
Transportation Trends

How do we explain VMT?

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Motivation

- Explain vehicle usage.
- Predict VMT (Vehicle miles traveled) for households in general, as well as based on vehicle ownership (one vehicle households vs. two vehicle households, etc.)
- Examine the links between
 - household characteristics,
 - characteristics of the primary driver of each vehicle, and
 - vehicle characteristics.

NHTS-National Household Travel Survey

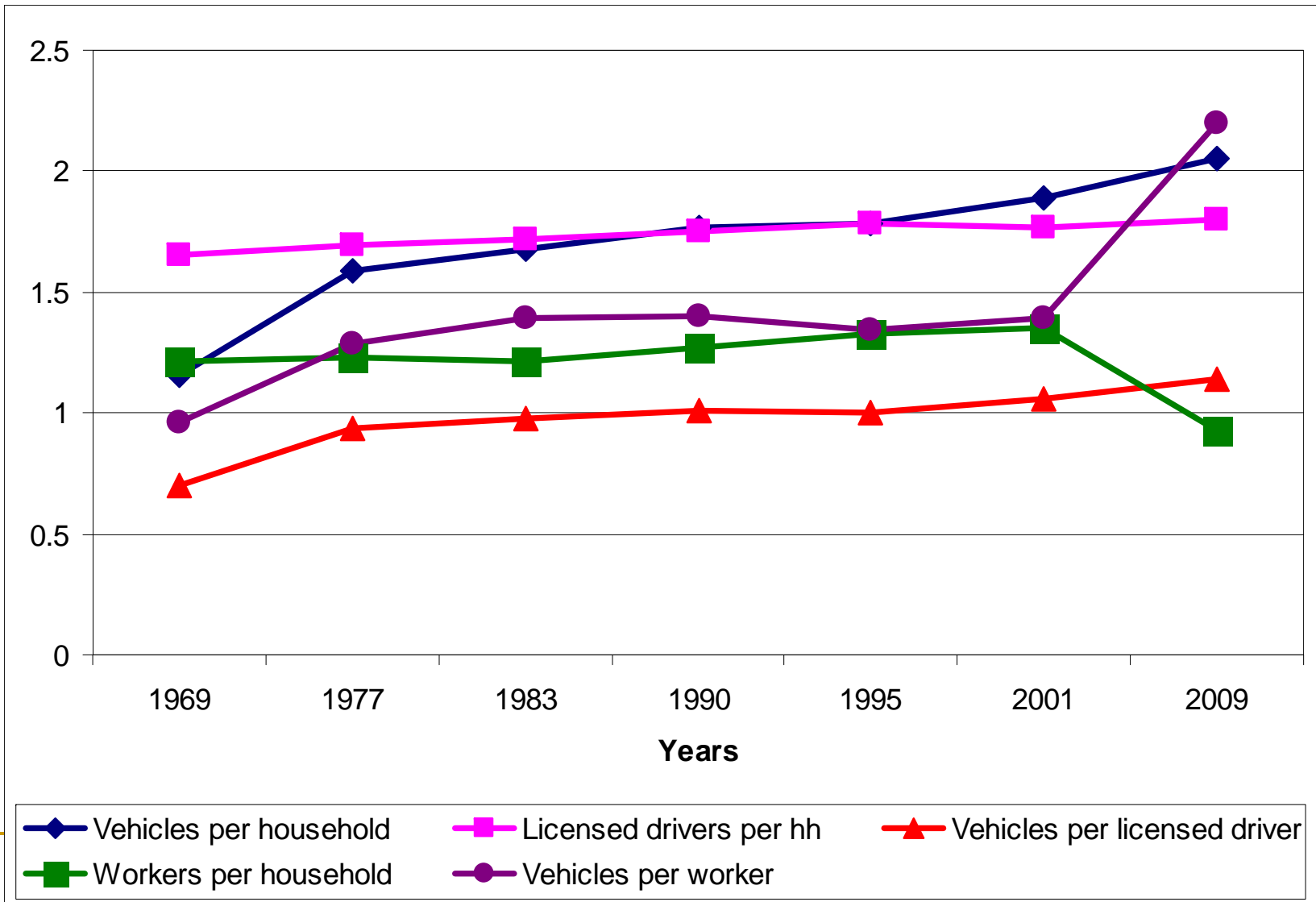
- U.S Department of Transportation
- Federal Highway Administration
- Years: 1969, 1977, 1983, 1990, 1995, 2001 and 2009.

- Data is publicly available at:
<http://nhts.ornl.gov/>

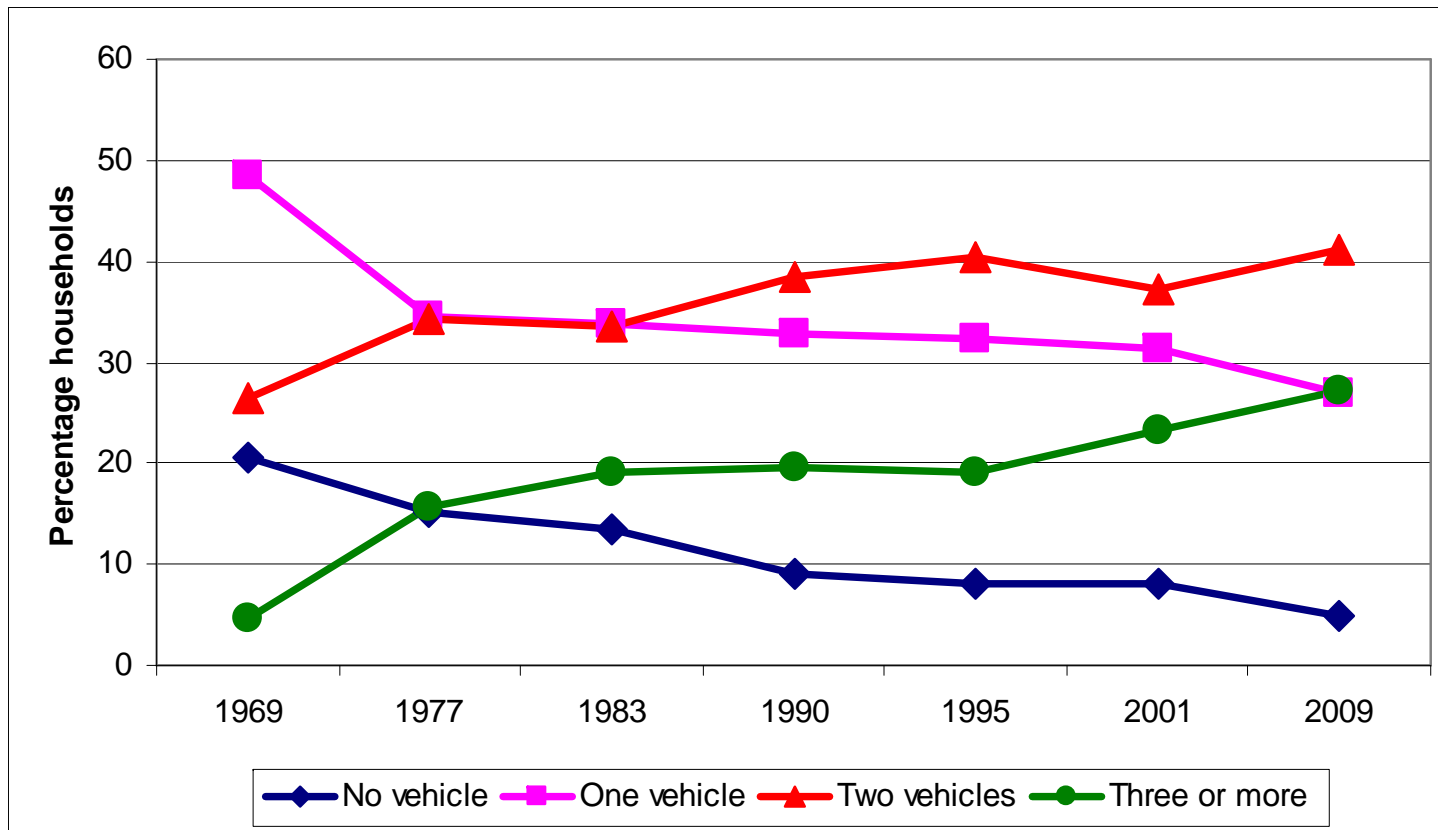
Increasing Sample Sizes

- 1969 – 15,000 households
- 1977 – 18,000 households
- 1983 – 6,300 households
- 1990 – 22,300 households
- 1995 – 42,000 households
- 2001 – 66,000 households
- 2009 – 150,000 households

Vehicles, drivers & licenses



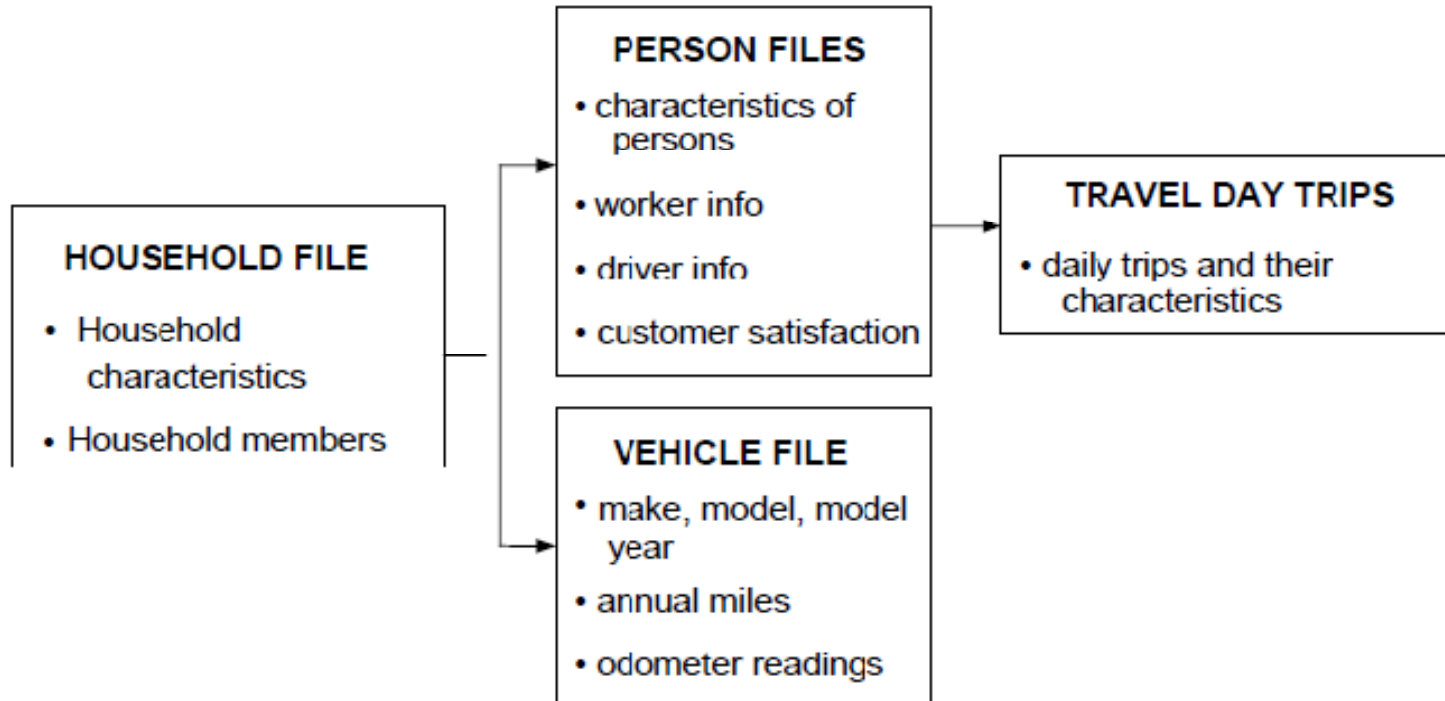
Number of vehicles per household



NHTS - 2009

- 150,147 Households
- 351,275 Persons
- 309,163 Vehicles
- 1,167,321 Travel day trips

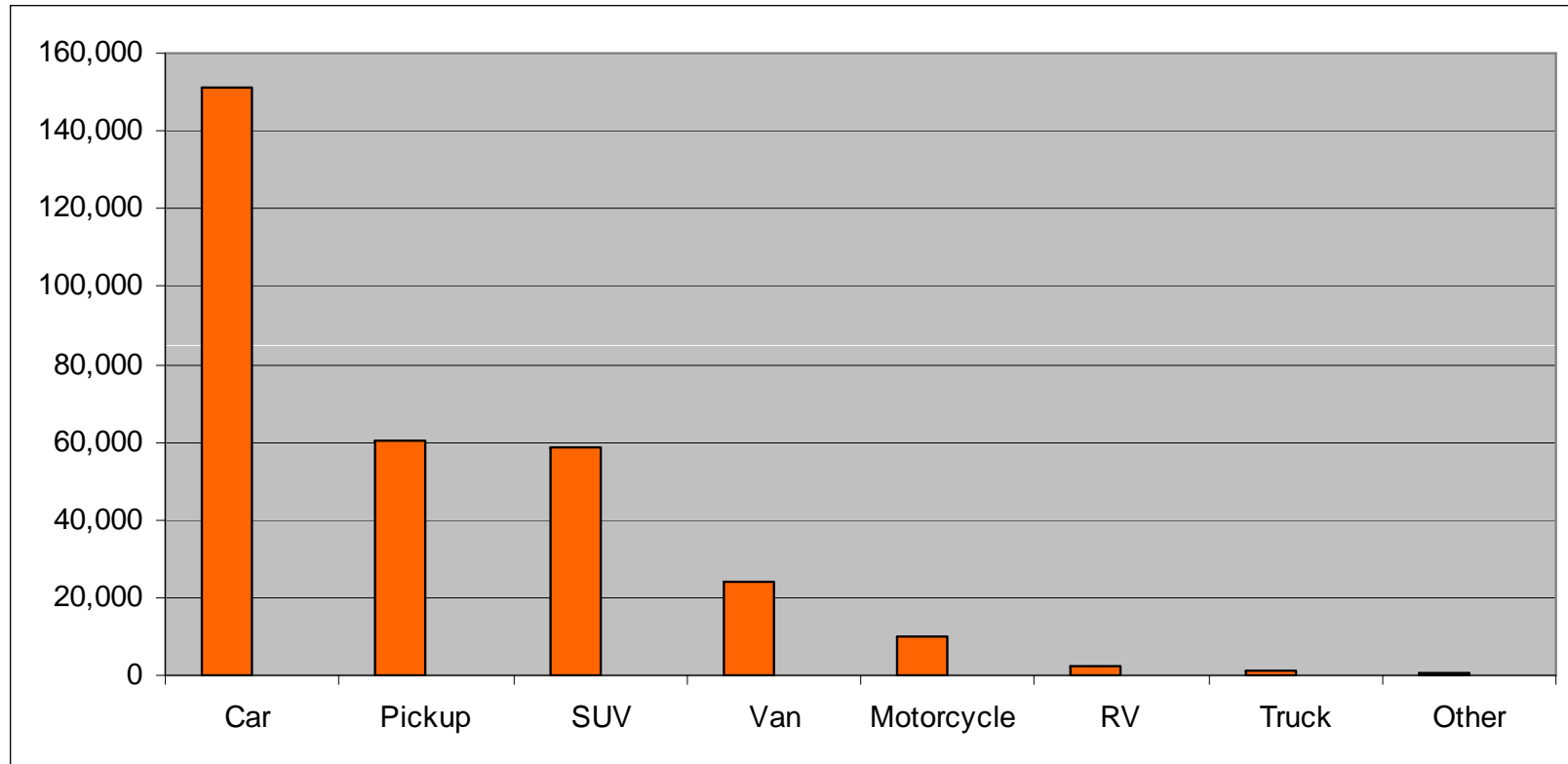
Datasets – 4 Main Data files



Data related

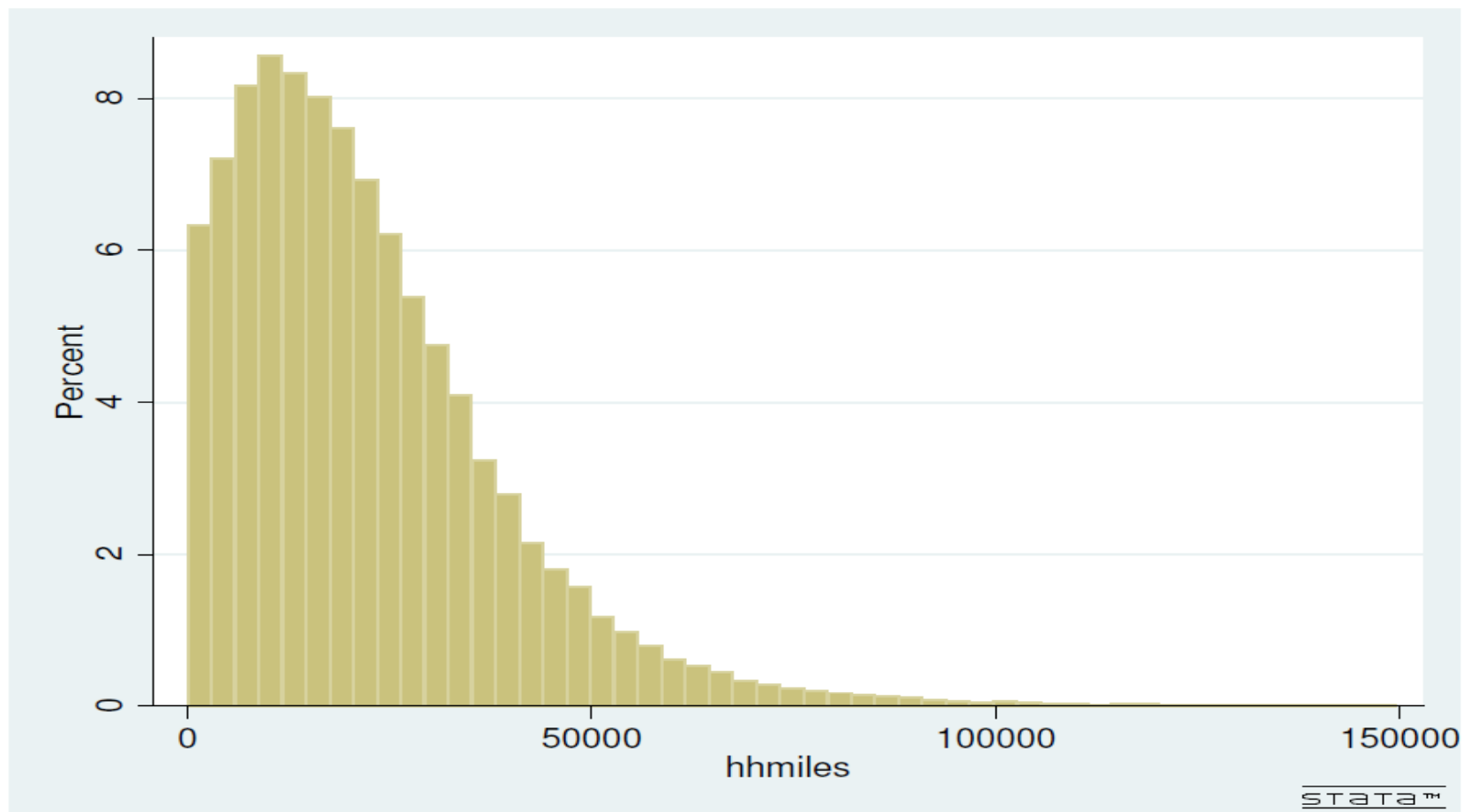
- Some limitations:
 - We do not have the geo-codes or tract ids.
(Although there may be a possibility to get them from add-on regions.)
 - However, we have
 - population density,
 - housing density,
 - percent renter information (at the tract level).
 - The trips data file only contains trips from one day.

Vehicle types



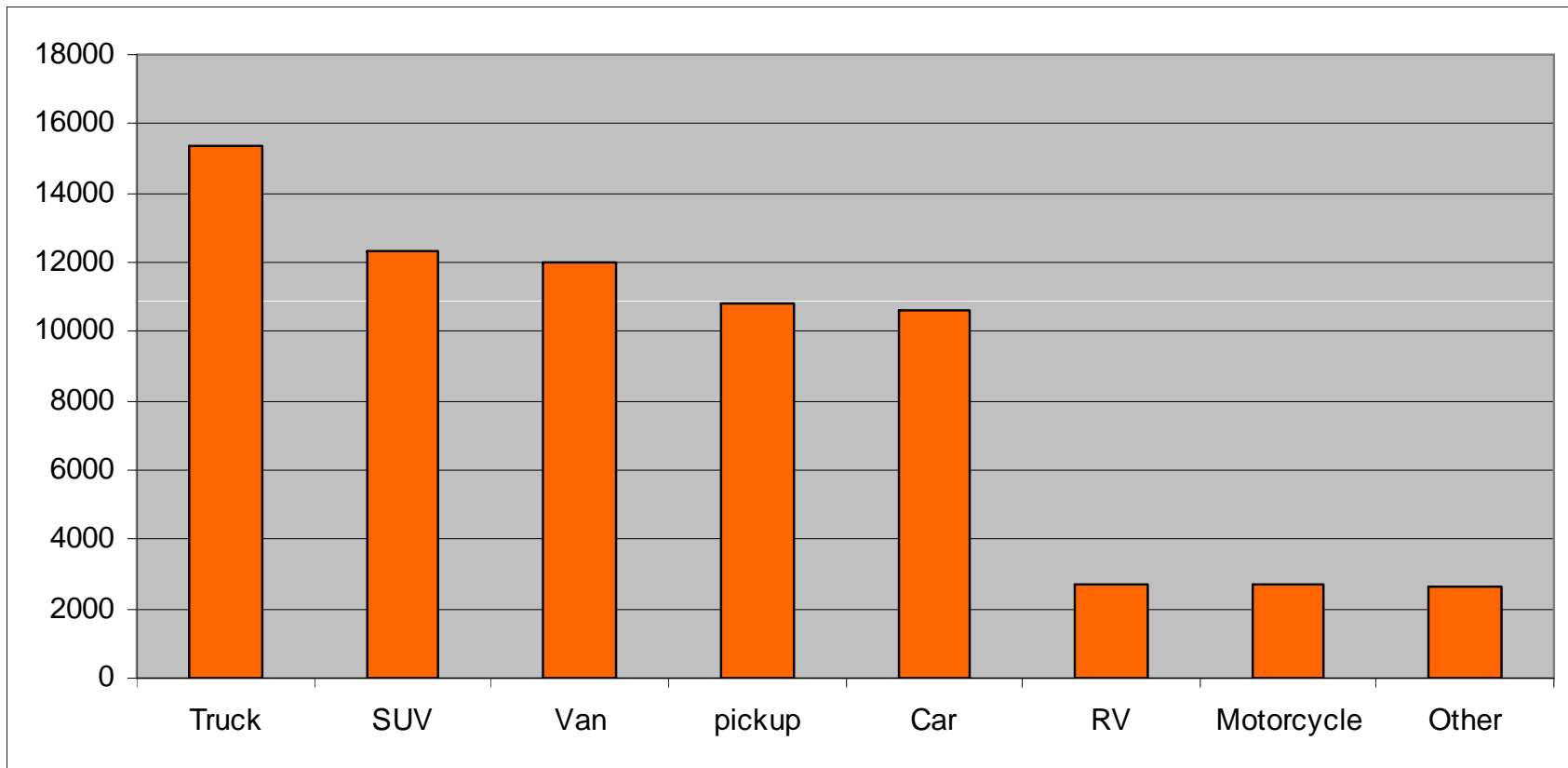
Around 48% of all vehicles (~308,000) are cars, followed by 20% pickup trucks and 20% SUVs

Distribution of Annual Household VMT

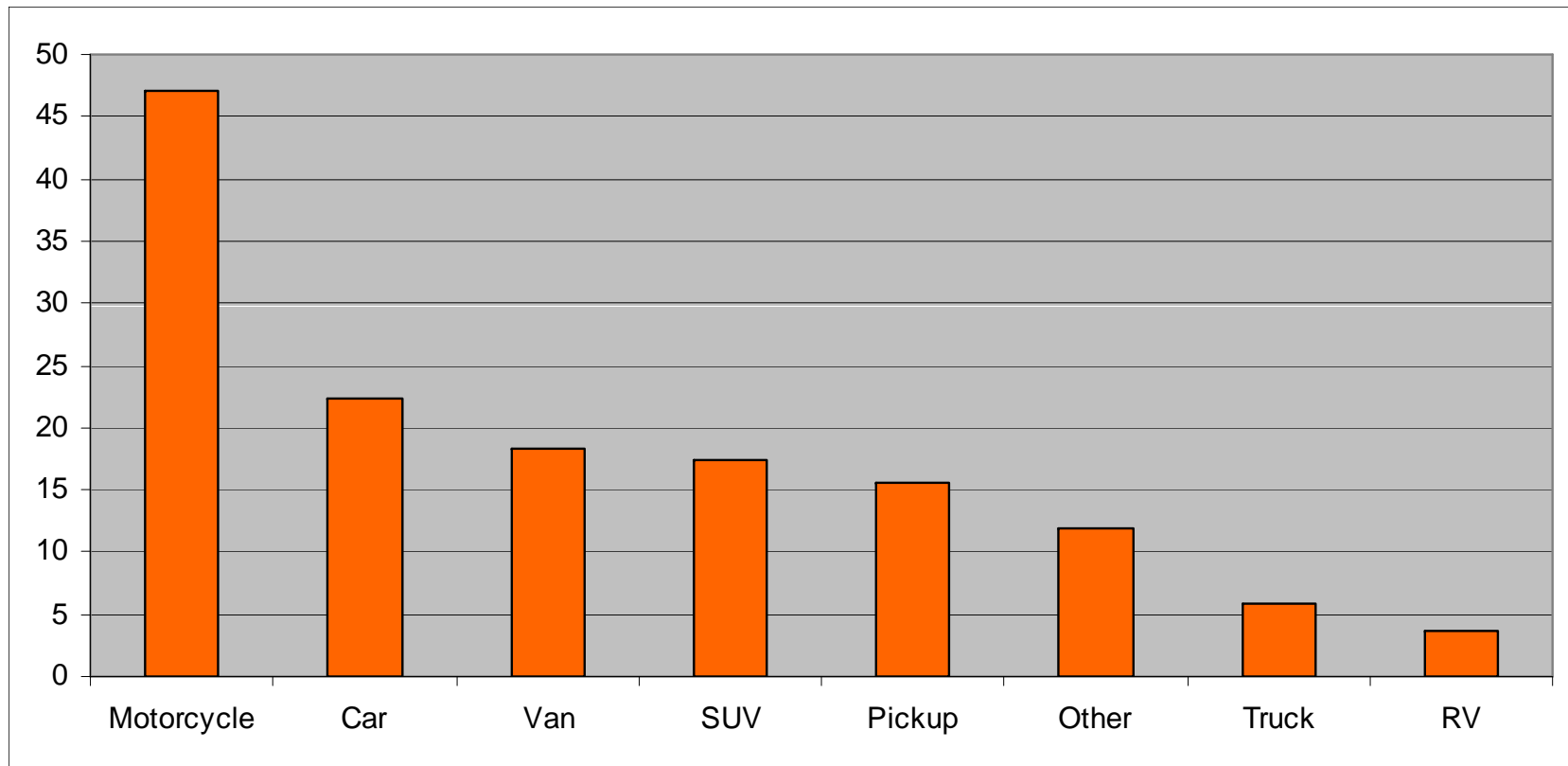


Mean: 23,048 St. Dev: 18,853 Min= 0 Max= 613,145

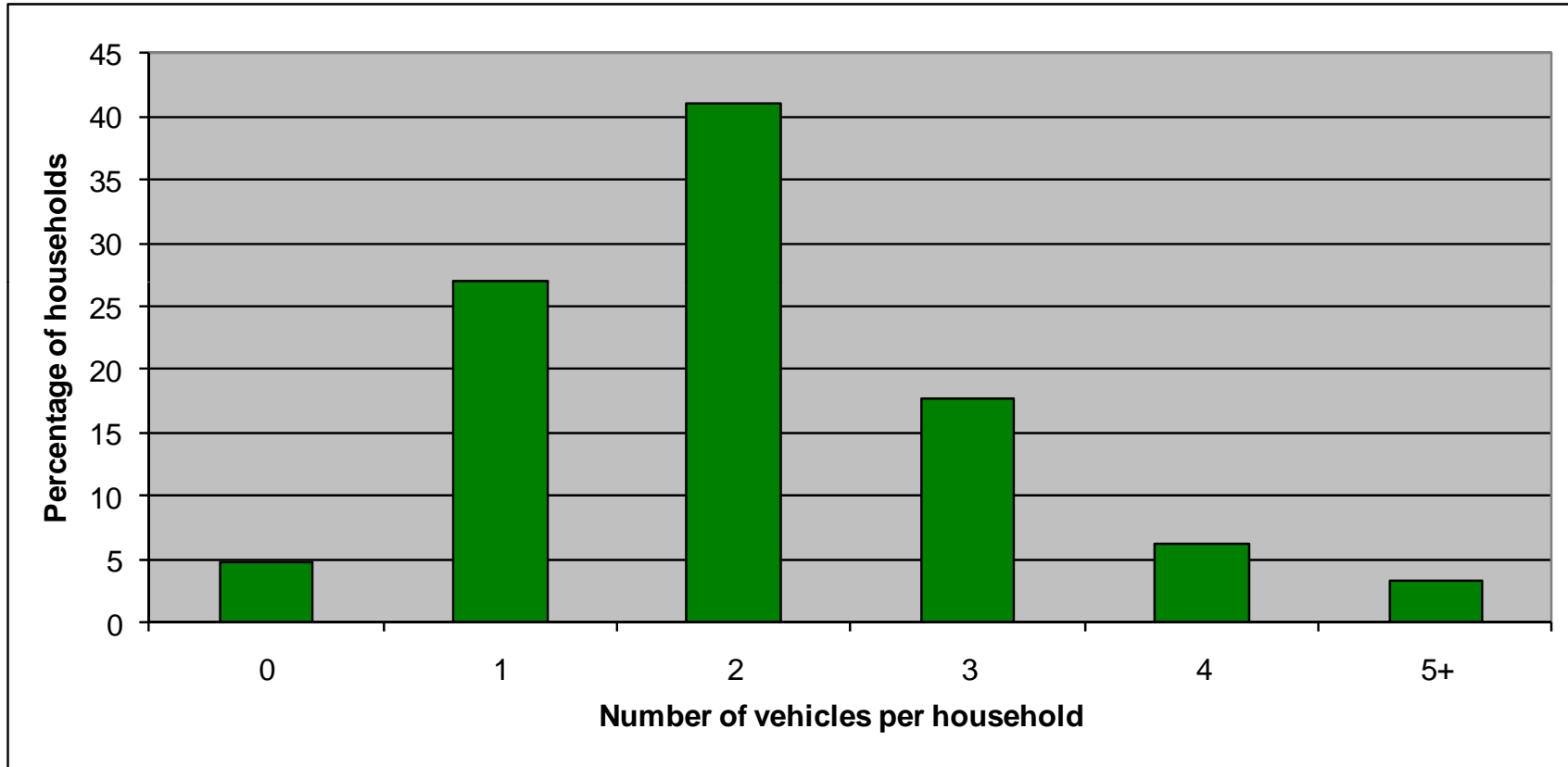
Annual miles (per vehicle)



Miles per gallon

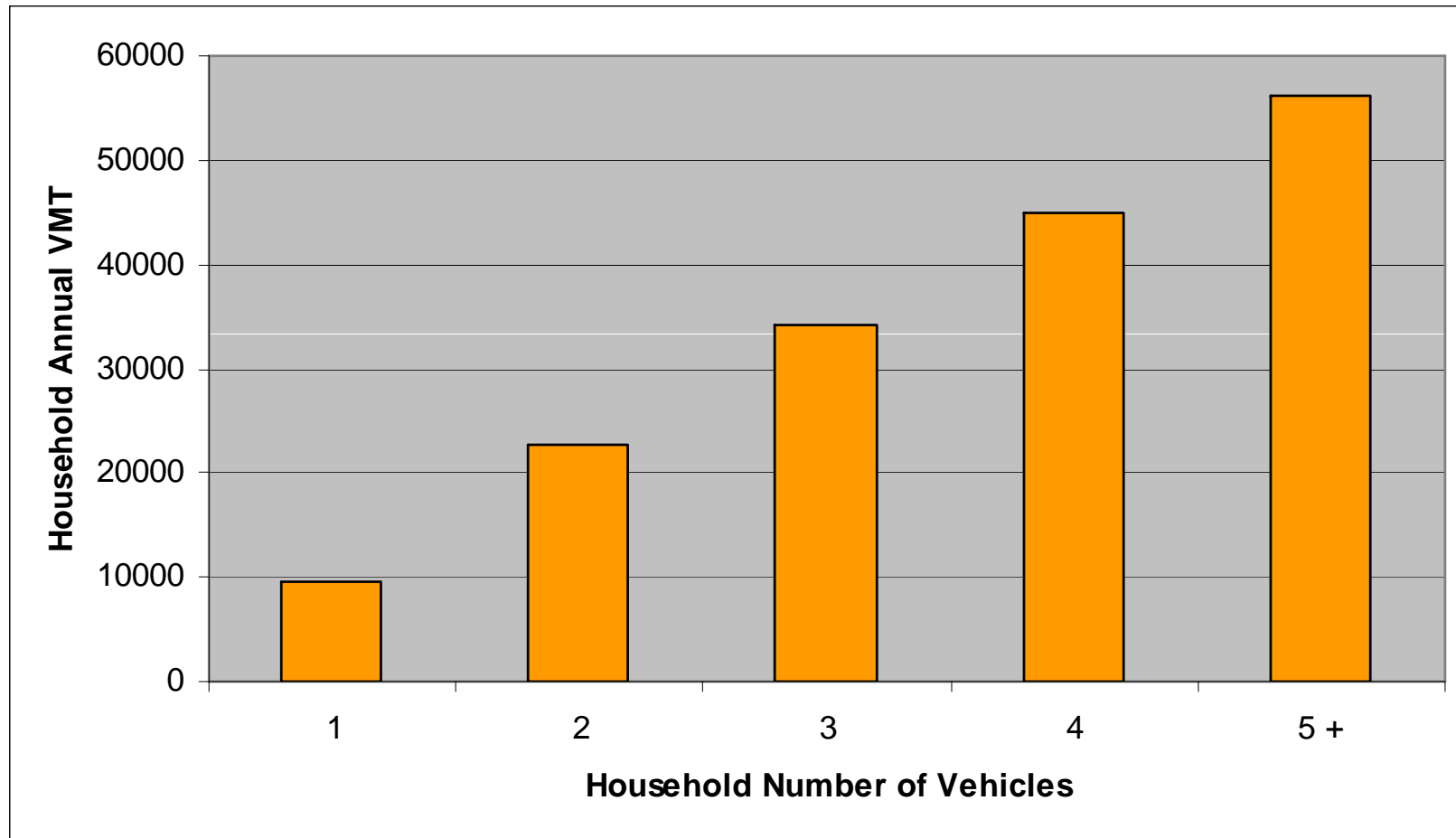


Vehicles per household



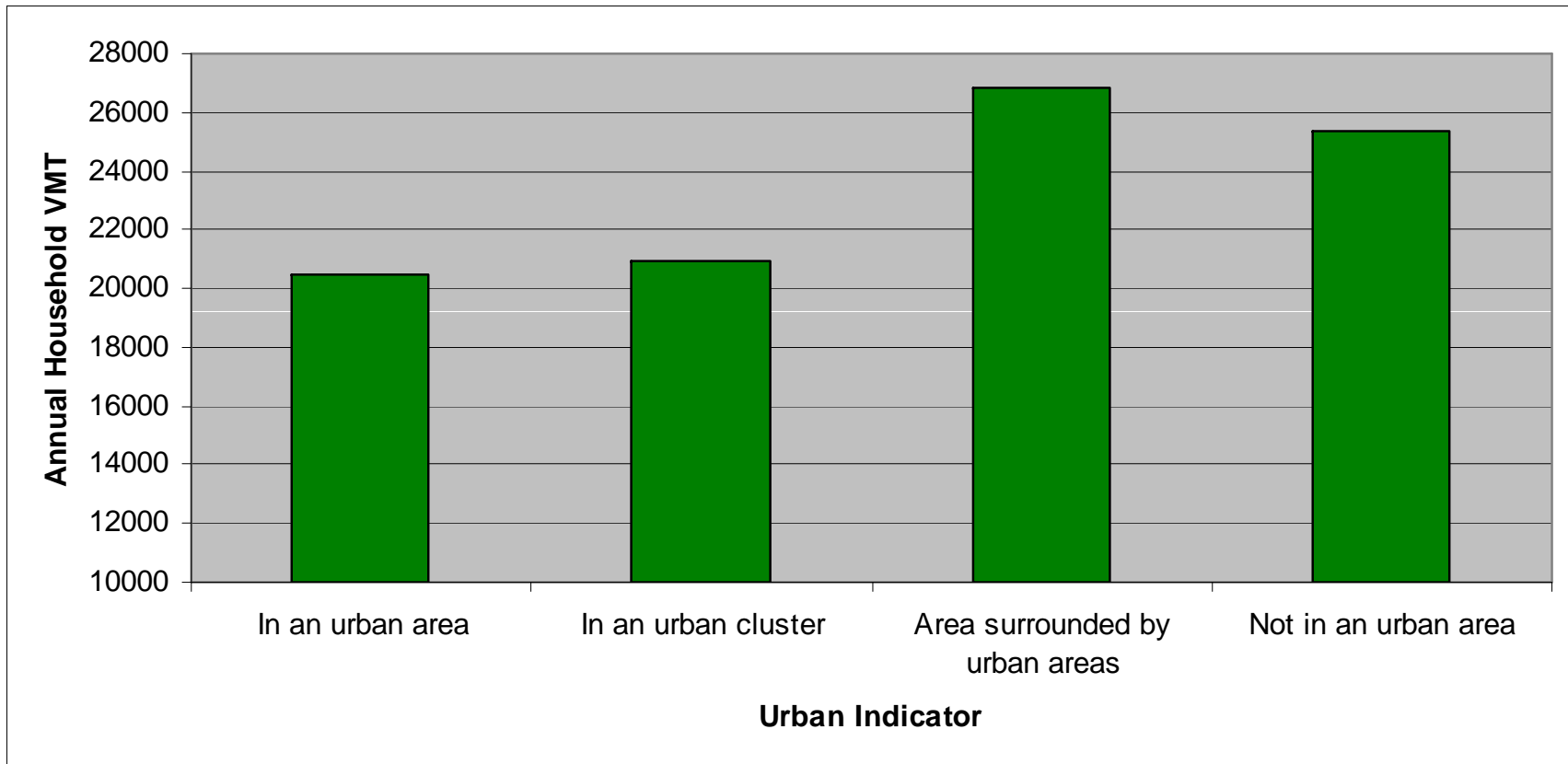
There are 150,147 households in the dataset.

Annual household VMT



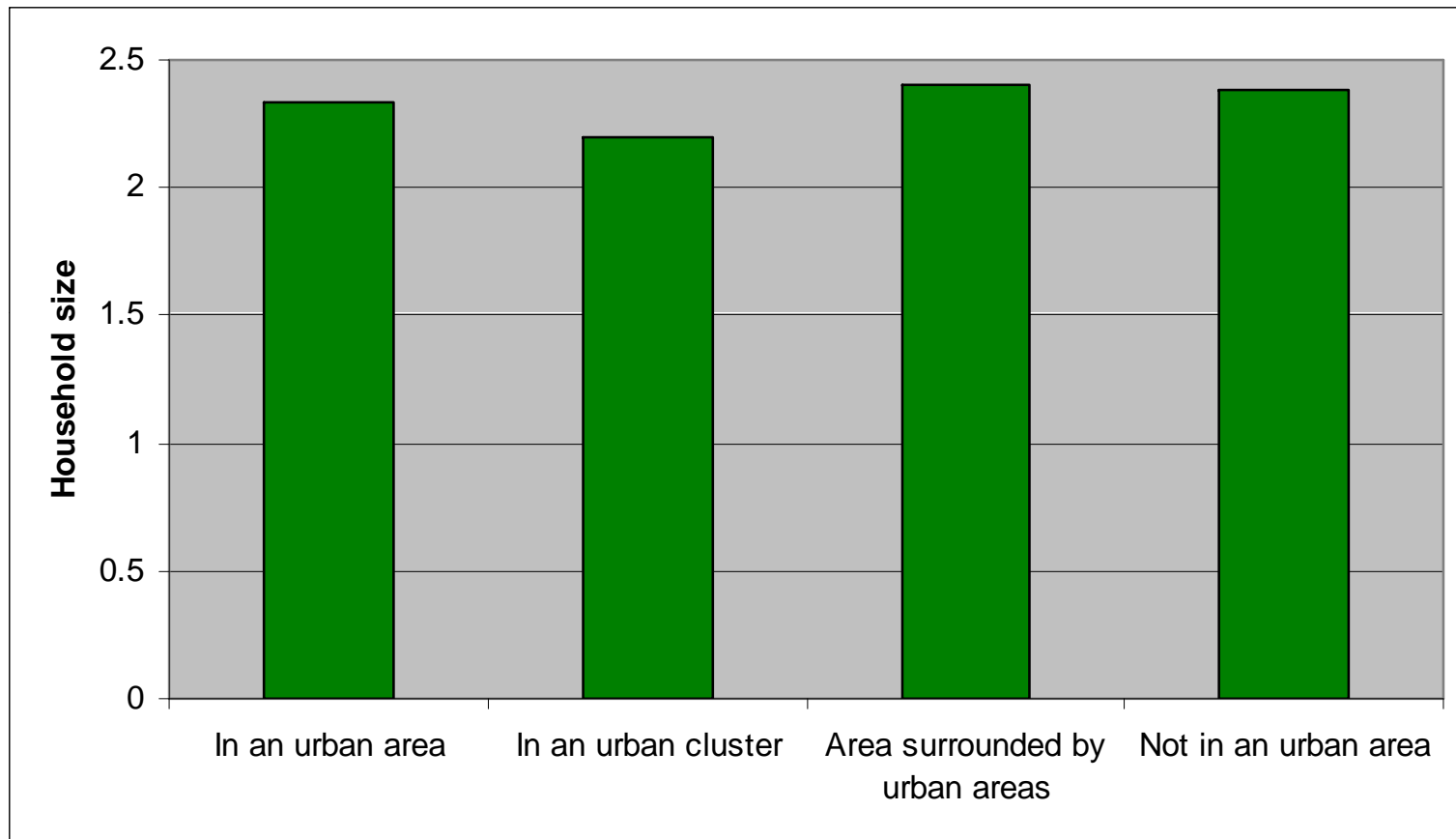
** Excluding households with RVs, motorcycles, commercial licenses, other vehicles.
New N= 120,822

Household miles versus urban indicator

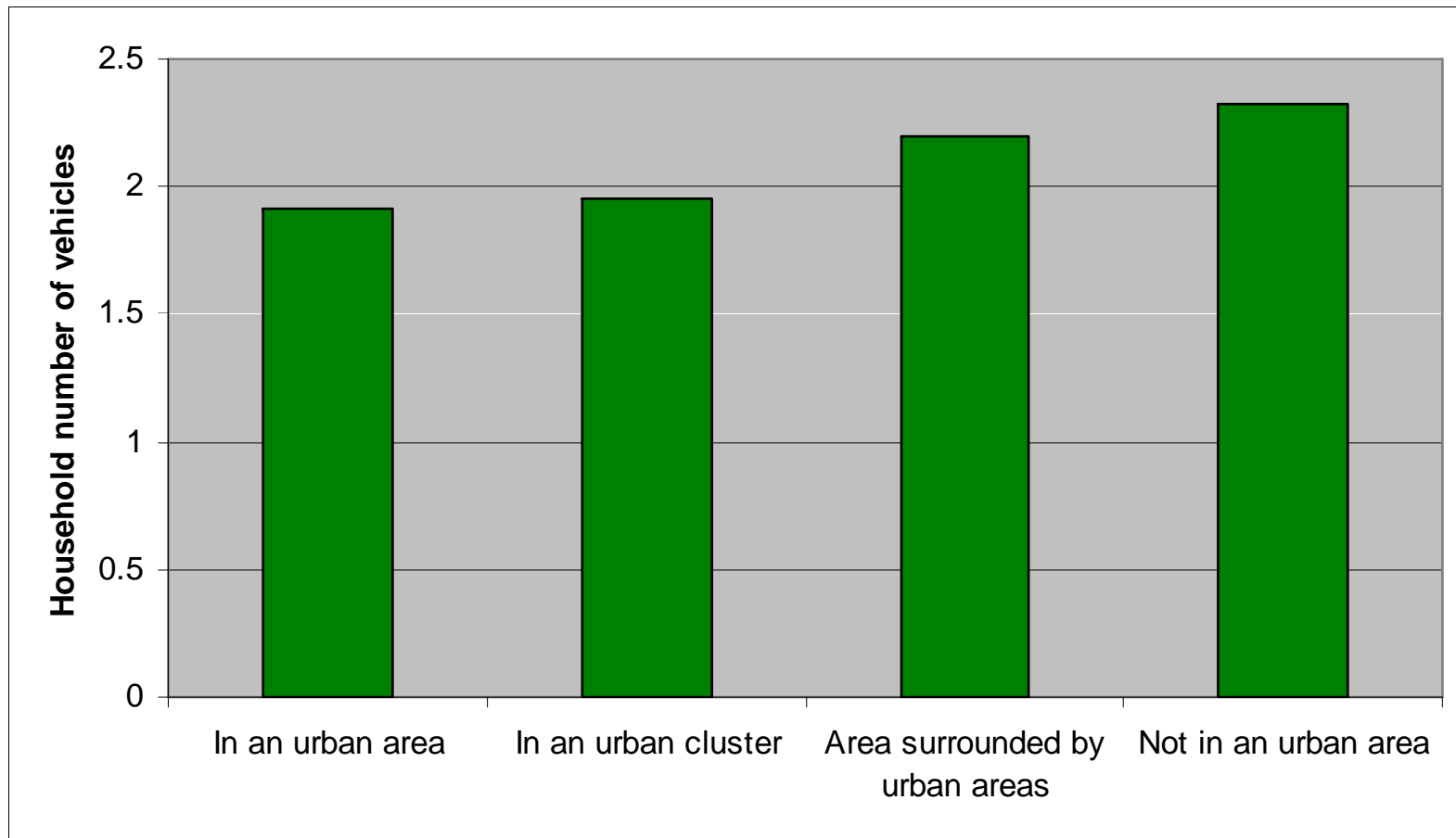


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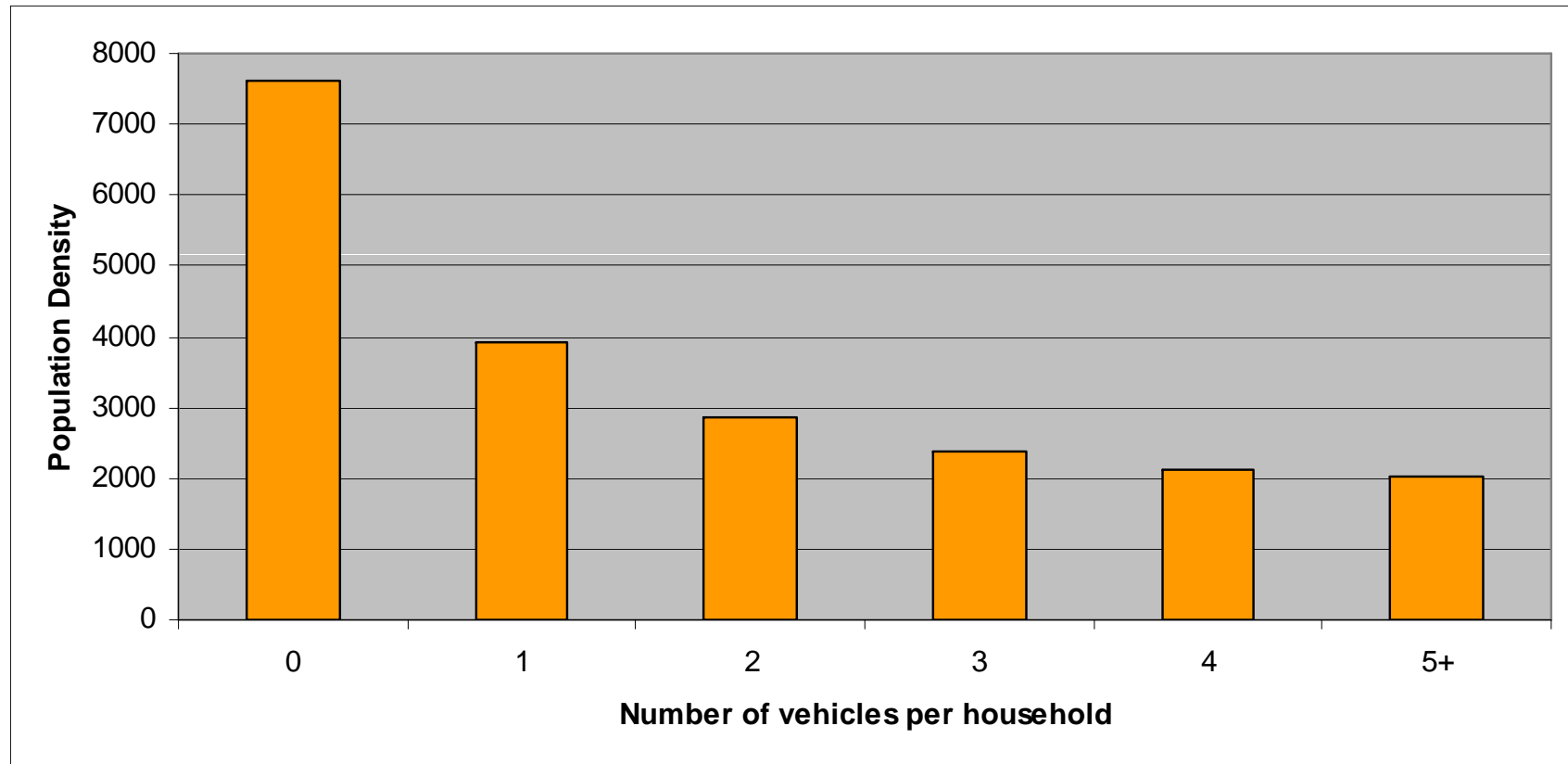
Household size versus urban indicator



Number of vehicles vs. urban indicator



Population density vs. vehicle ownership



** Excluding households with RVs, motorcycles, commercial licenses, other vehicles.

Option to telecommute

- Looking at the “option to telecommute” of the 139,000 workers, 87% of them do not have the option to telecommute.
- The mean value of work distance is 11 miles for the respondents who do not have the option to telecommute, and 16 miles for the ones who have the option to telecommute.

Household miles

- *Household miles = f (*
 - *household characteristics,*
 - *vehicle characteristics,*
 - *location characteristics,*
 - *gasoline cost)*
- OLS regression analysis.

$$\text{Log (annual household miles)} = \alpha + \beta_i X_i$$

Household miles for all*

Variables	Coef.	t
Log (gasoline cost)	-0.410	-8.25
<u>Household characteristics</u>		
Household vehicle count	0.425	130.61
Worker count	0.100	30.21
Number of children	0.037	13.38
Number of adults	0.115	27.87
Log (income)	0.136	38.09
Household respondent age	-0.009	-46.72
One has bachelor's or higher	0.040	8.02
Household respondent female	-0.086	-19.32
Public trans trips per adult	-0.003	-6.07
Telecommute option per worker	0.060	6.65
<u>Residential location characteristics</u>		
Log (population density)	-0.042	-29.43
Percent renter	0.000	-2.08
<u>Characteristics of the vehicle fleet</u>		
Mean vehicle age	-0.017	-38.20
At least one hybrid vehicle	0.031	2.92
Percent of SUVs	0.148	19.42
Percent of pickup trucks	0.205	22.34
Percent of vans	0.118	11.11
<i>Constant</i>	8.400	127.78
Number of observations		109,567
Adjusted R-squared		0.467

*Excluding households with commercial vehicles, and motorcycles, RVs, trucks and other vehicles.

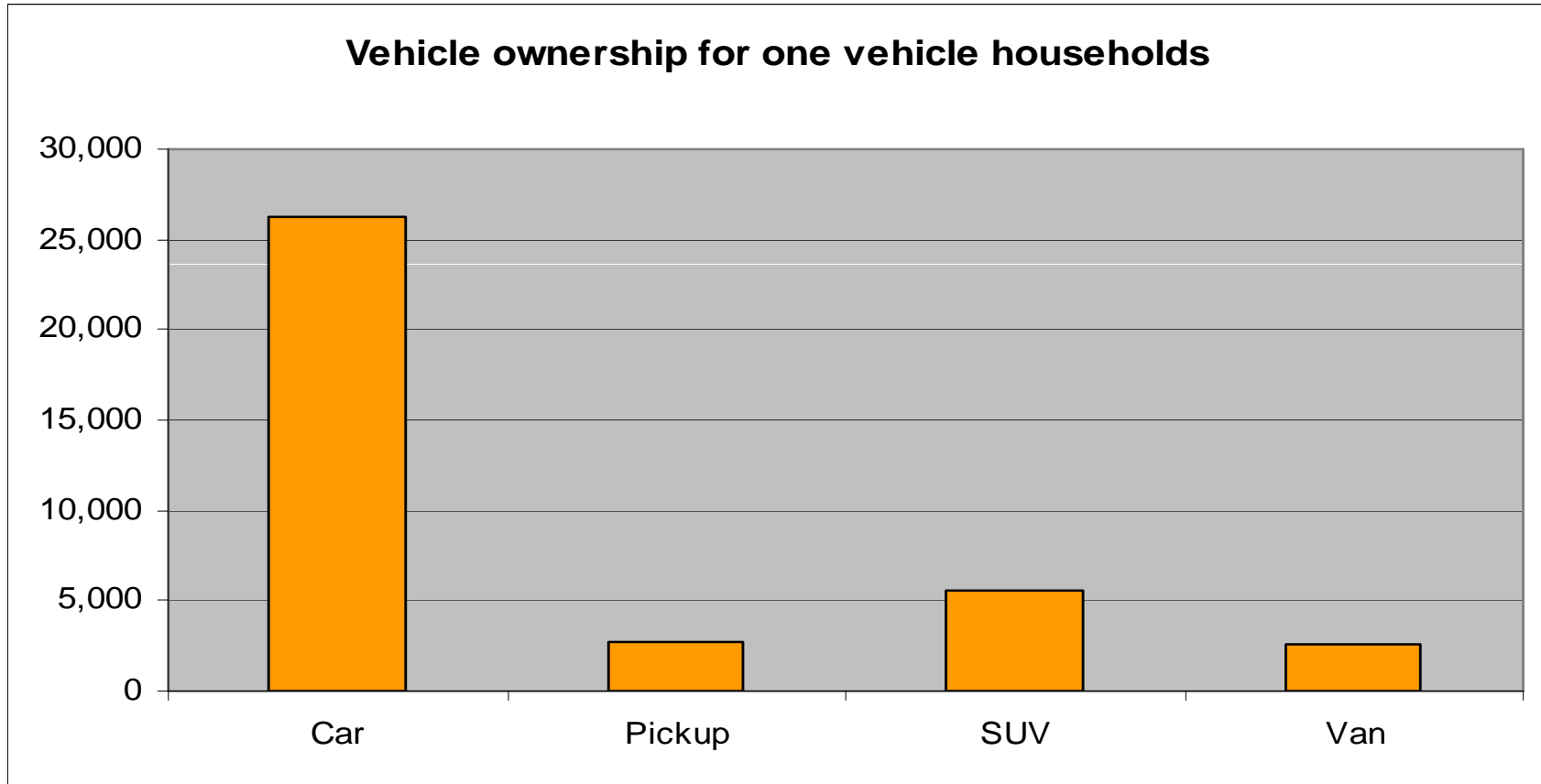
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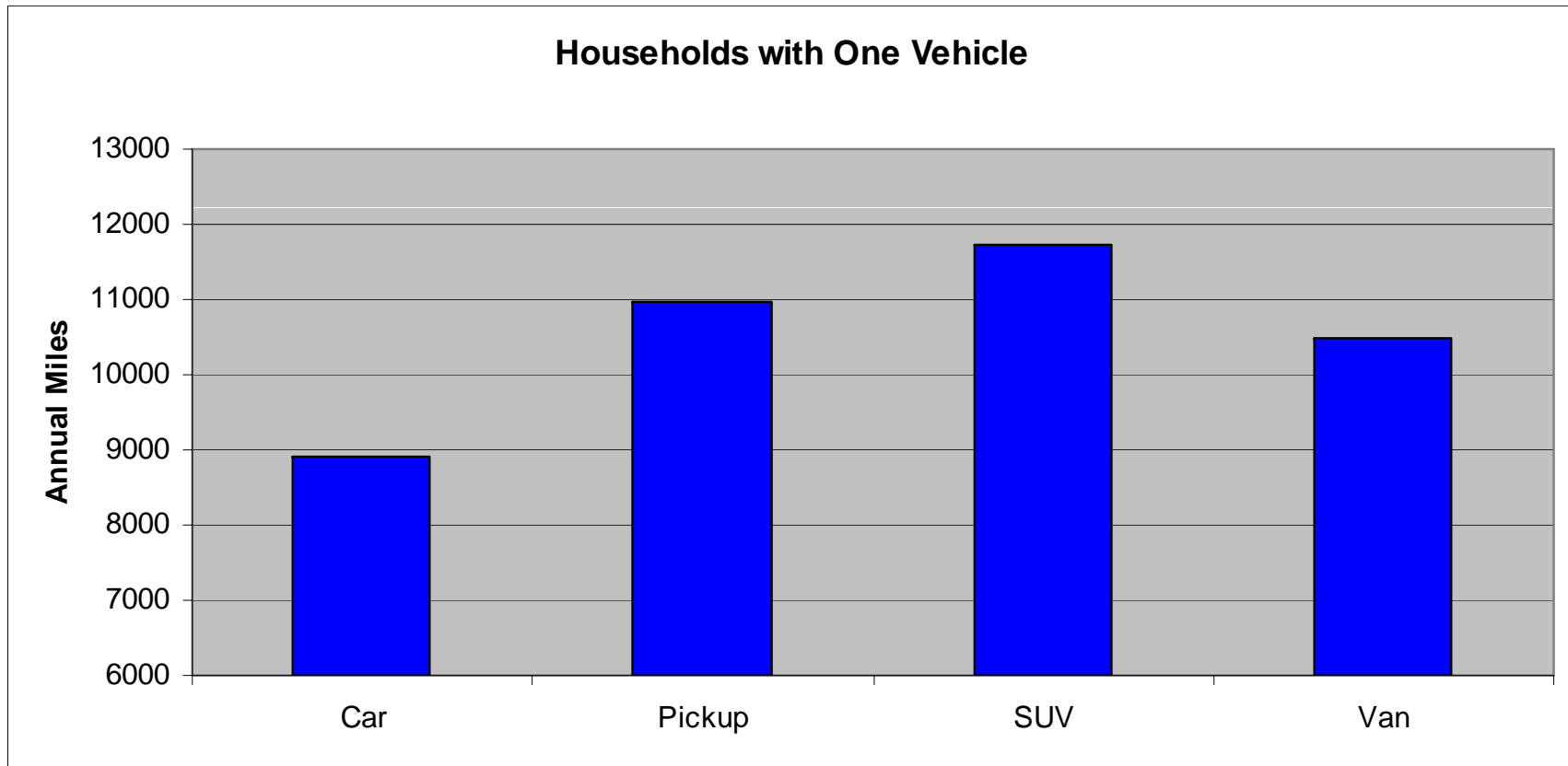
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Now let's look at one vehicle
households only...

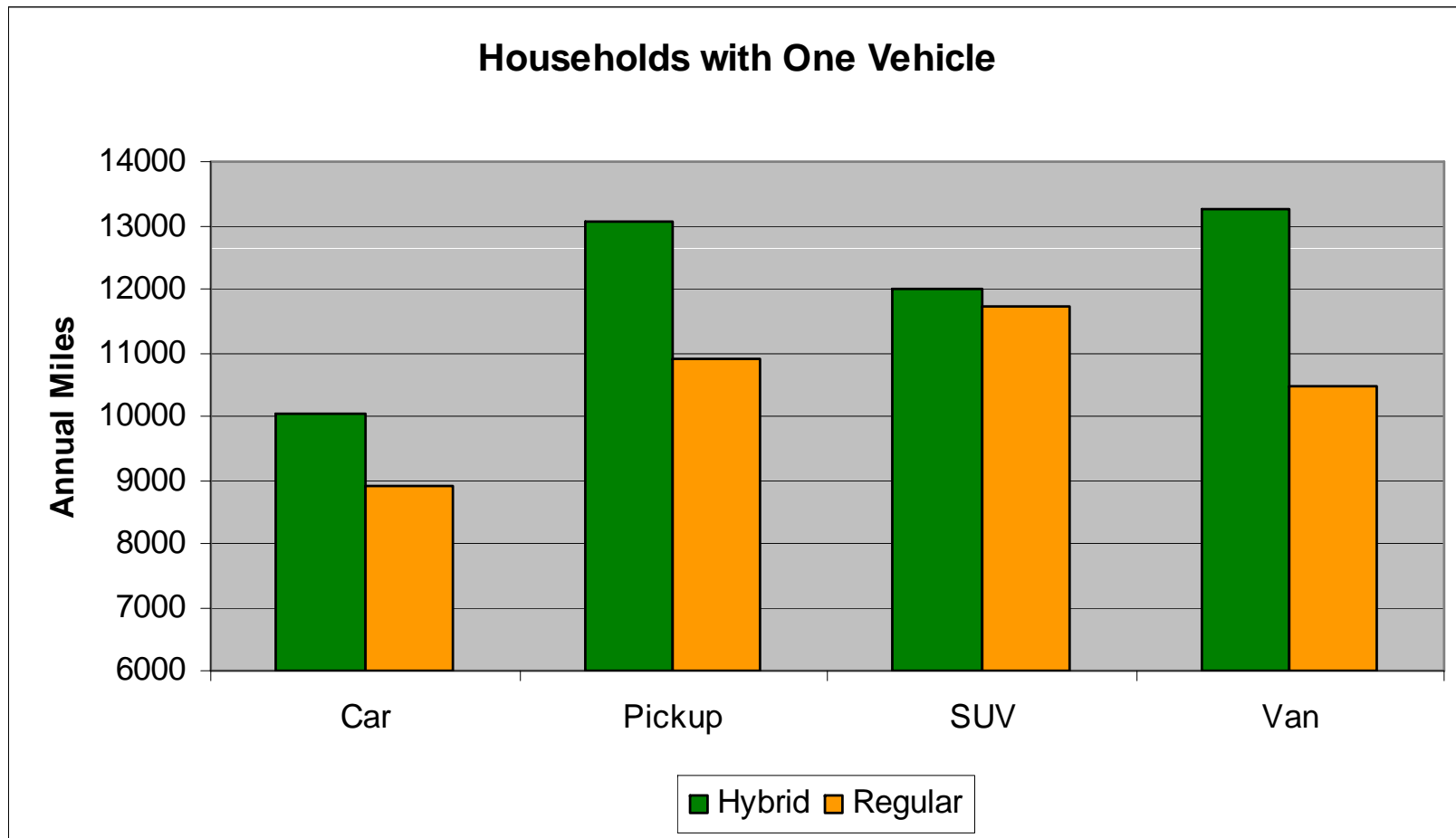
What type of vehicle do they own?



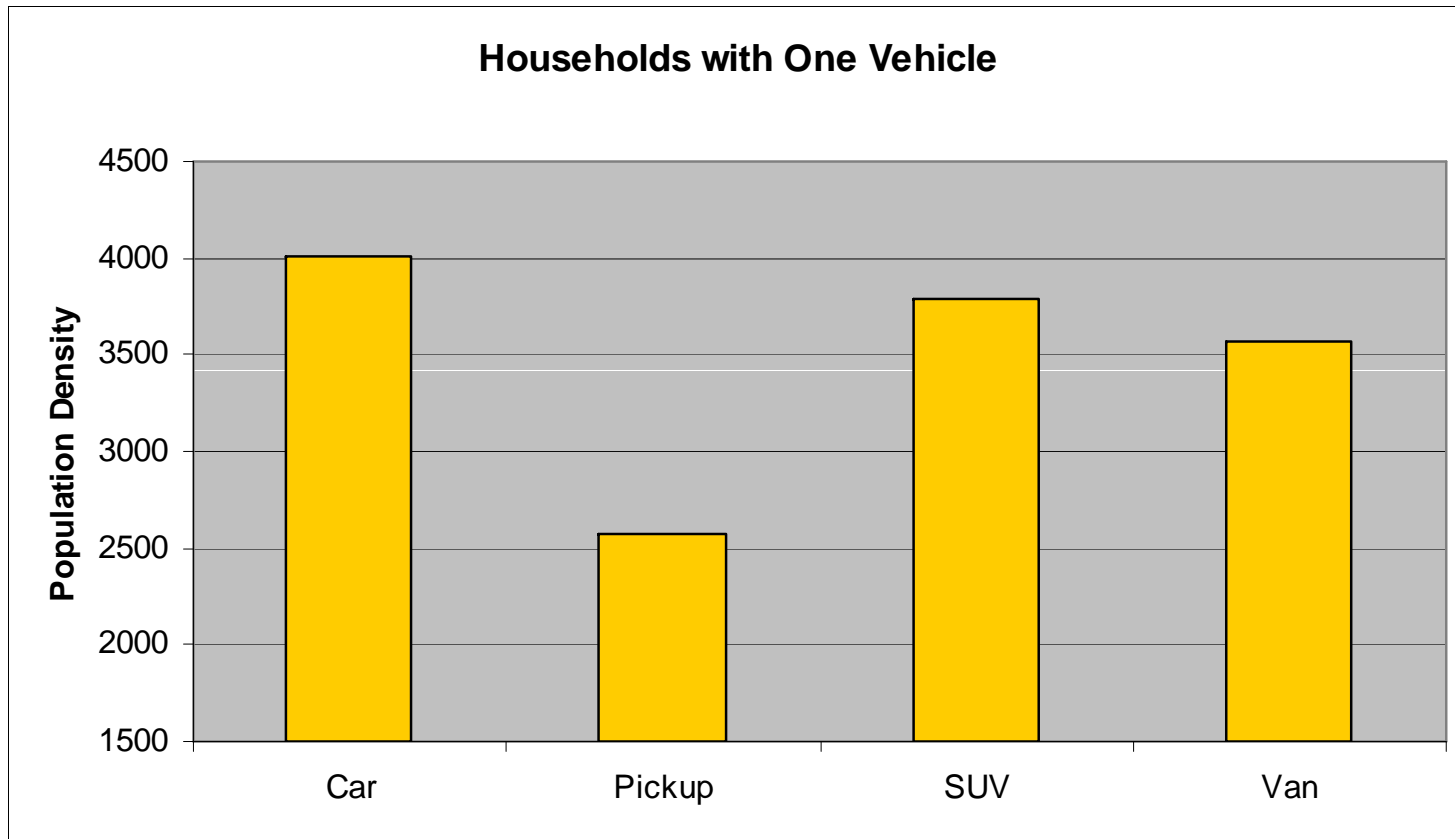
Annual miles vs. vehicle



Annual miles vs. hybrid dummy



Population density versus vehicle type



Although the difference looks small in this graph, the difference between the population density between cars and SUV's are statistically significant at the 95% level.

Households with one vehicle

Variables	Coef.	t stat.
Log (gasoline cost)	-0.564	4.51
<u>Household characteristics</u>		
Worker count	0.204	17.68
Number of children	0.060	6.26
Number of adults	0.084	8.43
Log (income)	0.097	12.26
Household respondent age	-0.009	21.17
One has bachelor's or higher	0.043	3.45
Household respondent female	-0.157	13.13
Public trans trips per adult	-0.003	-3.00
Telecommute option per worker	0.067	2.38
<u>Residential location characteristics</u>		
Log (population density)	-0.049	13.61
Percent renter	0.000	0.37
<u>Characteristics of the vehicle fleet</u>		
Vehicle age	-0.019	20.09
Hybrid vehicle	0.000	-0.01
SUV	0.164	10.65
Pickup truck	0.108	4.93
Van	0.097	4.62
<i>Constant</i>	9.394	59.74
Number of observations		33,582
Adjusted R-squared		0.126

*Excluding households with commercial vehicles, RVs, motorcycles and trucks.

Now let's look at two-vehicle households.

Households with two vehicles

Variables	Coef.	t
Log (gasoline cost)	-0.242	-4.33
<u>Household characteristics</u>		
Worker count	0.127	34.24
Number of children	0.039	12.69
Number of adults	0.046	7.65
Log (income)	0.072	16.38
Household respondent age	-0.006	-25.52
One has bachelor's or higher	0.016	2.83
Household respondent female	-0.024	-4.80
Public trans trips per adult	-0.002	-4.55
Telecommute option per worker	0.028	2.99
<u>Residential location characteristics</u>		
Log (population density)	-0.037	-22.71
Percent renter	0.000	-1.66
<u>Characteristics of the vehicle fleet</u>		
Mean vehicle age	-0.018	-31.74
At least one hybrid vehicle	0.021	1.83
Percent of SUVs	0.052	5.61
Percent of pickup trucks	0.030	2.86
Percent of vans	0.048	3.69
<i>Constant</i>	9.829	125.49
<hr/>		
Number of observations		50,956
Adjusted R-squared		0.179

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Two vehicle households

- Examination of the primary driver's characteristics is necessary.
- Instead of looking at total annual household miles or looking at each vehicle separately, examine the usage effects of one vehicle on the other.
- A bit more complicated modeling required, to deal with endogeneity.
- Hypothesis: *The share of VMT of each vehicle is affected by the characteristics of the vehicle and its driver as well as the characteristics of the second driver and its driver.*

SUR (Seemingly Unrelated Regression)

- Two equations are estimated.
 - First equation is for estimating the total VMT in two-vehicle households.
 - The second equation is to estimate the share of VMT by the first vehicle (defined by ownership period).
 - $Share_1 = (VMT_1 / VMT_2) * 100$
-

SUR (Seemingly Unrelated Regression)

- $\text{Log (Total VMT)} = f \{$
 - *household characteristics,*
 - *attributes of the residential location,*
 - *characteristics of the households' vehicle fleet,*
 - *gasoline cost}*

- $\text{SH1} = f \{$
 - *characteristics of the driver of the first vehicle,*
 - *characteristics of the driver of the second vehicle,*
 - *characteristics of the first vehicle,*
 - *characteristics of the second vehicle}*

The Total VMT Model

Variables	Coefficient	t-value
Log (Gasoline Cost) (\$/gallon)	-0.195	-2.98
<u>Household Characteristics</u>		
Worker Count (#)	0.189	15.98
(Worker Count) ²	-0.029	-6.00
Number of Children (#)	0.076	9.34
(Number of Children) ²	-0.0097	-4.21
Number of Adults (#)	0.045	6.15
Log (Income) (\$)	-0.294	-3.58
Log (Income) ²	0.017	4.36
Household Respondent Age (years)	0.0066	4.71
(Household Respondent Age) ²	-0.0001	-8.16
Bachelor (dummy)	0.023	3.43
Household Respondent Female (dummy)	-0.026	-4.45
Public Transportation Trips per Adult (#)	-0.0017	-2.66
Telecommute Option (# workers)	0.0106	0.96
<u>Residential Location Characteristics</u>		
Log (Population Density) (people/sq.mi.)	-0.038	-19.89
Percent Renter (%)	-0.0002	-1.17
<u>Characteristics of the Vehicle Fleet</u>		
Mean Vehicle Age (years)	-0.025	-12.76
(Mean Vehicle Age) ²	0.00044	5.62
At Least One Hybrid (dummy)	0.009	0.66
At Least One SUV (dummy)	0.017	2.75
At Least One Pickup (dummy)	0.009	1.45
At Least One Van (dummy)	0.028	3.37
<i>Constant</i>	11.39	25.85
Number of observations		31309
System-weighted R-squared		0.1304

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Share of First Vehicle's VMT

Variables	Coefficient	t-value
<u>First-Driver Characteristics</u>		
Employed (dummy)	3.437	12.40
Age (years)	-0.041	-2.85
Female (dummy)	-1.731	-6.03
Bachelor(dummy)	0.544	1.94
Telecommute Option (dummy)	1.080	2.44
Public Transportation Trips (#)	-0.062	-2.61
<u>First-Vehicle Characteristics</u>		
SUV (dummy)	1.214	4.23
Van (dummy)	2.556	6.28
Pickup (dummy)	-2.017	-5.81
Hybrid (dummy)	2.181	3.49
Vehicle Age (years)	-0.584	-22.46
<u>Second-Driver Characteristics</u>		
Employed (dummy)	-3.134	-10.97
Age (years)	0.048	3.32
Female (dummy)	1.691	5.85
Bachelor (dummy)	-0.430	-1.53
Telecommute Option (dummy)	-1.170	-2.70
Public Transportation Trips (#)	0.039	1.73
<u>Second-Vehicle Characteristics</u>		
SUV (dummy)	-1.103	-3.55
Van (dummy)	-2.531	-6.10
Pickup (dummy)	1.796	5.73
Hybrid (dummy)	-3.411	-3.16
Vehicle Age (years)	0.596	27.89
<i>Constant</i>	49.49	59.31
Number of observations		31,309
System-weighted R-squared		0.1304

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Findings

- Consistent with existing literature:
 - An increase in the number of vehicles, workers, adults and children in a household increases VMT.
 - Increasing population density decreases VMT.
 - Cost of gasoline is negatively associated with VMT.

Findings, cont'd.

- The results of the SUR model reveal the substitution patterns between vehicles in a two-vehicle household.
 - The results indicate that if the vehicle is an SUV, pickup truck, van or a hybrid vehicle, it is used more.
 - The older the vehicle the more the other vehicle is used.
 - The vehicle whose driver is a male, employed and has a bachelor's degree is used more.
-

Interesting Findings

- Option to telecommute increases VMT.
 - Households who own at least one SUV, pickup truck and van travel more than households who own cars only.
 - Owning a hybrid vehicle also increases the miles traveled.
 - If promoting hybrid vehicles due to concerns about energy results in more VMT, what will be the overall impacts in terms of growth and congestion in urban areas?
-

Future directions...

- Incorporate the vehicle type choice in the analysis.
- To account for selectivity bias, linking the model to a discrete choice model and adding a correction term involving the households' predicted vehicle type choice probabilities.