

# Ver. 2.3 travel model, trip generation: Development of the non-motorized trip end model

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# Background

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- In the Version 2.3 travel model, trip generation is conducted for total person trips including motorized (auto, transit) and non-motorized (walk, bike)
- Non-motorized trip model is used to separate trips estimated in the trip generation into motorized and non-motorized
  - Only motorized trips are carried through trip distribution and mode choice steps
- In the past, non-motorized trip model was applied only to HBW trip productions
  - Trip generation rates were estimated only for motorized trip for all other purposes
- In Version 2.3 of the Travel Model, non-motorized trip models are developed for each of the trip purposes for both trip production and trip attraction ends

# Data

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- 2007/2008 Household Travel Survey Data
  - Percentage of non-motorized trips
- Pseudo Round 8.0 Cooperative Land Use Forecast
  - Employment
  - Population
- Walkability Measures developed on the NAVTEQ street network

# Model Form

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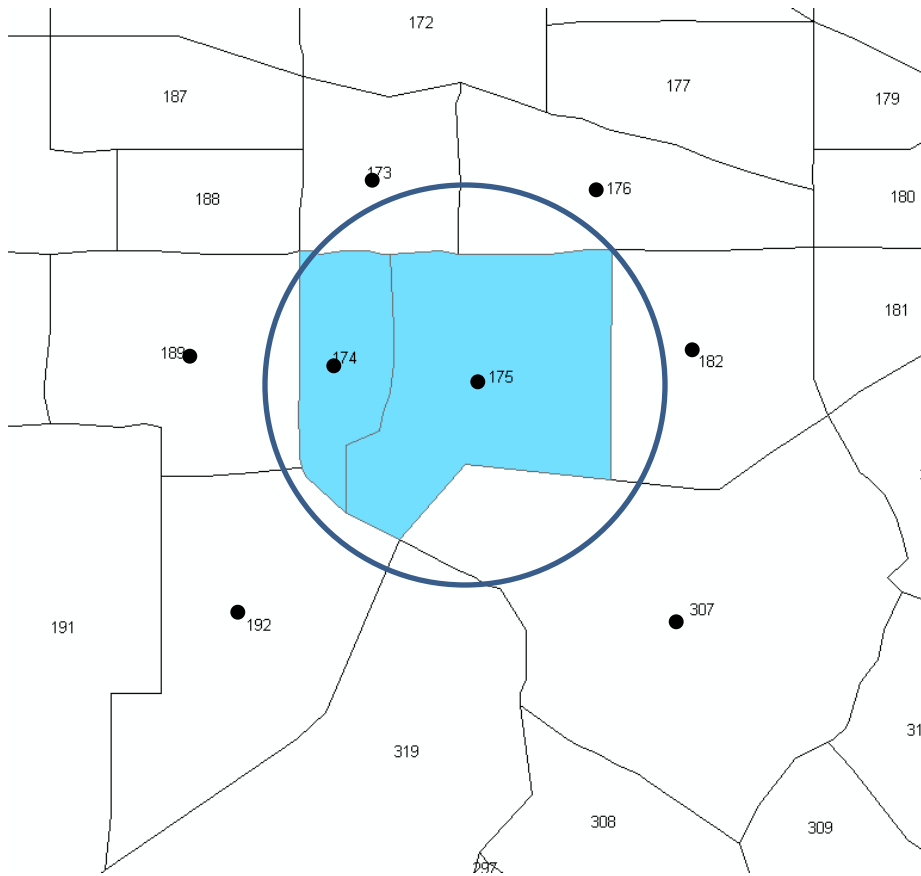
- Two different models considered
  - Binomial probit model
    - Discrete choice model
    - More intuitive when considering the choice between motorized and non-motorized modes
  - Linear regression model
    - Yields better results as determined from root mean square error (RMSE) and average error
    - Selected to model the non-motorized trips

# Dependent Variable

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- Non-motorized trips as percentage of total person trips
- Can be modeled at different levels of geography
  - TAZ
  - 0.5-mile floating TAZ
  - 1-mile floating TAZ
  - TAD
    - Not appropriate because this level of aggregation does not capture the different walking environments

# Floating Measures



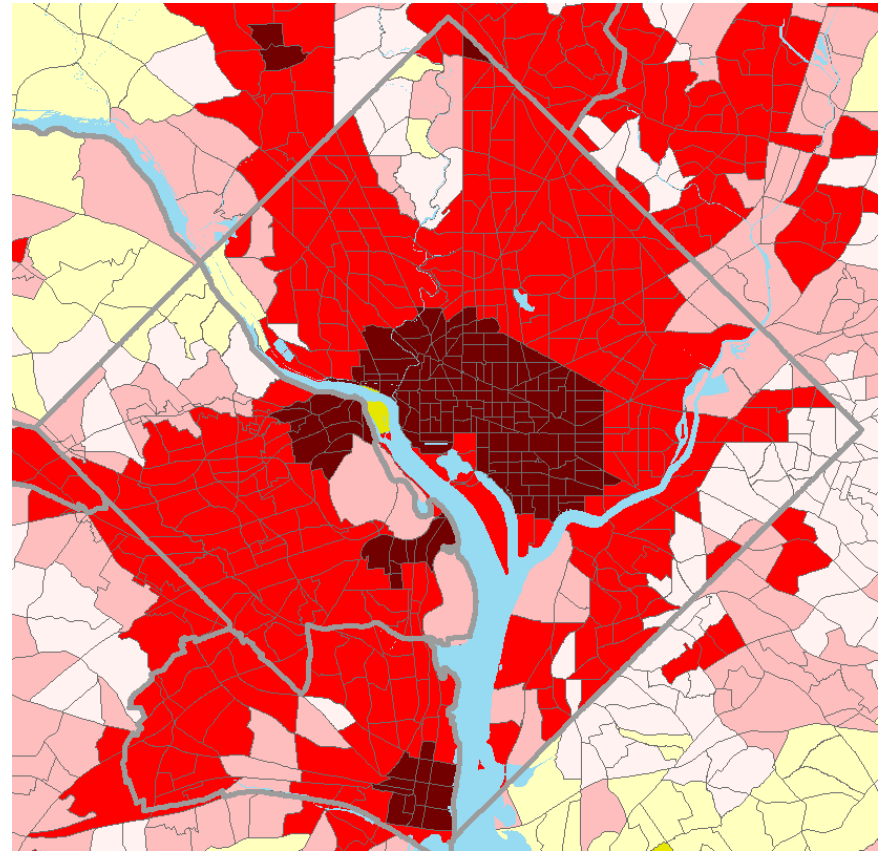
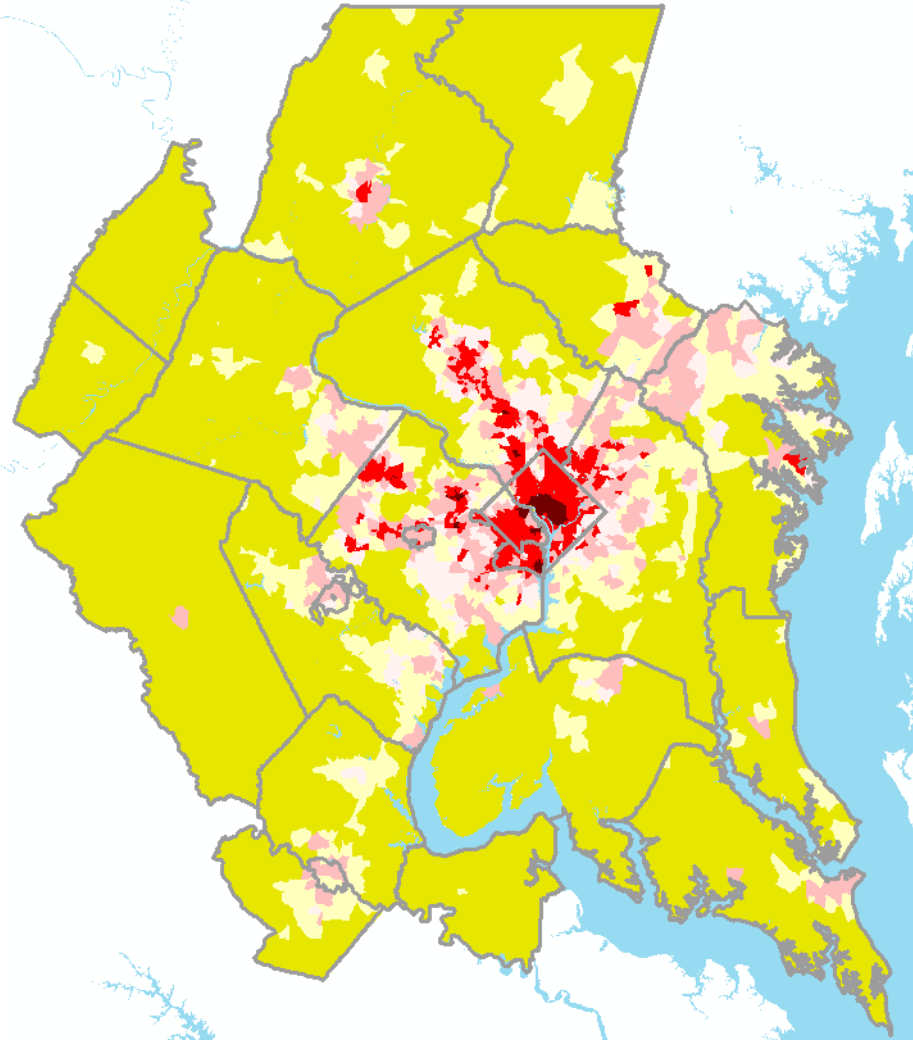
- Centroid of TAZ 174 is within 1 mile of the centroid of TAZ 175
- In 1-mile floating measure calculations, data from TAZ 174 will be added to TAZ 175
- Floating Employment =  $\frac{(EMP175+EMP174)}{(AREA175+AREA174)}$

# Independent Variables

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- Land Use
  - Employment Density
  - Population Density
- Accessibility Measures
  - Major/minor street density
  - Ratio of four-way intersections to cul-de-sacs and three way intersections
  - Street block density
  - Census block density
- All variables were considered at TAZ level, 0.5-mile floating, and 1-mile floating geography

# Area Type Map





# Observed Non-motorized Trips: Production End

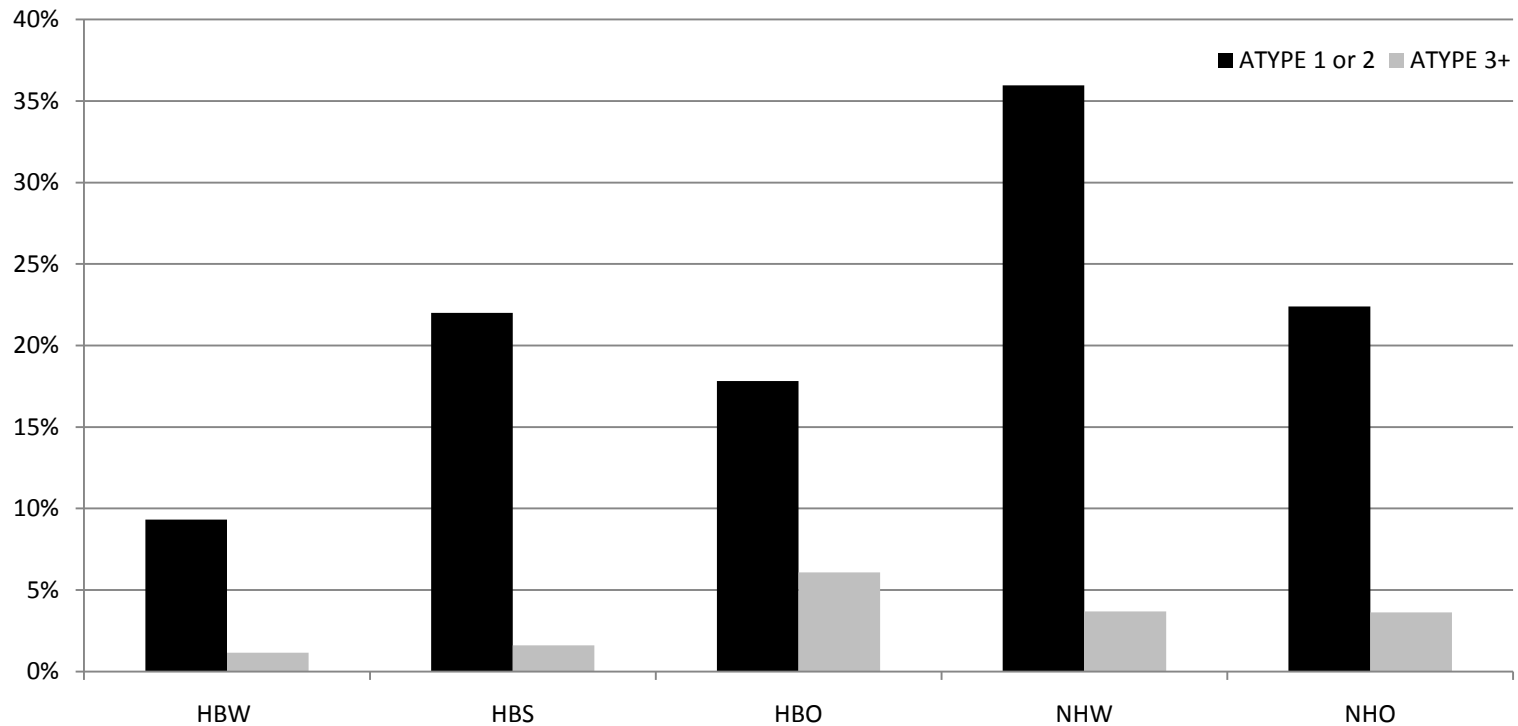
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	Trip Purpose	Non-Motorized Trips	Total Person Trips	% Non-motorized Trips
ATYPE 1 or 2	HBW	85,057	912,054	9.33%
	HBS	150,983	686,360	22.00%
	HBO	279,945	1,570,095	17.83%
	NHW	367,176	1,020,738	35.97%
	NHO	218,279	975,019	22.39%
ATYPE 3+	HBW	31,737	2,726,213	1.16%
	HBS	38,477	2,385,222	1.61%
	HBO	332,913	5,463,672	6.09%
	NHW	36,658	994,205	3.69%
	NHO	81,451	2,241,758	3.63%

# Non-motorized Trip Percentages: Production End

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Percent Non-motorized Trips



# Non-motorized Trip Percentages for Area Types 3+: Production End

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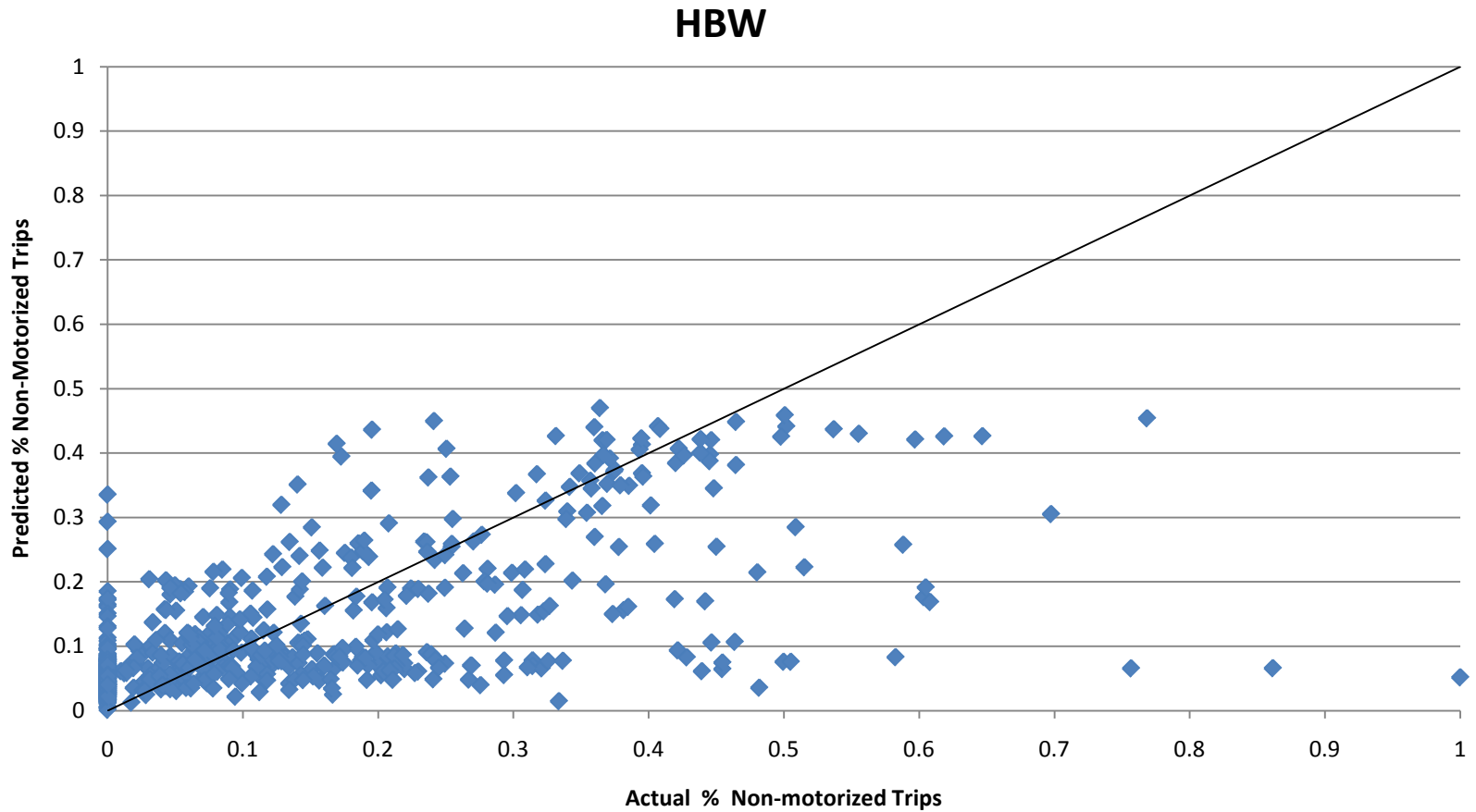
Area Type	HBW	HBS	HBO	NHW	NHO	Total
3	1.66%	2.68%	4.70%	3.68%	3.78%	4.28%
4	0.63%	4.99%	5.34%	1.76%	4.25%	4.23%
5	0.31%	0.42%	2.07%	1.20%	1.22%	1.81%
6	0.36%	0.10%	0.96%	0.44%	0.73%	0.97%

# HBW Non-motorized Trips: Production End

Variable	Definition	Coefficient	Std. Error	T- stat.	P-value	Avg. Value
Constant		-0.00388	0.009633	-0.402	0.6875	
POPDEN10	One-mile floating population density (persons/sq. mile)	2.20E-06	1.12E-06	1.963	0.0496	8943
EMPDEN10	One-mile floating employment density (employees/sq. mile)	3.54E-06	1.85E-07	19.148	0	16520
BLKDEN05	Street block density (blocks/sq. mile)	0.000474	0.000124	3.82	0.0001	71.99
Adjusted R <sup>2</sup>		0.44				
Number of Observations		758				

Note: Model is for area types 1 and 2

# HBW Trips Scatterplot



# NHW Non-motorized Trips: Production End

Variable	Definition	Coefficient	Std. Error	T- stat.	P-value	Avg. Value
Constant		-0.00775	0.01251	-0.62	0.5354	
POPDEN10	One-mile floating population density (persons/sq. mile)	7.57E-06	1.50E-06	5.06	0	8810
EMPDEN10	One-mile floating employment density (employees/sq. mile)	4.68E-06	2.32E-07	20.15	0	18700
BLKDEN05	Street block density (blocks/sq. mile)	0.001072	0.000169	6.352	0	71.61
Adjusted R <sup>2</sup>		0.54				
Number of Observations		721				

Note: Model is for area types 1 and 2

# HBS, HBO, NHO Non-motorized Trips: Production End

Variable	Definition	Coefficient	Std. Error	T- stat.	P-value	Avg. Value
Constant		7.60E-05	0.009568	0.008	0.9937	
POPDEN10	One-mile floating population density (persons/sq. mile)	8.60E-06	1.18E-06	7.264	0	8597
EMPDEN10	One-mile floating employment density (employees/sq. mile)	2.97E-06	1.86E-07	15.98	0	16758
BLKDEN05	Street block density (blocks/sq. mile)	0.001018	0.00013	7.826	0	68.58
Adjusted R <sup>2</sup>		0.49				
Number of Observations		829				

Note: Model is for area types 1 and 2

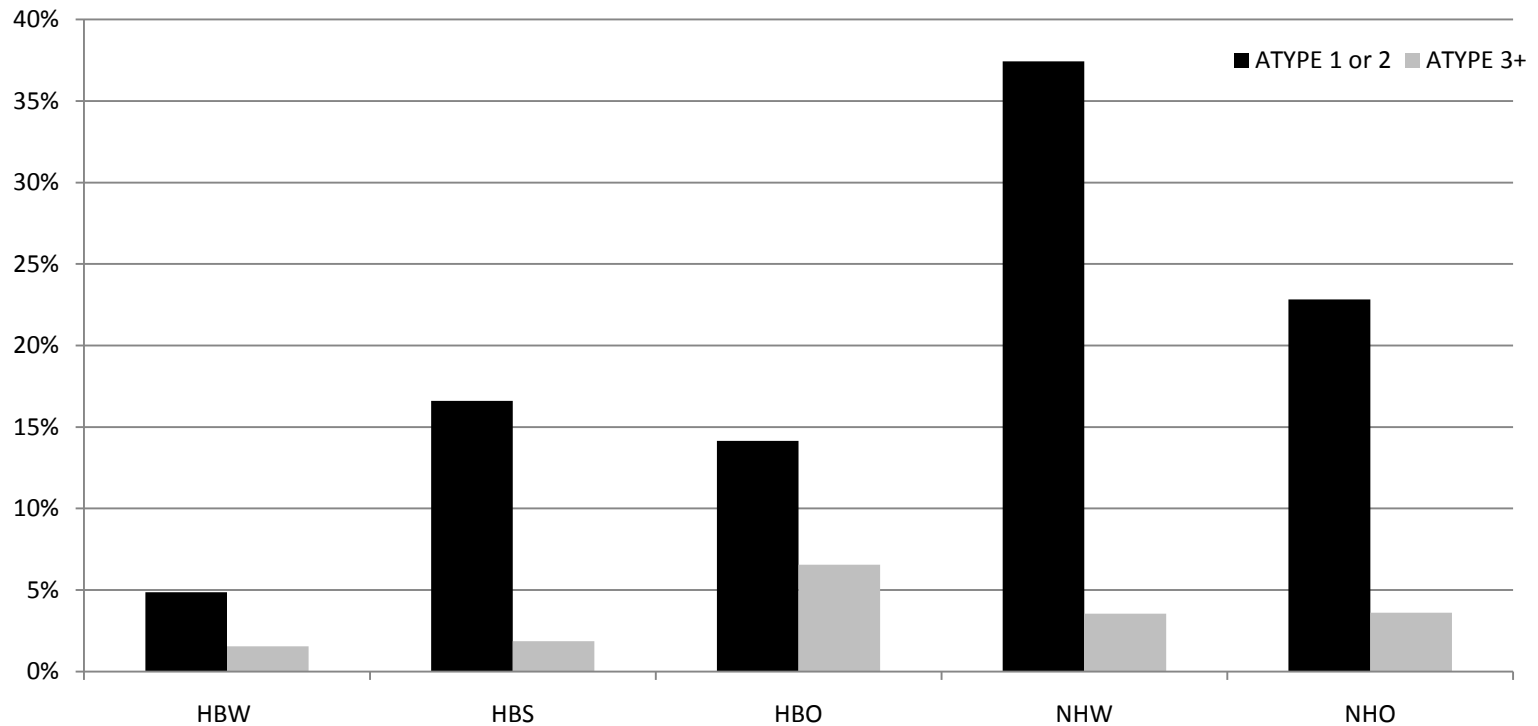
# Observed Non-motorized Trips: Attraction End

	Trip Purpose	Non-Motorized Trips	Total Person Trips	% Non-motorized Trips
ATYPE 1 or 2	HBW	88,897	1,824,361	4.87%
	HBS	149,116	897,883	16.61%
	HBO	282,431	1,995,643	14.15%
	NHW	367,102	980,719	37.43%
	NHO	218,176	956,027	22.82%
ATYPE 3+	HBW	27,896	1,813,651	1.54%
	HBS	40,348	2,173,683	1.86%
	HBO	330,427	5,038,156	6.56%
	NHW	36,722	1,034,228	3.55%
	NHO	81,552	2,260,761	3.61%



# Non-motorized Trip Percentages: Attraction End

Percent Non-motorized Trips



# Non-motorized Trip Percentages for Area Types 3+: Attraction End

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Area Type	HBW	HBS	HBO	NHW	NHO	Total
3	2.10%	2.62%	5.74%	3.90%	4.53%	2.10%
4	2.62%	6.63%	9.27%	2.19%	5.33%	2.62%
5	0.87%	1.55%	4.53%	1.85%	2.60%	0.87%
6	1.49%	1.23%	4.52%	2.22%	1.62%	1.49%

# HBW Non-motorized Trips: Attraction End

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Variable	Definition	Coefficient	Std. Error	T- stat.	P-value	Avg. Value
Constant		-0.01235	0.005422	-2.277	0.0228	
POPDEN10	One-mile floating population density (persons/sq. mile)	4.03E+04	6.54E+05	6.169	0	8738
BLKDEN05	Street block density (blocks/sq. mile)	0.000287	7.12E+03	4.038	0.0001	70.14
Adjusted R <sup>2</sup>		0.15				
Number of Observations		752				

Note: Model fit is poor so an average non-motorized trip percentage for area types 1 and 2 will be used

# NHW Non-motorized Trips: Attraction End

Variable	Definition	Coefficient	Std. Error	T- stat.	P-value	Avg. Value
Constant		-0.00383	0.012245	-0.312	0.7547	
POPDEN10	One-mile floating population density (persons/sq. mile)	5.41E+04	1.48E+04	3.665	0.0002	8769
EMPDEN10	One-mile floating employment density (employees/sq. mile)	5.34E+04	2.30E+05	23.196	0	18003
BLKDEN05	Street block density (blocks/sq. mile)	0.001217	0.000165	7.382	0	70.43
Adjusted R <sup>2</sup>		0.57				
Number of Observations		756				

Note: Model is for area types 1 and 2

# HBS, HBO, NHO Non-motorized Trips: Attraction End

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Variable	Definition	Coefficient	Std. Error	T- stat.	P-value	Avg. Value
Constant		-0.0157	0.00953	-1.647	0.0995	
POPDEN10	One-mile floating population density (persons/sq. mile)	1.08E+03	1.18E+04	9.203	0	8612
BLKDEN05	Street block density (blocks/sq. mile)	0.001294	0.000125	10.35	0	68.87
Adjusted R <sup>2</sup>		0.37				
Number of Observations		822				

Note: Model is for area types 1 and 2

# Non-motorized Models Summary

- Trip Generation Non-motorized models

	HBW	HBS	HBO	NHW	NHO
Constant	✓	✓	✓	✓	✓
POPDEN10 One-mile floating employment density (persons/sq. mile)	✓	✓	✓	✓	✓
EMPDEN10 One-mile floating employment density (employees/sq. mile)	✓	✓	✓	✓	✓
BLKDEN05 Street block density (blocks/mile)	✓	✓	✓	✓	✓

- Trip Attraction Non-motorized models

	HBW	HBS	HBO	NHW	NHO
Constant		✓	✓	✓	✓
POPDEN10 One-mile floating employment density (persons/sq. mile)		✓	✓	✓	✓
EMPDEN10 One-mile floating employment density (employees/sq. mile)				✓	
BLKDEN05 Street block density (blocks/mile)		✓	✓	✓	✓

# Conclusion

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- Non-motorized trip models were developed based on 2007/2008 HTS for both production and attraction trip ends
- Models are split into HBW, NHW, and other (HBS, HBO, NHO) trip purposes
- Models are estimated only for area types 1 and 2; fixed percentages are assumed for all other area types
- Model fit varies from  $R^2=0.37$  to 0.57