



HOUSING AND TRANSPORTATION AFFORDABILITY INITIATIVE

UNDERSTANDING THE COMBINED COST OF HOUSING AND TRANSPORTATION



The Impact of Transportation on Affordability: An Analysis of Auto Cost White Paper

December 2012

Prepared for:

**U.S. Department of Transportation
Office of the Secretary**

and

**U.S. Department of Housing
and Urban Development (HUD)
Office of Sustainable Housing
and Communities**

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Acknowledgments:

The Manhattan Strategy Group, HUD Office of Sustainable Housing and Communities and the U.S. Department of Transportation would like to give special thanks to all HUD and DOT staff who provided input into the development of this report.

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Introduction

This paper calculates expenditures on a variety of costs of car ownership from the 2006-2010 waves of the Consumer Expenditure Survey (CEX). The Consumer Expenditure Survey is conducted by the Bureau of Labor Statistics (BLS) and tracks the expenditure patterns of a representative set of U.S. households.

This research was undertaken to provide a measure of the costs of auto ownership and usage based on reported expenditures for use in the U.S. Department of Housing and Urban Development's (HUD) Location Affordability Index (LAI), a measure of housing and transportation costs based on location. Other available measures of auto ownership costs have limitations that reduce their suitability for inclusion in the LAI. The American Automobile Association's (AAA) *Your Driving Costs* is one measure that has been used to estimate household transportation costs. Because its cost estimates are based on a hypothetical driver owning a newer auto (5 years old or less) it is not representative of the range of household incomes or the existing fleet mix. The Internal Revenue Service (IRS) mileage reimbursement rate is also limited for this application in that it provides one cost for all vehicles regardless of age and value.

When it comes to measuring the costs of car purchasing, the approach taken in the development of the LAI is to measure expenses when expenditures take place. Under this measure, a household has no current purchasing costs unless it purchases a vehicle in a given year or is paying finance charges for a vehicle. An alternative means for measuring the cost of car ownership is to measure purchase costs through a depreciation cost model. Under this approach, even if a household has no spending on the purchase or financing of a vehicle, it still incurs the cost of owning the vehicle measured as the decline in the value of the car over the course of the year. The second section of the report provides information on patterns of auto depreciation using data on car buying from the CEX. The LAI uses the expenditure-based method because it endeavors to capture actual spending outlays. Alternatively, the depreciation approach measures the change in the value of the asset holdings of a household. The LAI website also provides an online cost calculator, the My Transportation Cost Calculator, that utilizes annual depreciation costs

The BLS produces detailed tables of average expenditures across a variety of characteristics such as income quintile, age of householder, and region; these tables are available at their website (www.bls.gov/cex). They do not, however, produce public tables broken into per-vehicle spending, or separately by number of vehicles in the household. In addition, the vehicle spending categories presented in the CEX tables are different from those that are ideal for use in the LAI. As a result, this report uses the CEX microdata to calculate average spending across vehicle spending categories different from those that are available in the publicly available CEX tables.

I. Expenditures on car ownership

Categorizing Expenditures

In this report, expenditures related to the purchase and operation of cars and trucks are divided into four categories. First, there is the cost of purchasing the vehicle from a dealer or a prior owner (“purchase costs”). Second, there is the cost of continuing to own a purchased vehicle even if it is not driven (“ownership costs”). Third, there is the cost of keeping the vehicle in drivable shape, e.g. maintenance and repairs (“drivability costs”). Fourth, there is the cost of the fuel used to drive the vehicle (“driving costs”). This report treats each of these costs separately and explains how expenditures related to each are coded in the Consumer Expenditure Survey and how they are dealt with in the tabulations presented here.

Purchasing Costs

The cost of purchasing a vehicle is measured as the price paid minus the value of any vehicles sold through a trade-in or other means. In other words, if a consumer purchased a car with a price of \$20,000 and traded in a vehicle worth \$7,500, then the purchase cost would be \$12,500 representing the consumer’s net expenditures for the new car. Car purchases are measured in this manner whether the car is new or used when purchased. In addition, financing costs, lease and rental costs are also included in purchasing costs (Appendix A includes further details on categorization of expenditures).

Ownership Costs

The cost of owning a vehicle includes those costs that are incurred even if it sits in a driveway. This measure includes car insurance, property tax payments, registration, audio equipment and video equipment. Financing payments and lease payments are not included in this measure because those are part of the purchasing costs.

Drivability Costs

The cost of keeping a car in drivable condition includes repair costs, motor oil, and similar expenses. Inspection and licensing are also included in this category.

Driving (“Fuel”) Costs

The cost of driving a vehicle is the cost of fuel to operate the vehicle. This measure includes three fuel expenditure categories measured in the CEX – spending on gas, on diesel, and on gas on out of town trips. Spending on tolls is not included in this measure because toll expenses vary across geography. Appendix B provides more information about toll costs in the data.



Average Expenditures

Data are presented separately by income category. The results contain annual spending data from 2006-2010, and all incomes and expenses are inflation-adjusted to real 2010 dollars using the Consumer Price Index All Urban Consumers (CPI-U). The averages are weighted by population weights provided in the survey microdata.

Instead of breaking the data into income quintiles, the income categories are divided at round numbers that are multiples of \$20,000. The five resulting income categories are approximately equal sizes, and are summarized in the table below. Note that the distribution in column (2) is not conditional on vehicle ownership. The final column of the table below shows the distribution of income among households that have at least one car or truck.

Table 1: Income Group Categories

Income group number	Income range (2010 dollars) (1)	Percent of total households (2)	Average income in range (3)	Percent of all vehicle owners (4)
1	<\$20,000	20.7	\$10,869	15.5
2	\$20,000 - \$39,999	22.5	\$29,608	22.4
3	\$40,000 - \$59,999	17.1	\$49,353	18.3
4	\$60,000 - \$99,999	21.2	\$77,315	23.3
5	>=\$100,000	18.5	\$166,322	20.5

Table 2 shows calculations on the average total spending on the purchase of new or used cars and trucks among households with at least 1 car or truck. Column 1 shows net outlays for vehicle purchases (subtracting the value of any car or truck that is either traded-in or sold), which includes finance charges on a car already owned, and rental and lease payments. Column 2 presents the average number of cars and trucks owned or leased by the households.

Table 2: Total average annual spending on the purchase of cars and trucks among households with at least 1 vehicle

Income group number	Car and truck purchases (less cars sold or traded in) (1)	Number of vehicles (2)
1	\$1,306.9	1.4
2	\$2,196.7	1.6
3	\$2,881.2	1.9
4	\$4,180.7	2.2
5	\$6,613.7	2.5
Overall average	\$3,567.4	1.9



Columns (1) through (4) of Table 3 report the average annual *per vehicle* spending for the expenditure categories outlined above. For each household, total spending in each category is divided by the number of cars and trucks in the household to compute a per-vehicle expenditure measure. The per-vehicle expenditures are then averaged by income group. Note that, because the ratio of spending to number of vehicles is calculated for each household separately and then averaged, these numbers differ slightly from the ratio of the average measures presented in Table 2. Column (5) reports the average number of vehicles for each income group. Because the costs of repairs are typically proportionate to the cost of fuel, the final column of the table presents the average ratio of the drivability to fuel costs in the sample. In other words, the ratio of drivability to fuel costs is calculated for every consumer unit in the data and the ratio is then averaged by income group. Note that this is different from the ratio of average fuel to average drivability costs, which would be calculated as the ratio of column (2) to column (3).

Table 3: Per-vehicle spending by income group among households with at least 1 vehicle

Income group number	Per vehicle purchase costs (1)	Per vehicle (fixed) ownership costs (2)	Per vehicle (variable) drivability costs (3)	Per vehicle fuel costs (4)	Number of vehicles (5)	Average Ratio drivability to fuel costs (6)
1	\$805.7	\$513.8	\$360.1	\$1,168.4	1.4	0.452
2	\$1,136.3	\$625.3	\$395.9	\$1,365.3	1.6	0.429
3	\$1,337.5	\$668.8	\$440.3	\$1,491.7	1.9	0.427
4	\$1,655.5	\$691.0	\$464.6	\$1,551.1	2.2	0.426
5	\$2,297.3	\$761.2	\$582.4	\$1,634.8	2.5	0.495
Overall average	\$1,485.3	\$659.2	\$452.8	\$1,456.5	1.9	0.445

Per-Vehicle Auto Cost by Number of Vehicles

Vehicle expenditure patterns may differ substantially by the number of vehicles possessed by the household. Table 4, panels (A)-(C), present average annual per vehicle spending by income group and by the number of vehicles. As in Table 3, these numbers represent the ratio of costs to number of vehicles at the individual household level and then averaged by income group. Among households with at least one vehicle, the distribution of number of vehicles is as follows: 39.5% are one-vehicle consumer units, 38.4% are two-vehicle consumer units, and 22.1% are three or more vehicle consumer units. Note that these are averages across ownership patterns as they currently exist. Households with one car versus two cars may purchase systematically different types of cars, and may replace their cars at different frequencies. As a result, a comparison of per-vehicle costs across one versus two vehicle households does not necessarily reflect the change in per-vehicle spending that would be experienced by an individual household that purchases a second car.



Table 4: Average per-vehicle spending by income group and number of vehicles owned
Panel A: Households with one vehicle

Income group number	Purchase costs (1)	Ownership costs (2)	Drivability costs (3)	Fuel costs (4)	Average Ratio drivability to fuel costs (5)
1	\$601.6	\$552.9	\$388.8	\$1245.6	0.449
2	\$765.3	\$731.6	\$464.0	\$1601.1	0.437
3	\$916.8	\$837.3	\$568.8	\$1876.4	0.459
4	\$1126.7	\$922.6	\$642.4	\$2100.6	0.487
5	\$1389.6	\$1063.7	\$829.4	\$2292.7	0.552
Overall	\$849.9	\$753.6	\$515.9	\$1676.5	0.461

Panel B: Households with two vehicles

Income group number	Per vehicle purchase costs (1)	Per vehicle ownership costs (2)	Per vehicle drivability costs (3)	Per vehicle fuel costs (4)	Average Ratio drivability to fuel costs (5)
1	\$1239.1	\$419.4	\$288.8	\$1008.9	0.446
2	\$1352.9	\$529.3	\$332.4	\$1150.4	0.398
3	\$1326.8	\$604.3	\$381.0	\$1357.7	0.397
4	\$1287.5	\$666.5	\$442.3	\$1527.9	0.400
5	\$1477.5	\$745.7	\$579.4	\$1725.1	0.462
Overall	\$1350.4	\$625.7	\$429.3	\$1424.8	0.418

Panel C: Households with three or more vehicles

Income group number	Per vehicle car and truck purchase price (1)	Per vehicle (fixed) ownership costs (2)	Per vehicle (variable) drivability costs (3)	Per vehicle fuel costs (4)	Average Ratio drivability to fuel costs (5)	Number of vehicles (6)
1	\$1604.4	\$386.6	\$273.8	\$822.4	0.516	3.3
2	\$2225.9	\$400.6	\$257.2	\$872.1	0.483	3.3
3	\$2193.9	\$468.9	\$309.1	\$1006.2	0.430	3.4
4	\$2666.1	\$535.4	\$350.6	\$1127.5	0.415	3.5
5	\$3598.2	\$664.8	\$492.2	\$1279.6	0.513	3.6
Overall	\$2830.9	\$549.1	\$380.9	\$1119.3	0.466	3.5

Based on the information in the tables above, the average household in Income Group 4 (with income between \$60,000 and \$99,999) with one vehicle spends almost \$4800 per year to own and operate its vehicle. The average household from Income Group 4 with two vehicles spends approximately \$7850 to own and operate its vehicles.

II. Auto depreciation patterns

A limitation of a consumption-based approach to expenditures on car purchases is that it only captures outlays when they originally occur. For example, if a family were to purchase a \$20,000 car in the year 2010 and finance it at a 5% interest rate over five years, this measure would capture a \$20,000 expense in the year 2010, and only the interest charges on the loan in the subsequent years. This method of accounting for expenditures fails to capture the flow cost of auto ownership. In particular, the flow cost of auto ownership should reflect the fact that a car is worth less and less over time as it ages. It may also be appropriate to include the opportunity cost of holding a physical asset instead of having an equivalent amount of cash in an interest-bearing account. The tabulations below omit this opportunity cost because it is small when the risk free interest rate is low, as was the case in the time period covered in this report.

One approach with intuitive appeal is to determine the market price of a car in each year, and use that to calculate the flow cost of auto ownership. The decline in the value of the car in a year is that year's flow cost of ownership. The example below presents the pattern of the costs of ownership if the current market price of a car when it is new and for every subsequent year until the family trades it in for a new car is known. Note that these tabulations use current dollars instead of inflation-adjusted dollars. With inflation adjustment the depreciation rate would be somewhat higher.

Table 5: Hypothetical depreciation and flow costs of car ownership

Age of car in years	Market price of car (1)	Decline in value of car this year (2)
0	\$20,000	--
1	\$16,000	\$4,000
2	\$12,000	\$4,000
3	\$10,000	\$2,000
4	\$8,000	\$2,000
5	\$6,500	\$1,500

To implement this approach, one would need an estimate of the market price of the car as it ages. The Blue Book value would be one source of this market price, if it were readily available.

Another commonly used approach in the absence of the availability of reliable market price estimates is to pick a constant rate of depreciation (e.g., 20 percent per year).

This section uses data from the Consumer Expenditure Survey to empirically estimate the decline in a car's value over time. In particular, the survey contains data on the make and model year of vehicles owned by respondents and the year of purchase and purchase price. Patterns over time in the purchase price of the same make and model year of vehicle can be used to trace out depreciation patterns. For example, among all households that own model year 2005 Jeeps, some of those households would have bought their Jeep new in 2005, while others bought theirs used after one year, two years, and so on. The average price paid for this car when it was one- year old, two-years old, and so on, as a percent of its price when it was new, can be used to trace out the rate of depreciation.

In the analysis that follows, vehicle data are included across interviews from the first quarter of 2003 through the first quarter of 2011. The additional years of CEX data were included to increase the number of cars observed in each make-by-year cell. For tractability, the analysis is limited to model years 1995 and later, and to the ten car makes that accounted for at least 2.5 percent of the overall distribution of cars in the data.¹

Column (1) of Table 6 shows the results of implementing an empirical depreciation model including separate intercept terms for each make-by-year group. The results are determined by allowing the data to ascertain the shape of the depreciation curve, allowing each year of a car's age to be entered into the regression framework in an unrestricted manner. This unrestricted "dummy variable" approach suggests that a car depreciates until it is worth about ten percent of the original purchase price (at about 11 years of age), then hovers around that value for the subsequent few years. Conceptually, this can be thought about as the salvage value. Column (2) fits a kinked line through the estimates presented in column (1). More information on the analytical model can be found in Appendix A.

¹ These are: Buick, Chevrolet, Dodge, Ford, GMC, Honda, Jeep, Nissan, Pontiac and Toyota.



Table 6: Empirical depreciation schedules based on CEX purchase prices and different functional form imposition

<i>Age of vehicle in years</i>	<i>Unrestricted age-in-years dummy variables (1)</i>	<i>Kinked line -19% in year 1 -8% in years 2-8 -4% in years 8-12 (2)</i>
1	-0.186	-0.19
2	-0.287	-0.27
3	-0.361	-0.35
4	-0.410	-0.43
5	-0.500	-0.51
6	-0.606	-0.59
7	-0.669	-0.67
8	-0.744	-0.75
9	-0.773	-0.79
10	-0.823	-0.83
11	-0.881	-0.87
12	-0.894	-0.91

Notes: Depreciation based on nominal value in year X as a percentage of nominal value at the time the car is new. Model allows for unrestricted effects of the interaction between car make and model year.

Appendix A: Technical Appendix

Data

The tables in this report are based on data from the Interview portion of the Bureau of Labor Statistics' (BLS) Consumer Expenditure Survey (CEX). The CEX is designed to capture spending patterns that are representative of the total U.S. civilian population. Tabulations are based on data from the first quarter of 2006 through the first quarter of 2011 covering the period from January 2006 to December 2010. The unit of analysis in the CEX is a "consumer unit" which is an individual or group of individuals who live together and make joint expenditure decisions. The term "consumer unit" is used interchangeably with "household" throughout the report because in practice a "consumer unit" is very similar to a household or family. In many other analyses using the CEX data these terms are also used interchangeably. The interview survey covers purchases made in the three calendar months prior to the month of the interview. Data are provided for approximately 7000 consumer units for the typical month. Unweighted sample sizes for each year are presented in Appendix Table A1, below.

Consumer units are asked about purchases across a wide range of expenditure categories. For vehicle purchases and repairs, they are asked to report actual expenses incurred in each of the months covered by the survey. For gasoline and other fuels, they are asked to report the average monthly expenditure on fuel. This monthly average is reported as the amount spent in each of the three months covered by the survey. Nominal dollar values are converted to inflation-adjusted 2010 dollars using the CPI-U. When a variable represents monthly expenditure (purchase costs, ownership costs, drivability costs, fuel costs, and tolls) the monthly CPI-U is used to adjust the expense. When the variable is an annual figure (property tax where applicable and annual income), the annual CPI-U is used.

There are many files in the CEX. Three different types of files are used for this report – the consumer unit characteristics and income files (the "FMLY" file), the monthly expenditure files (the "MTBI" file), and the detailed expenditure files covering owned, rented and leased vehicles (the "EXPN" file). Data on consumer unit income and weights come from the FMLY files. The income variable used in this report is FINCBTXM which measures annual before tax consumer unit income. The weight used to calculate means in this analysis is FINLWT21, the weight for the total sample that is used by BLS when it estimates total or mean expenditures. The file also contains additional information on the socio-demographics of the consumer unit.

The MTBI files contain all of the detailed information on monthly expenditures by consumer units. Expenditures are classified by Universal Classification Codes (UCCs) which are six digit codes that identify items or groups of items. Appendix Table A2 lists how different UCCs are grouped into the broader categories used in this analysis. Consumer units report monthly expenditure. Annual amounts are calculated by summing across the twelve months of the year.

The EXPN files contain detailed information on vehicles including make, model year, purchase dates and purchase prices. This file provides information on the number of owned, rented and leased vehicles. In the tables in this report, the number of vehicles is equal to the number of cars and trucks owned, rented or leased by the household. Other vehicles, such as boats and motorcycles, are not included in the number of vehicle totals. However, the non-purchase related UCCs do include expenses (such as repairs and insurance) for these other vehicles. For many expenses, there is no data on which vehicle type was covered by the expense. Make and model year are provided for all vehicles owned by the household during the months covered by the survey. Purchase date and price paid are only provided when the vehicle is purchased during the survey period or if there are outstanding payments on the vehicle.

The CEX also contains information on the geographic location of the household. While not presented in this report, geographic variation in vehicle expenditures could also be tabulated using the microdata. The microdata provide information on the region, urban/rural status and population size of the area where nearly all households live. For a small subset of households, population size and region are suppressed due to issues of confidentiality. State of residence is also provided for many households and the metropolitan area (CMSA) is provided for the largest metropolitan areas beginning in 2006.

Depreciation Model

The depreciation model uses gross purchase price (including the value of any car traded in), vehicle make, model year and year of purchase to calculate the type, value and age of a car when purchased. Age of car at the time of purchase is calculated as the difference between the year of purchase and the model year. Because model years do not perfectly match calendar years, some new cars are calculated to be purchased a year before they are made and these are recoded so that age at purchase equals zero in the analysis. Price of a new car is calculated as the average price for the make-by-model-year cell when the age of car at purchase is equal to zero. Current price as a percent of new-car price (PCTNEW) is calculated as the ratio of price paid at the time of purchase to the average price of the make-by-model-year vehicle when new. The analysis is limited to the ten makes most commonly observed in the data (Buick, Chevrolet, Dodge, Ford, GMC, Honda, Jeep, Nissan, Pontiac and Toyota), and to cars with model year 1995 or more recent. Appendix Table A3 displays sample sizes by make and age at purchase for the data used in the analysis. Information on the model of the vehicle during the time frame analyzed here is not available. All dollar values are in nominal terms, and the analysis is done without the use of sampling weights.

The results presented in Table 6, column (1) are from a model in which PCTNEW is regressed on a vector of dummy variables for age of car at time of purchase, and a vector of make-by-model-year specific dummy variables. The results are substantially unchanged if the make-by-model-year controls are omitted, if the analysis is limited to model years 2000 and later, and if the data are aggregated to the level of make by model-year by age-at-purchase. See Appendix Table A4, below.



Appendix Table A1: Sample sizes for expenditure analysis (Number of Expenditure – Months)

Year	Overall sample size	Sample size if number of vehicles > 0
2006	84,942	73,986
2007	81,856	71,620
2008	82,702	72,788
2009	84,629	74,178
2010	84,600	73,387
Total	418,729	365,959

Appendix Table A2: Detailed list of expenditures included in each measure

CEX UCC	CEX Name
<u>Purchase Costs</u>	
450110	New cars (net outlay)
450210	New trucks or vans (net outlay)
460110	Used cars (net outlay)
460901	Used trucks or vans (net outlay)
510110	Automobile finance charges
510901	Truck or van finance charges
450310	Basic lease charge (car lease)
Minus 450311	Charges other than basic lease, such as insurance or maintenance (Portion of car lease)
450313	Cash down payment (car lease)
450314	Termination fee (car lease)
450410	Basic lease charge (truck/van lease)
Minus 450411	Charges other than basic lease, such as insurance or maintenance (Portion of truck/van lease)
450413	Cash down payment (truck/van lease)
450414	Termination fee (truck/van lease)
520511	Auto rental, excl. trips
520521	Truck or van rental, excl. trips
<u>Value of Trade Ins</u>	
450116	Trade-in allowance for new cars
450216	Trade-in allowance for new trucks or vans
450312	Trade-in allowance (car lease)
450412	Trade-in allowance (truck/van lease)
460116	Trade-in allowance for used cars
460907	Trade-in allowance for used trucks or vans
<u>Value of Cars and Trucks Sold (Subtracted from Purchase Costs to Create Purchases less Cars Sold or Traded In)</u>	
860100	Amount automobile sold or reimbursed
860200	Amount truck or van sold of reimbursed



Ownership (Fixed) Costs

500110	Vehicle insurance
450311	Charges other than basic lease, such as insurance or maintenance (Portion of car lease)
450411	Charges other than basic lease, such as insurance or maintenance (Portion of truck/van lease)
480214	Vehicle audio equipment excluding labor
480215	Vehicle video equipment
520110	State Registration
520560	Global positioning services
TAXPROPX	Property Taxes on Vehicles (Annual Value)



Drivability (Variable) Costs

470211	Motor oil
470212	Motor oil on out-of-town trips
470220	Coolant/antifreeze, brake & transmission fluids, additives, and radiator/cooling system protectant (not purchased with tune-up)
480110	Tires (new, used or recapped); replacement and mounting of tires, including tube replacement
480212	Vehicle products and services
480213	Vehicle parts, equipment, and accessories
490110	Body work, painting, repair and replacement of upholstery, vinyl/convertible top, and glass, installation of carpet
490211	Clutch and transmission repair
490212	Drive shaft and rear-end repair
490221	Brake work
490231	Steering or front end repair
490232	Cooling system repair
490311	Motor tune-up
490312	Lubrication and oil changes
490313	Front end alignment, wheel balance and rotation
490314	Shock absorber replacement
490318	Repair tires and miscellaneous repair work, such as battery charge, wash, wax, repair and replacement of windshield wiper, wiper motor, heater, air conditioner, radio and antenna
490319	Vehicle air conditioner repair
490411	Exhaust system repair
490412	Electrical system repair
490413	Motor repair and replacement
490501	Vehicle accessories including labor
490900	Auto repair service policy
520310	Driver's license
520410	Vehicle inspection
520550	Towing charges (excl. contracted or pre-paid)

Fuel Costs

470111	Gasoline
470112	Diesel fuel
470113	Gasoline on out-of-town trips

Tolls

520541	Tolls or electronic toll passes
520542	Tolls on out-of-town trips



Categories Included in CEX Vehicle Costs, But Not Included in Report

450220	New motorcycles, motor scooters, or mopeds (net outlay)
460902	Used motorcycles, motor scooters, or mopeds (net outlay)
520902	Motorcycle, motor scooter, or moped rental
850300	Finance charges on other vehicles
620113	Membership Fees for Auto Service Clubs
510902	Motorcycle finance charges
520512	Auto rental on out-of-town trips
520522	Truck or van rental on out-of-town trips
520531	Parking fees at garages, meters, and lots excl. fees that are costs of property ownership
520532	Parking fees on out-of-town trips
520905	Motorcycle, motor scooter, or moped rental – out-of-town trips

Appendix Table A3: Sample sizes by make and age at purchase for the data used in the depreciation analysis

<i>Make of car:</i>	<i>Age of car at time of purchase</i>										
	0	1	2	3	4	5	6	7	8	9	10 or more
Buick	682	170	126	140	68	68	46	30	12	25	29
Chevrolet	6,219	1,422	1,291	1,113	766	589	465	373	294	220	309
Dodge	2,975	910	611	561	401	311	227	177	114	94	92
Ford	6,135	1,779	1,371	1,308	828	649	517	388	215	157	208
GMC	1,349	222	247	212	192	104	68	41	30	30	40
Honda	3,823	351	397	477	318	167	137	80	40	33	57
Jeep	1,090	191	204	324	175	126	104	60	67	24	41
Nissan	2,515	422	298	329	219	93	80	56	26	17	32
Pontiac	1,084	386	299	271	191	78	96	58	64	12	25
Toyota	5,567	690	455	556	478	279	155	142	71	67	96

Appendix Table A4: Alternate specifications of the empirical depreciation model

VARIABLES	(1) Baseline specification	(2) No model- by-year fixed effects	(3) Column (2) with Make Years 2000+	(4) Column (2) with Make Years 2005+	(6) Aggregated data
1 year old	-18.60*** (0.440)	-18.83*** (0.447)	-18.77*** (0.448)	-17.54*** (0.764)	-17.36*** (2.407)
2 years old	-28.75*** (0.489)	-28.59*** (0.489)	-28.90*** (0.507)	-31.34*** (1.019)	-27.14*** (2.449)
3 years old	-36.13*** (0.501)	-35.34*** (0.489)	-36.19*** (0.530)	-38.17*** (1.237)	-33.81*** (2.497)
4 years old	-41.04*** (0.596)	-39.64*** (0.576)	-39.48*** (0.670)	-46.60*** (1.793)	-39.69*** (2.581)
5 years old	-50.02*** (0.709)	-48.64*** (0.688)	-48.82*** (0.856)	-55.82*** (3.129)	-49.09*** (2.647)
6 years old	-60.64*** (0.813)	-57.95*** (0.778)	-60.21*** (1.144)	-82.02*** (23.73)	-60.11*** (2.756)
7 years old	-66.87*** (0.935)	-64.00*** (0.897)	-65.70*** (1.429)		-62.12*** (2.892)
8 years old	-74.39*** (1.136)	-63.82*** (1.093)	-70.21*** (1.876)		-69.03*** (3.052)
9 years old	-77.35*** (1.301)	-69.42*** (1.277)	-75.47*** (2.154)		-73.19*** (3.261)
10 years old	-82.33*** (1.683)	-67.52*** (1.658)	-72.27*** (3.690)		-73.82*** (3.486)
11 years old	-88.11*** (2.016)	-74.75*** (2.015)	-84.24*** (14.27)		-77.67*** (4.049)
Make years included	1995+	1995+	2000+	2005+	1995+
Observations	60,513	60,513	51,375	18,998	1,074
R-squared	0.354	0.307	0.252	0.132	0.612

Notes: Standard errors in parentheses. Dependent variable is current value of car as a percentage of the make-by-year average price of a new car. Column (1) includes dummy variables for age of car and the interaction of make and model year. Column (2) omits the make-by-year fixed effects, and only includes dummy variables for age of car. Columns (3) and (4) replicate the specification in Column (2), but limit the analysis to car make years 2000 and later, and 2005 and later, respectively. Column (5) averages the data to the make-by-year-by-age at purchase level and estimates the same specification as in Column (2) with the aggregated data. *** p<0.01, ** p<0.05, * p<0.1.



Appendix B: Toll Costs

This appendix includes the costs of tolls. In the main analysis, toll costs are omitted entirely. Toll costs are calculated for consumer units that have at least one vehicle and positive spending on gas. The percent of households with any toll expenses is also reported. Appendix Table B1 presents the percent of households with any toll expenses, and the average annual toll spending if the household incurred any toll expenses. Appendix Table B2 provides separate estimates by region of residence; Appendix Table B3 provides separate estimates by number of vehicles owned. Note, as shown in Appendix Table B2, that toll spending varies widely across regions.

Appendix Table B1: Toll spending per vehicle for households with at least 1 vehicle

Income category	Percent of households with any toll expenses (1)	Average annual toll expenses if >0 (2)
1	5.3	122.2
2	6.3	124.7
3	9.7	139.3
4	13.4	142.5
5	22.7	143.8
Total	11.8	139.1

Appendix Table B2: Toll spending per vehicle for households with at least 1 vehicle by Region

Inc. cat	Northeast		Midwest		South		West	
	% with any toll (1)	Avg annual toll if >0 (2)	% with any toll (3)	Avg annual toll if >0 (4)	% with any toll (5)	Avg annual toll if >0 (6)	% with any toll (7)	Avg annual toll if >0 (8)
1	13.6	146.7	13.6	90.0	4.4	108.9	4.3	130.6
2	15.9	132.1	15.9	93.0	5.6	119.5	3.7	157.9
3	23.4	157.0	23.4	88.8	8.5	145.5	5.7	128.0
4	29.4	156.9	29.4	84.7	11.6	141.7	8.6	167.9
5	44.4	178.0	44.4	91.3	19.4	123.2	14.5	141.2
Total	27.7	162.3	27.7	89.2	9.7	130.2	7.9	147.4



Appendix Table B3: Toll spending per vehicle for households with at least 1 vehicle by Number of Vehicles

Income cat	Number of Vehicles =1		Number of Vehicles =2		Number of Vehicles >=3	
	% with any toll (1)	Avg annual toll if >0 (2)	% with any toll (3)	Avg annual toll if >0 (4)	% with any toll (5)	Avg annual toll if >0 (6)
1	5.0	140.9	5.8	91.7	7.2	64.6
2	6.0	164.0	6.9	87.3	6.3	68.9
3	11.1	203.3	9.4	97.8	7.8	64.9
4	16.0	231.0	13.4	118.7	11.1	82.0
5	22.2	263.0	23.5	145.9	22.0	96.4
Total	9.4	204.4	13.2	123.5	13.8	87.7