

# Variation in the cost of car ownership in the United States

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## Motivation

In most of the U.S., owning a car is so useful that virtually everyone who can afford to own a car does. Part of the reason for this is that cars offer transportation service that is simply unmatched by alternative modes, given our land use patterns and transport infrastructure. Walking and biking are too slow and/or dangerous. Buses and trains don't usually go exactly where people need to go when they need to go there. Even carpooling presents substantial coordination challenges.

And so, cars are an expensive necessity for most Americans, simply because cars are practically required for at least some of the trips they make. Once a household invests in a car, however, even trips that might be conveniently made by alternative modes often default to become car trips. This is because much of the cost of car ownership is fixed—paid regardless of how much the car is used.

With emerging alternatives to car ownership that provide convenient car access, such as ridehailing, car ownership may become a choice rather than a necessity for more U.S. households. Indeed, many observers have pointed out that it may be economical for many households to and replace at least one of their household vehicles with a combination of ridehailing, carsharing, and car rental, plus non-car modes of travel (e.g., transit, walking, and biking).

This analysis uses 2017 National Household Travel Survey (NHTS) data to look at car ownership and use costs in detail, highlighting the wide variation in how much Americans are paying to own and operate their cars. Understanding this variation is critical to making accurate predictions about which households might entertain the idea of “shedding” a household car.

While vehicle cost and expenditure estimates are available (e.g., [Consumer Expenditure Survey](#) and [American Automobile Association](#)), there have been limited scholarly attempts to understand the variation in the experienced full costs of vehicle ownership and use. The AAA cost estimates are high because they are only for vehicles during the first 5 years of ownership, and assume that the vehicles were purchased new. Many scholars and other observers have used the AAA estimates in their own work (e.g., Brown, 2018).

Polzin, Chu, and Raman (2008) is a rare exception, and the most similar study to ours that we have seen. These authors specifically asked what it would take in terms of transit service and fares to entice

households to reduce their vehicle holdings, and used household expenditure data from the Bureau of Labor Statistics to inform their estimates of the cost of vehicle ownership and use.

## Data and methods

This project puts the 2017 NHTS data together with vehicle ownership and use cost data from multiple sources to arrive at estimates of how much it cost households to own and operate their vehicles in 2017. The costs included in these estimates cover fuel and fuel taxes, vehicle maintenance, tire replacement, insurance, registration fees and other annual vehicle taxes, and vehicle depreciation. Our annual per-vehicle cost estimates are the sum of these five cost components. Our annual per-mile cost estimates for each vehicle are the sum of these five cost components divided by the NHTS annual VMT estimate. Our household annual vehicle cost estimates are the sum of these costs over all vehicles owned by the household. Table A.1 identifies the NHTS variables and other data sources used for each component of cost, along with key assumptions made. Not included in these cost estimates are tolls, interest charges for those who financed their vehicle purchase, garaging and parking costs, and sales tax on the original vehicle purchase.

## Results

We find high variation in the cost of car ownership across geographies, income groups, and vehicle ages. Figures 1 through 5, A1, A2, and A3—with brief descriptions below them—illustrate our findings.

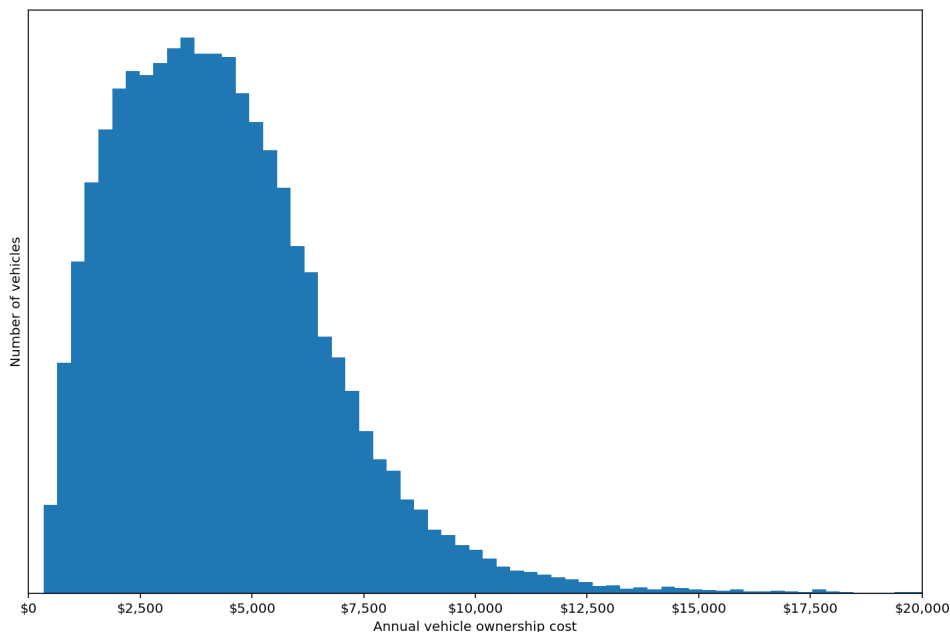


Figure 1: The annual per-vehicle cost of vehicle ownership in the United States is highly variable, with some vehicles costing their owners less than \$2,000 annually, while others cost over \$10,000, suggesting that using a single estimate for vehicle costs may produce incorrect results.

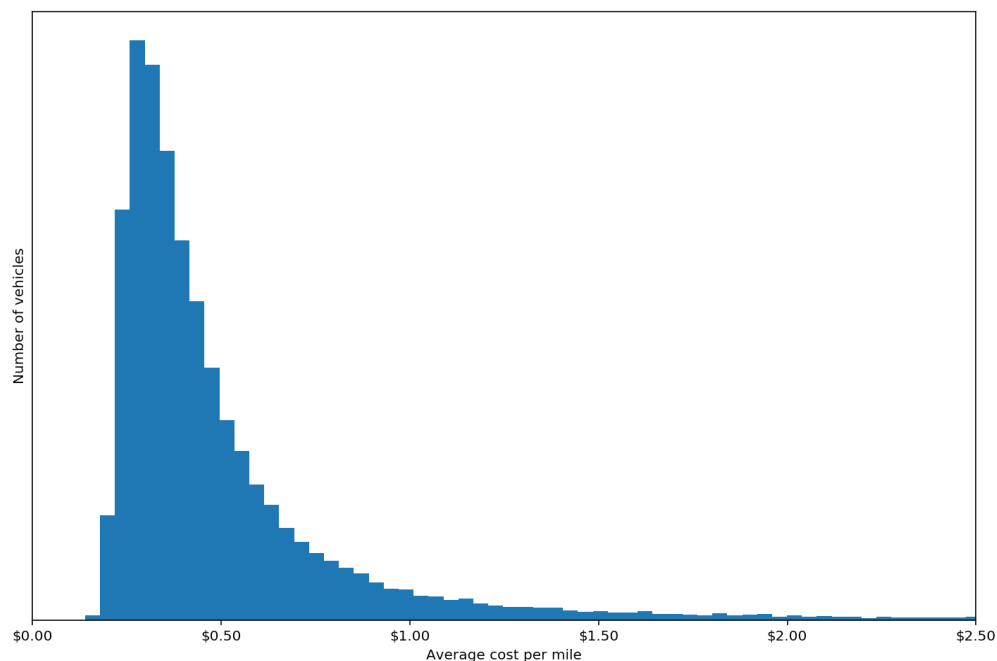


Figure 2: Similarly, the average per-mile cost of vehicle ownership is highly variable.

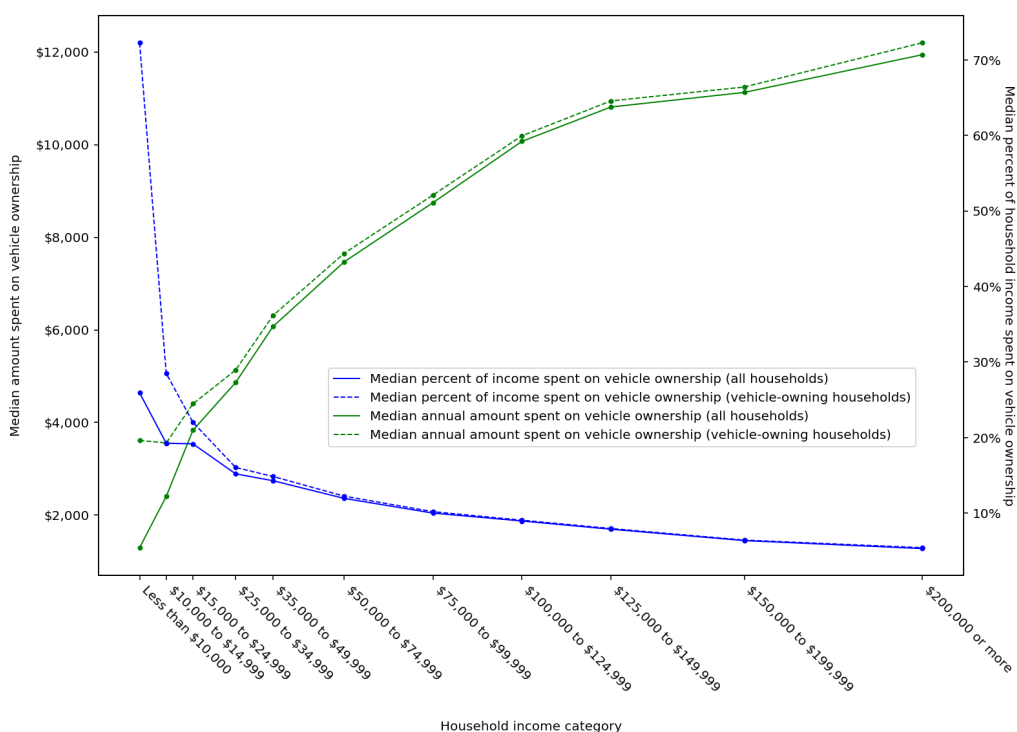


Figure 3: While high-income households spend much more on vehicle ownership than low-income households (green lines, left axis), they spend a much lower percentage of their total income (blue lines, right axis). Vehicle-owning households perform spend more than the median across all households, but the gap narrows quickly as income increases (due to higher car ownership at higher incomes).

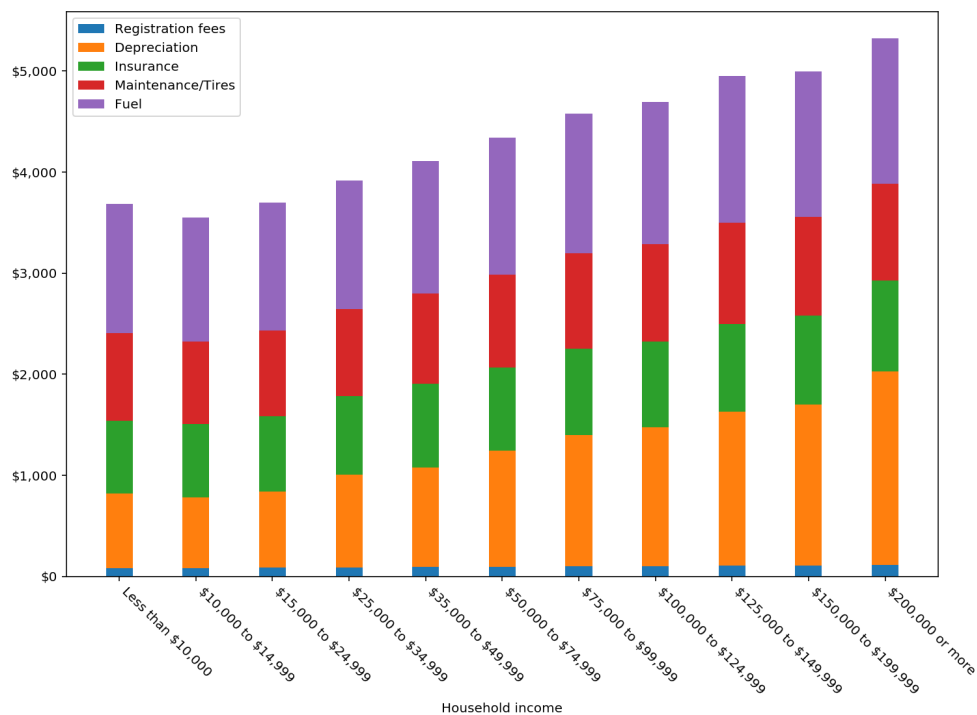


Figure 4: Components of per-vehicle cost, by household income. Higher income households spend more on depreciation (due to owning newer cars), which is largely the driver of their increased costs overall; other components of cost do not vary much. The values presented are means.

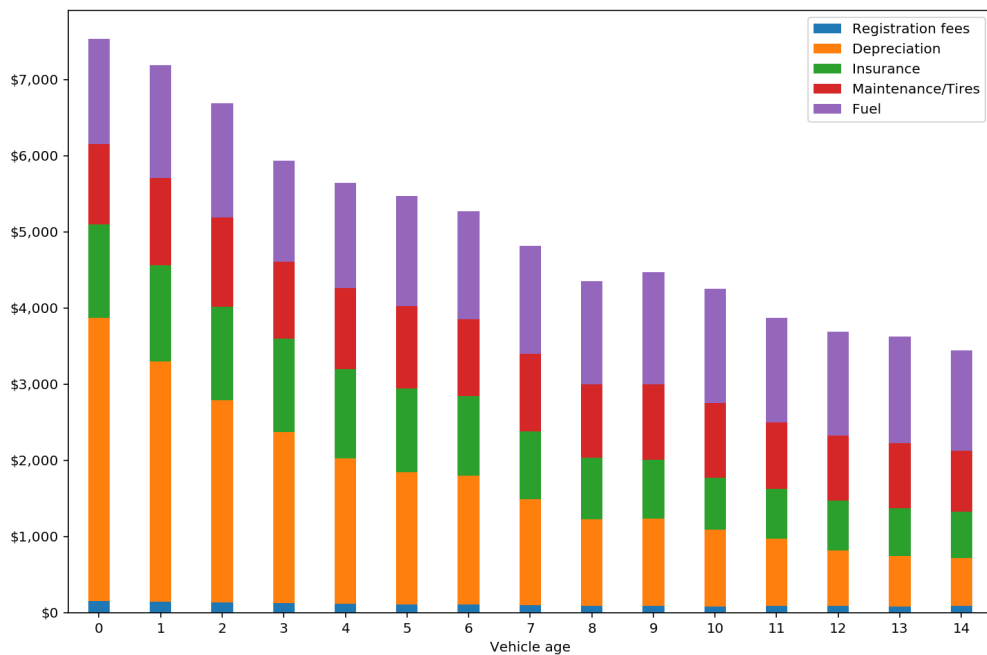


Figure 5: Components of per vehicle cost, by vehicle age. Again, differences in mean per-vehicle cost are driven primarily by depreciation (which is much larger for new vehicles), while other cost components are similar.

## Discussion

This analysis clearly illustrates that vehicle ownership costs vary dramatically across both households and individual vehicles. Lower-income households spend much less on vehicle ownership overall, but only somewhat less *per vehicle owned*. Older vehicles are much less expensive than newer vehicles. The full distribution of costs per vehicle and costs of vehicle ownership per mile driven depends on multiple other factors that vary based on where people live, how much they drive, and the particular vehicle they have chosen to own—among other things.

Understanding the variation in vehicle ownership costs is a critical first step to being able to realistically model the potential of emerging alternatives to car ownership. To be truly transformative, these alternatives must be cost-competitive with the status quo of vehicle ownership. Only then might households begin to reduce the number of vehicles they own, leading to the potentially virtuous circle that proponents of concepts like “Mobility as a Service” envision for our transportation future.

Somewhat optimistically, imagine that the per-mile cost of vehicle access via ridehailing, carsharing, or car rental were \$1.50 (this is at the low end of the range cited by Sperling, Pike, and Chase, 2018). If that were true, our analysis suggests that direct substitution of miles driven currently in household-owned vehicles with miles driven in rented or shared vehicles would be a cost-effective solution for only about 9% of American households. Interestingly, multiple previous studies have found that 9-11% of ridehailing users gave up a car after starting to use ridehailing, or acquired one when ridehailing service was suspended (Clewlow and Mishra, 2017; Hampshire et al., 2017; Etherington, 2018).

This percentage is smaller for households that own fewer vehicles, and somewhat larger for higher income households. The fraction of total vehicle miles traveled that would be shifted away from privately-owned vehicles would be much smaller; this analysis suggests it would be only 0.7%. Since car ownership is characterized largely by fixed costs, it is not surprising that the vehicles that can be cost-effectively shed are driven less than the national average; over 70% of vehicles with an average cost per mile of \$1.50 or more are driven less than 2,000 miles per year.

These initial results are perhaps not surprising, but they should be sobering for those who hope for a shared mobility future. They are, however, quite conservative; it is almost certain that, were these vehicles to be shed, some of their miles would be replaced with car-sharing or ridehailing services, but others would be replaced by other household vehicles, public transport, walking, cycling, delivery services, and, for some low value trips where the marginal cost exceeds the marginal benefit, not taking the trip at all. These other options have lower per-mile costs than ridehailing, meaning that it might be cost effective for substantially more households to reduce their vehicle ownership. The next step is to dig deeper into these data to get a better understanding of which individuals and households might have cost-competitive alternatives to car ownership other than paying for shared car access.

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## Appendix: Additional Tables and Figures

Table A.1: Data Sources and Key Assumptions

Cost Component	Data Source(s)	Key Assumptions
fuel and fuel taxes	EIA fuel prices; EPA fuel economy; NHTS best estimate of annual VMT	<p>Annual average fuel prices by fuel type (gasoline and diesel) by finest geography available (state, PADD subregion, or PADD region). EPA fuel economy is matched by make, model, and model year to each NHTS vehicle. The fuel economy used for calculation is the EPA's adjusted combined city/highway MPG.</p> <p>12.5% of the NHTS vehicles did not match to the EPA fuel economy database (2.9% were missing because the NHTS vehicles were pre-1984 model year; the EPA database begins in model year 1984). Multiple imputation was used to fill in these values.</p>

registration fees and other annual vehicle taxes	<a href="#">National Conference of State Legislatures vehicle registration fees summary by state</a> ; multiple individual state vehicle registration fee websites; estimate of vehicle value; NHTS state, vehicle class, and vehicle model year	Vehicle registration fees vary dramatically by state, and often by county, city, or metropolitan area within each state. Fee schedules can be flat annual fees or more complex schedules based on current vehicle value, vehicle weight, vehicle age, vehicle horsepower, or the number of years the vehicle has been registered in the state. Detailed code that estimates these fees, including notes on all assumptions and sources, is included in this analysis. Since county of residence is not included in the NHTS
insurance	<a href="http://www.carinsurance.com">www.carinsurance.com</a> average insurance rates by decadal driver age, coverage options, and state; estimate of vehicle value; NHTS age of primary driver for each vehicle, state, household income, and # household vehicles	<p>The NHTS state and primary driver age are merged with estimated average vehicle insurance cost tables for three coverage options: state minimum liability, higher liability, and higher liability plus comprehensive/collision coverage. Vehicles that did not have a primary driver, had a primary driver who was not a household member, or had a primary driver under the age of 14 were randomly assigned to other drivers in the household; any drivers that were not the primary driver of another vehicle were preferentially matched.</p> <p>We assume that vehicles worth more than \$10,000 have comprehensive coverage. Households with income above \$35,000 opt for higher liability coverage, while households with incomes below \$35K opt for the state minimum coverage. If income is missing, we use home ownership as a proxy, with homeowners opting for higher liability coverage. The 7 vehicles that are worth less than \$10,000 and have missing household income and homeownership are assumed to have state minimum coverage.</p> <p>Further, we assume that households with more than one vehicle get a multiple-vehicle insurance discount of 25%.</p>
maintenance, repair, and tire replacement	AAA Your Driving Costs, 2017 Edition; NHTS best estimate of annual VMT	Costs per mile driven are uniform across the vehicle population at \$0.08/mile.
depreciation	<a href="#">October 2017 used vehicle listings</a> from	We estimated vehicle value by matching vehicles to a sample of 1.2 million used car listings from

	<a href="http://www.truecar.com">www.truecar.com</a> ; NHTS vehicle make, model, model year, and best estimate of annual VMT	<p>TrueCar.com. A weighted average of the listing prices of matching was used as the value for each vehicle, with the weights being the reciprocal of the absolute difference between the NHTS reported odometer reading and the mileage of the listed used vehicles.</p> <p>20.1% of NHTS vehicles did not match the vehicle listings database (9.0% were pre-1997 model year vehicles, and historical vehicles not in this listings database). Multiple imputation used to fill in these missing vehicle values.</p> <p>A depreciation table for the first 15 years of a vehicle's life was created from the estimated values of vehicles in the NHTS, stratified by vehicle type. This depreciation table was used to estimate the depreciation each vehicle would experience over the next year of its life, based on the vehicle's estimated value; vehicles older than 15 years old were assumed to not depreciate. The depreciation table was also used to estimate the MSRP by "appreciating" vehicles current values back to when they were new.</p>
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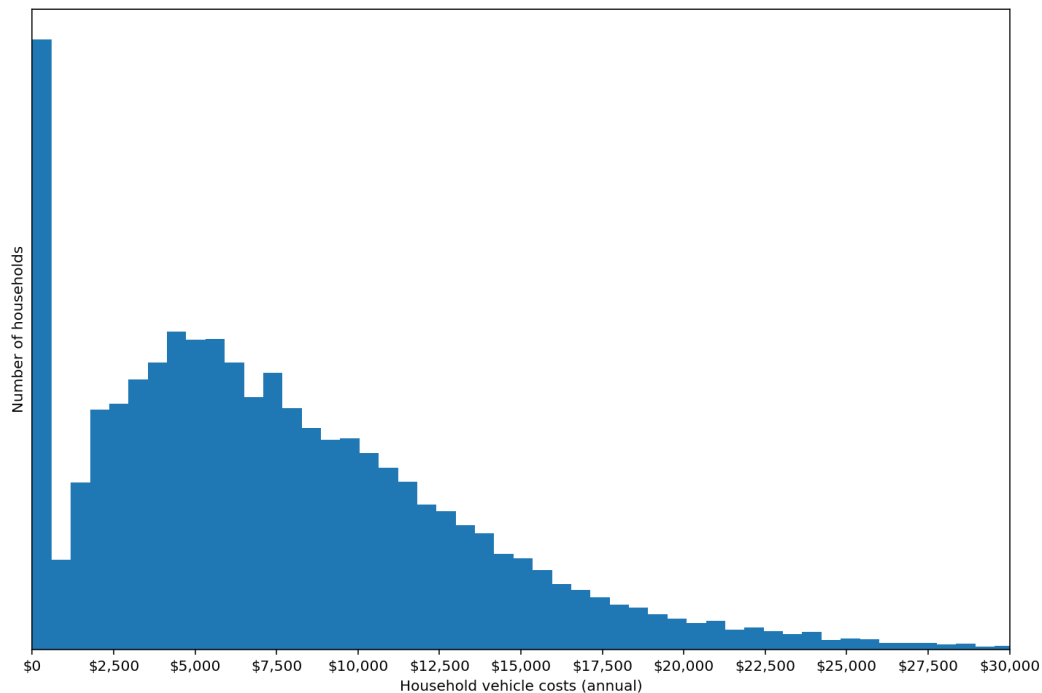


Figure A.1: Households spend highly-varying amounts on vehicle ownership. There is a large spike at \$0 due to zero-vehicle households. Among vehicle-owning households, costs are highly heterogeneous as well, with much of the density lying between \$2,500 and \$10,000 annually.



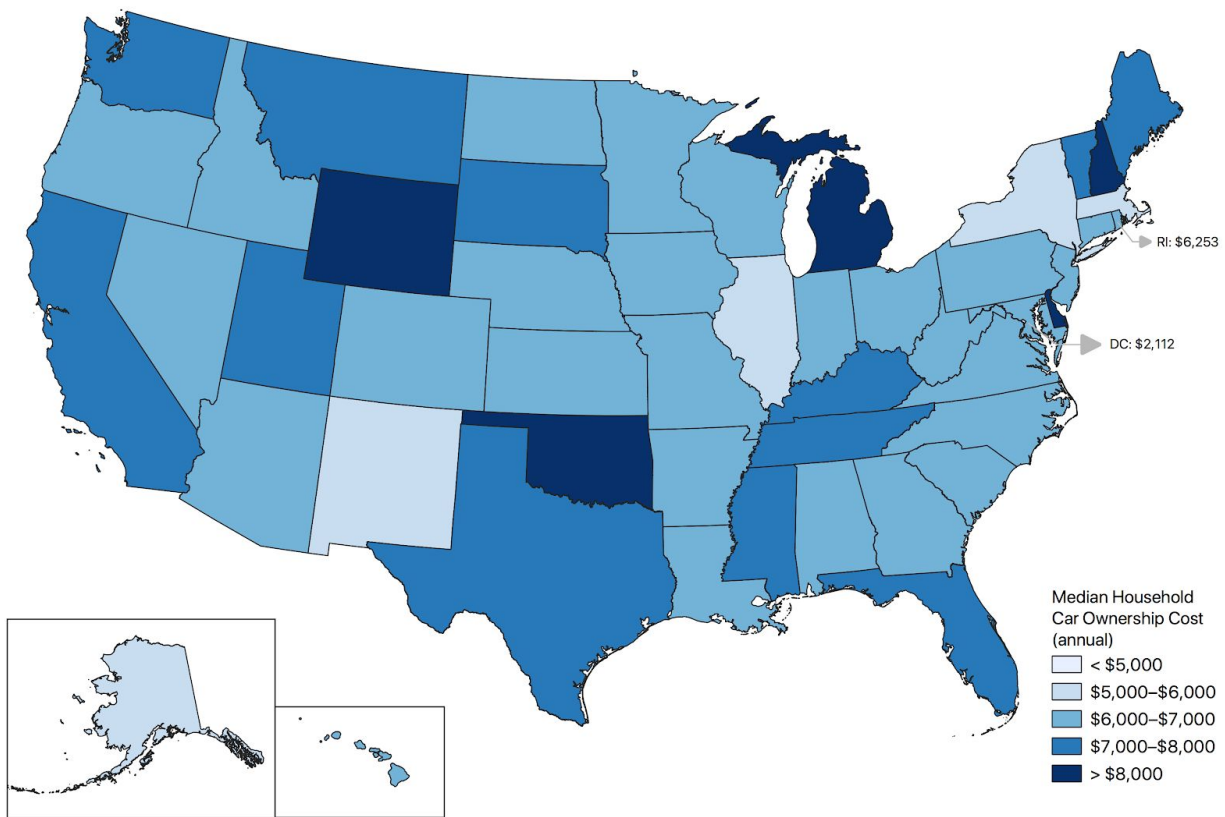


Figure A.2: There is relatively little between-state variation in household vehicle ownership costs; most states have a median annual household cost of vehicle ownership between \$6,000 and \$7,000. Costs are very low in a number of states with large cities and, presumably, lower household vehicle ownership, such as New York, Illinois, Massachusetts, and the District of Columbia.

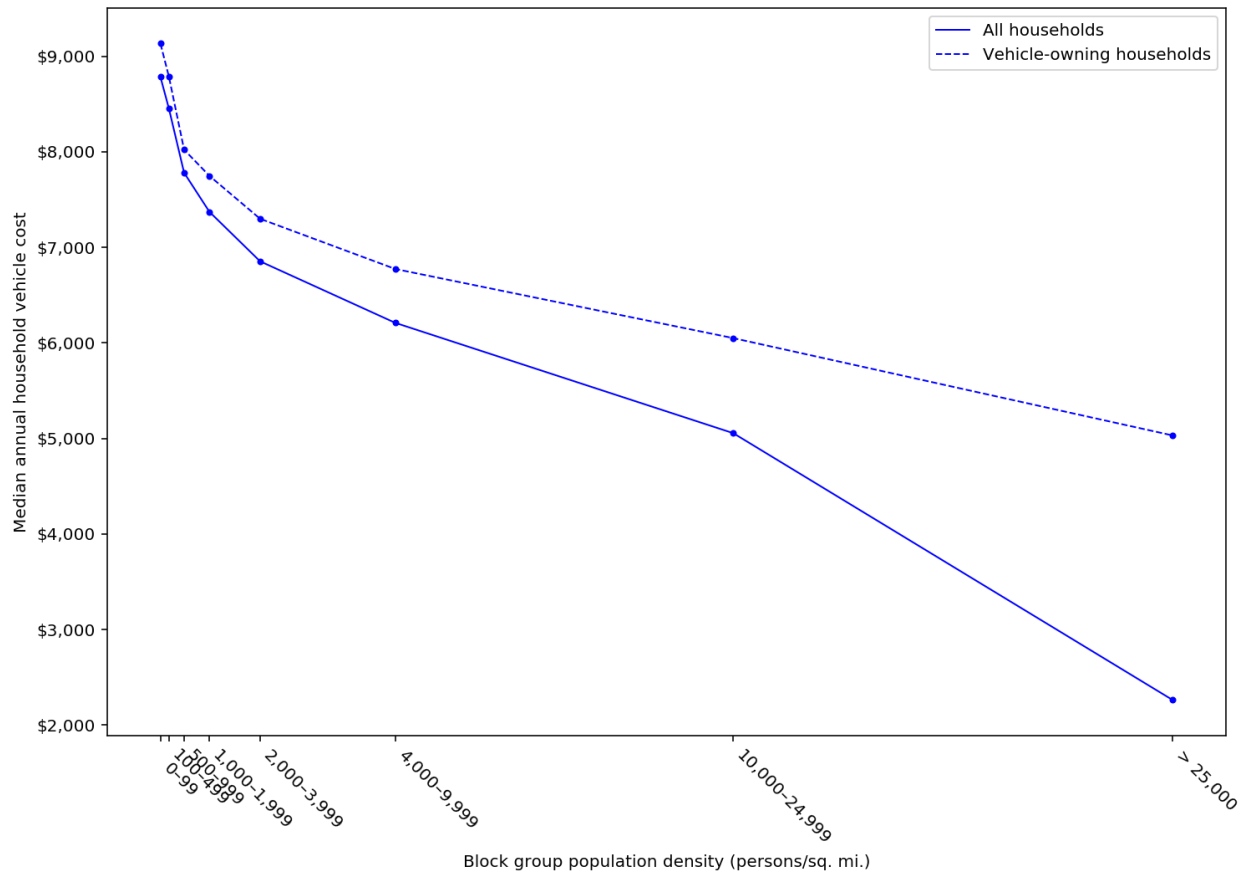


Figure A.3: Households that live in higher population density areas spend considerably less on vehicle ownership. As expected, the effect is less pronounced among vehicle-owning households; part of the lower cost is due to households that live at higher densities driving their vehicles less, and partly due to these households owning fewer (or no) vehicles.