0.4812	0.4837	0.4565	0.4467	0.2319	0.4023	0.4452	0.3886	0.2858
CONST			0.452	0.4021	0.4755	0.4445	0.1811	0.4173	0.4883	0.0753	0.4202	0.3898	0.337	0.2819
MANF				0.3749	0.4759	0.4461	0.2625	0.4155	0.4811	0.0758	0.3923	0.3897	0.3227	0.2654
WHTR					0.4743	0.4402	0.0485	0.4266	0.4056	0.0852	0.4816	0.3932	0.4136	0.4118
RETR						0.4822	0	0	0	0	0	0	0	0
TRWA							0.0030	0.0119	0.0035	0.0456	0.0042	0.0269	0.006	0.0081
INFOMS								0.468	0.4655	0.2909	0.4312	0.4592	0.4199	0.3404
FINC									0	0	0.0001	0.4473	0.0172	0.1934
PROFS										0.0273	0.4045	0.3397	0.3305	0.3728
EDUSC											0	0.4260	0	0.0003
HECA												0.3183	0.3743	0.4013
ARTSC													0	0.0076
ADMIN														0.4783
UTIL														

Sector Specific Non-Commercial Vehicle Trip Rate Variation

- Non-Commercial Vehicle Trips : Are they different or same across employment sectors?

P-value of difference

	AGR	CONST	MANF	WHTR	RETR	TRWA	INFOMS	FINC	PROFS	EDUSC	HECA	ARTSC	ADMIN	UTIL
AGR		0.0128	0.0436	0.0548	0.2331	0.0002	0.2238	0.2888	0.3023	0	0.0003	0.1878	0.0222	0.0099
CONST			0.0414	0.0386	0.1664	0	0.0571	0.3901	0.4027	0.4698	0.2715	0.0064	0.0304	0.3512
MANF				0.4501	0.3732	0.0911	0.0043	0.2611	0.268	0.0423	0.0175	0.0007	0.4702	0.3539
WHTR					0.3917	0.1247	0.0025	0.2211	0.2305	0.0257	0.0098	0.0003	0.4113	0.2951
RETR						0.1541	0	0.0183	0.0278	0	0	0	0.1718	0.2007
TRWA							0.0003	0.0999	0.1118	0.0025	0.0012	0.0001	0.0574	0.1183
INFOMS								0.3487	0.3597	0	0.0111	0.4802	0.0805	0.0892
FINC									0.492	0.3052	0.1634	0.0111	0.1689	0.4968
PROFS										0.3452	0.2097	0.0274	0.1805	0.4911
EDUSC											0.0002	0	0	0.1691
HECA												0	0	0.0756
ARTSC													0	0
ADMIN														0.3398
UTIL														

Explanatory Variables

- Parking Availability
- Employment Density
- Metropolitan Planning Organization (MPO) Area Type
- TAZ Area Type
- Establishment/Activity Center Type (Freestanding and Non-Freestanding)

Descriptive Statistics for Non-Commercial Vehicle Trips

Variable	% of sites with parking facility	% of sites with employment density greater than 10 per acre	MPO area size			TAZ area type			% of non-freestanding sites
			Small (%)	Medium (%)	Large (%)	Non-CBD (%)	CBD fringe (%)	CBD (%)	
AGR	93	31	10	7	83	3	21	76	66
CONST	93	14	14	13	73	1	15	84	71
MANF	90	11	20	16	64	0	21	79	75
WHTR	88	13	6	17	77	1	18	81	75
RETR	82	10	11	20	69	1	16	83	61
TRWA	89	20	25	23	52	0	14	86	80
INFOMS	76	12	6	12	82	0	18	82	41
FINC	86	10	13	14	73	1	19	80	58
PROFS	78	10	12	20	68	2	29	69	51
EDUSC	95	15	19	17	64	0	9	91	93
HECA	85	5	23	18	59	1	28	71	46
ARTSC	83	12	6	17	77	1	15	84	60
ADMIN	96	14	62	4	34	2	4	94	61
UTIL	93	43	7	7	86	0	14	86	100

Descriptive Statistics for Commercial Vehicle Trips

Variable	% of sites With parking Facility	% of sites with employment density greater than 10 per acre	MPO area size			TAZ area type			% of non-freestanding sites
			Small (%)	Medium (%)	Large (%)	Non-CBD (%)	CBD fringe (%)	CBD (%)	
AGR	92	27	12	8	80	4	23	73	62
CONST	92	11	16	15	69	1	16	83	70
MANF	90	11	22	17	61	0	21	79	74
WHTR	88	10	7	19	74	2	20	78	76
RETR	82	9	11	22	67	1	17	82	62
TRWA	91	19	26	23	51	0	14	86	81
INFOMS	80	13	7	13	80	0	20	80	40
FINC	87	9	14	16	70	1	19	80	61
PROFS	81	8	13	23	64	2	32	66	52
EDUSC	95	14	20	18	62	0	9	91	93
HECA	87	5	27	21	52	1	32	67	45
ARTSC	82	10	7	20	73	1	18	81	61
ADMIN	98	15	70	4	26	2	5	93	60
UTIL	91	27	9	9	82	0	18	82	100

Criteria for Retaining Explanatory Variables in the Model

- A confidence level (CI) of 65% and more
- Reasons for such a low CI
 - Don't have much support for explanatory variables from the past studies
 - Small sample size
- Models
 - Ordinary Least Square Regression
 - Robust Regression

TA Model for Non-Commercial Vehicles

Employment Classification	Agriculture, Forestry, Fishing & Hunting, Mining & Quarrying	Construction	Manufacturing	Wholesale Trade	Retail Trade	Transportation & Warehousing	Information Sector
Alternative Specific Constant	2.147(1.693)	2.748(6.586)	2.592(6.467)	5.490(4.915)	18.807(1.498)	7.920(1.405)	2.909(1.660)
Parking Availability indicator variable					13.244(1.667)		2.405(1.216)
Employment Density indicator variable (>10 per acre)						54.607(2.366)	
MPO Area Size indicator variable (small is base)							
Medium	1.695(1.774)	1.796(1.823)		1.780(1.533)	10.325(1.159)	14.164(1.659)	1.908(1.491)
Large	1.695(1.774)	1.796(1.823)		1.780(1.533)	10.325(1.159)	14.164(1.659)	2.697(1.772)
TAZ Area Type indicator variable (non-CBD is base)							
CBD		-0.741(-1.992)			-13.318(-1.452)		
Freestanding Establishment Type indicator variable	-2.045(-1.751)	-2.007(-2.670)	-1.597(-2.010)	-3.885(-3.453)	-24.557(-3.885)		-0.504(-1.282)

TA Model for Non-Commercial Vehicles

Employment Classification	Finance, Insurance, Real Estate	Professional, Scientific, Management, Administrative, Waste Management	Educational Sector	Health Care	Arts, Entertainment, Recreation, Accommodation & Food Service	Public Administration & Other Services	Utilities
Alternative Specific Constant	9.856(3.138)	5.567(5.066)	12.068(12.987)	6.797(9.470)	12.853(5.438)	6.717(6.732)	10.250(1.867)
Parking Availability indicator variable	1.739(0.600)				2.476(0.924)		
Employment Density indicator variable (>10 per acre)	2.560(1.617)	3.236(1.935)		1.180(1.926)		4.761(2.626)	
MPO Area Size indicator variable (small is base)							
Medium		-1.217(-1.128)	1.923(1.880)	-1.162(-1.714)	2.971(1.706)	-1.632(-1.255)	-5.452(-1.803)
Large		-1.217(-1.128)	1.923(1.880)	-1.162(-1.714)	2.971(1.706)	-1.632(-1.255)	-5.452(-1.803)
TAZ Area Type indicator variable (non-CBD is base)							
CBD			-10.323(-1.620)		-6.770(-1.076)		
Freestanding Establishment Type indicator variable	-9.490(-4.877)	-4.299(-6.240)	-8.394(-5.406)	-5.504(-9.569)	10.882(1.900)	-6.159(-4.784)	

TA Model for Commercial Vehicles

Employment Classification	Agriculture, Forestry, Fishing & Hunting, Mining & Quarrying	Construction	Manufacturing	Wholesale Trade	Retail Trade	Transportation & Warehousing	Information Sector
Alternative Specific Constant	0.079(1.362)	0.278(1.607)	0.327(1.751)	0.182(1.425)	0.394(1.681)	0.028(1.049)	0.204(1.747)
Parking Availability indicator variable	0.111(0.727)			0.568(1.373)	0.209(0.962)	0.716(1.270)	
Employment Density indicator variable (>10 per acre)	0.117(1.253)	0.346(1.733)		0.351(0.974)			
MPO Area Size indicator variable (small is base)							
Medium	0.045(1.294)	-0.138(-0.986)					
Large	0.045(1.294)	-0.138(-0.986)	0.156(0.983)	0.421(1.513)	0.748(4.233)	0.428(1.104)	0.384(1.706)
TAZ Area Type indicator variable (non-CBD is base)							
CBD	-0.100(-1.391)	-0.598(-1.097)					
Freestanding Establishment Type indicator variable	0.068(0.789)	0.310(2.278)	0.157(1.616)	0.318(0.997)	-0.363(-2.136)		-0.200(-1.282)

TA Model for Commercial Vehicles

Employment Classification	Finance, Insurance, Real Estate	Professional, Scientific, Management, Administrative, Waste Management	Educational Sector	Health Care	Arts, Entertainment, Recreation, Accommodation & Food Service	Public Administration & Other Services	Utilities
Alternative Specific Constant	0.669(2.526)	0.570(2.458)	0.569(14.364)	0.410(7.981)	0.095(6.218)	0.181(4.577)	0.750(1.535)
Parking Availability indicator variable							
Employment Density indicator variable (>10 per acre)			0.047(0.947)	0.105(1.847)			
MPO Area Size indicator variable (small is base)							
Medium	-0.289(-1.069)		-0.339(-7.771)	-0.226(-3.775)			-0.442(-1.464)
Large	-0.289(-1.069)	-0.201(-1.854)	-0.339(-7.771)	-0.226(-3.775)	0.163(4.724)	-0.156(-2.014)	-0.442(-1.464)
TAZ Area Type indicator variable (non-CBD is base)							
CBD						0.231(0.952)	
Freestanding Establishment Type indicator variable	-0.192(-1.000)	-0.212(-1.933)	-0.080(-1.151)				

Sample Size for Commercial Vehicles TA Rates Comparison

- AT_I = CBD and CBD fringe
- AT_II = urban
- AT_III = suburban
- AT_IV = rural

Employment Sector	AT_I	AT_II	AT_III	AT_IV
Agriculture, Forestry, Fishing & Hunting, Mining & Quarrying	13	5	13	15
Construction	37	19	97	34
Manufacturing	51	27	106	37
Wholesale Trade	46	32	102	33
Retail Trade	250	199	470	123
Transportation & Warehousing	22	6	38	46
Information Sector	11	9	15	5
Finance, Insurance, Real Estate	92	88	174	51
Professional, Scientific, Management, Administrative & Waste Management Service	114	66	139	29
Educational Sector	61	117	338	161
Health Care	133	74	198	40
Arts, Entertainment, Recreation, Accommodation & Food Services	133	107	224	75
Public Administration and Other Services	16	9	63	40
Utilities	4	1	12	8

Sample size for Non-Commercial Vehicles

TA Rates Comparison

- AT_I = CBD and CBD fringe
- AT_II = urban
- AT_III = suburban
- AT_IV = rural

Employment Sector	AT_I	AT_II	AT_III	AT_IV
Agriculture, Forestry, Fishing & Hunting, Mining & Quarrying	13	5	13	18
Construction	38	20	101	42
Manufacturing	53	28	109	42
Wholesale Trade	46	36	109	41
Retail Trade	256	207	511	143
Transportation & Warehousing	22	6	38	48
Information Sector	11	9	17	5
Finance, Insurance, Real Estate	96	90	191	55
Professional, Scientific, Management, Administrative & Waste Management Service	116	74	151	40
Educational Sector	62	118	350	179
Health Care	134	76	228	48
Arts, Entertainment, Recreation, Accommodation & Food Services	135	110	251	94
Public Administration and Other Services	16	13	69	44
Utilities	4	1	12	13

TA Models for Different Trip Purposes & Mode Combination

- **Trip Purposes**
 - Home based work (HBW)
 - Home based others (HBO) ; school trips, social/recreational trips, shopping trips, dinning out, personal business, pickup/drop-offs, and others
- **Modes**
 - Car/Van
 - Transit
 - Walk and Bike

Average Trip Rate for HBO trips

Employment Category	Car/Van	Transit	Walk/Bike
Agriculture, Forestry, Fishing & Hunting, Mining & Quarrying	0.187	0	0
Construction	0.130	0	0
Manufacturing	0.457	0	0
Wholesale Trade	0.857	0	0.004
Retail Trade	10.005	0.049	0.286
Transportation & Warehousing	3.399	0	0.040
Information Sector	0.667	0	0
Finance, Insurance, Real Estate	1.329	0.004	0.034
Professional, Scientific, Management, Administrative & Waste Management Service	0.164	0	0.003
Educational Sector	3.314	0.012	0.081
Health Care	0.603	0.003	0.006
Arts, Entertainment, Recreation, Accommodation & Food Services	3.829	0.020	0.121
Public Administration and Other Services	1.275	0.001	0
Utilities	0.919	0	0

TA Model for HBO Trips Using Car/Van

Employment Classification	Agriculture, Forestry, Fishing & Hunting, Mining & Quarrying	Construction	Manufacturing	Wholesale Trade	Retail Trade	Transportation & Warehousing	Information Sector
Alternative Specific Constant	0.074(1.494)	0.120(1.156)	0.605(3.013)	0.933(2.694)	10.672(2.079)	3.497(1.876)	3.136(1.037)
Parking Availability indicator variable					6.023(1.297)		1.561(0.983)
Employment Density indicator variable (>10 per acre)	0.384(1.400)	0.375(2.840)					
MPO Area Size indicator variable (small is base)							
Medium				2.212(2.733)	11.405(2.558)	2.3602(0.967)	-1.955(-1.179)
Large							
TAZ Area Type indicator variable (non-CBD is base)							
CBD				-1.784(-0.885)			
Freestanding Establishment Type indicator variable		-0.108(-1.702)	-0.533(-1.399)	-1.362(-2.151)	-15.857(-4.167)	-2.931(-0.949)	-1.576(-1.038)

TA Model for HBO Trips Using Car/Van

Employment Classification	Finance, Insurance, Real Estate	Professional, Scientific, Management, Administrative, Waste Management	Educational Sector	Health Care	Arts, Entertainment, Recreation, Accommodation & Food Service	Public Administration & Other Services	Utilities
Alternative Specific Constant	2.814(1.774)	0.730(4.381)	2.887(2.580)	1.715(4.116)	6.859(7.607)	2.560(4.517)	6.396(5.879)
Parking Availability indicator variable			0.802(0.915)	0.289(0.958)			
Employment Density indicator variable (>10 per acre)					2.809(1.466)	1.677(1.863)	0.604(1.045)
MPO Area Size indicator variable (small is base)							
Medium		-0.160(-0.835)				-1.066(-1.610)	-6.250(-6.064)
Large		-0.449(-2.671)				-1.066(-1.610)	-6.250(-6.064)
TAZ Area Type indicator variable (non-CBD is base)							
CBD		-0.201(-0.845)	-2.355 (-0.542)		-4.619(-0.982)		
Freestanding Establishment Type indicator variable	-2.657(-2.690)	-0.409(-3.898)	-2.853(-3.057)	-1.679(-4.694)	-6.723(-5.524)	-2.348(-3.654)	

Application of TA Rates in Advance Travel Demand Models & Potential Explanatory Variable

- Can be used to check the overall trip attraction per activity type for each zone
- Potential Explanatory variable: Distance to major throughway

Significance of the New Variable

Employment Classification	Wholesale Trade	Retail Trade	Health Care	Arts, Entertainment, Recreation, Accommodation & Food Service
Alternative Specific Constant	1.630(2.356)	7.713(1.446)	2.139(4.041)	4.501(7.351)
Parking Availability indicator variable		6.715(1.538)	0.667(1.237)	
Employment Density indicator variable (>10 per acre)				2.052(1.250)
MPO Type (small is base)				
Medium				
Large	2.183(2.536)	13.081(3.269)		
Area Type (non-CBD is base)				
CBD	-1.715(-0.726)			-3.993(-1.049)
Freestanding Establishment type indicator variable	-1.472(-2.065)	-13.498(-3.750)	-1.705(-4.320)	-5.385(-5.281)
Distance to the nearest major thoroughway (in miles)	-0.813 (-2.042)	-1.273 (-2.931)	-0.623 (-3.041)	-1.413 (-1.937)

TA Rates at a Disaggregate Level

- Provides more flexibility
- May be required in some of the travel demand models
- The disaggregation is based on availability of data and hence can change in future

NAICS Employment Classification	LUC employment Classification	Weight
Agriculture, Forestry, Fishing & Hunting, Mining, Quarrying	Greenhouse, Nursery, and Floriculture Production	0.0131
	Other Crop Farming	0.1528
	Support Activities for Crop Production	0.2823
	Oil and Gas Extraction	0.1637
	Oil and Gas Extraction	0.0298
	Support Activities for Mining	0.3584
	Greenhouse, Nursery, and Floriculture Production	0.0131

Conclusions/Important Findings

- Trip attraction rates vary across employment sectors and vehicle types.
- Parking availability, MPO area size, employment density, TAZ area type and establishment type have a significant effect on TA rate.
- TA rates from certain TAZ types can be combined/borrowed.
- Distance to major thoroughway can be considered in future TA models.

Module 5

Workshop Wrap-up

- Recommendations and Discussion
- TxDOT Feedback and Direction

RMC Project 6760

Half-Day Workshop



QUESTIONS?

