

5.1 Vehicle Costs

This chapter examines direct financial costs of vehicle use. These are divided into fixed costs, which are unaffected by mileage, and variable costs, which increase with mileage. This indicates the savings from transportation improvements that allow consumers to reduce their vehicle ownership and use. Note: monetary units are in 2007 U.S. dollars unless indicated otherwise.

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5.1.2 Definitions and Perspectives

Vehicle Costs include direct user expenses to own and use private vehicles (plus incremental costs for mobility substitutes such as telework). These indicate the savings that result from reduced vehicle ownership and use. Vehicle costs can be measured in various ways, including per vehicle-mile, passenger-mile, vehicle-year, household-year, producing different results. These can be divided into *fixed* (also called *ownership* or *time-based*, which are unaffected by the amount a vehicle is driven) and *variable* (also called *operating*, *marginal* or *incremental*, which increase with vehicle mileage). Some costs that are often categorized as *fixed*, such as depreciation and insurance, actually increase with vehicle mileage, as discussed below. Private cars are usually depreciated over a 10 year period, buses over 20 years, and trains over 30 to 40 years.

Fixed Costs

- Vehicle purchase or lease
- Insurance
- Registration and vehicle taxes

Variable Costs

- Maintenance and repair
- Fuel, fuel taxes and oil
- Paid parking and tolls

5.1.3 Discussion

Variation in ‘Fixed’ and “Variable” Costs

Some costs usually categorized as fixed are actually partly variable; they increase to some degree with vehicle use, and decline when vehicle travel is reduced. Depreciation, insurance and parking are partly variable since increased driving increases the frequency of repairs and replacement, reduces vehicle resale value, and increases the risks of crashes, traffic and parking citations. Used vehicle price guides (www.edmunds.com and www.kbb.com) indicate that mileage-related depreciation is typically about \$0.055 between 50,000 and 100,000 miles on a five-year old car, and much higher for low-mileage newer cars.¹ Similarly, maintenance costs for older vehicles depend greatly on distance driven. Vehicle leases often have “excessive mileage” charges averaging about 10¢ per mile (typically over 15,000 annual miles).

Vehicle Ownership

Consumers can often achieve considerable savings by reducing vehicle ownership. For example, if improved transport options (better walking and cycling conditions or public transit services) allow 10% of households to avoid purchasing a second car, the savings average \$200-400 annually per household (assuming \$2,000 to \$4,000 in annual savings per vehicle). Cumulative savings can be large. A study by McCann found that households in communities with better transit services and more accessible land use patterns spend less than \$5,500 annually on transportation while residents of more automobile dependent regions spend more than \$8,500 annually on transportation². See section 5.1.5 below for more information on automobile ownership marginal costs.

Driving Conditions

Vehicle operating costs per mile vary depending on driving patterns and conditions. Fuel consumption per vehicle-mile tends to increase at speeds over 55 mph, under 20 mph, and under stop-and-go driving conditions ([Energy and Emission Reductions](#)).³ Vehicle operating costs are about 40% higher on urban arterials than highways, and costs increase proportional to travel time when congestion reduces traffic speed to 30 mph on a highway or 20 mph on an arterial (see discussion in Chapter 5.5).⁴ Roadway investment models provide detailed vehicle cost estimates (fuel, oil and tires, and sometimes maintenance) or various vehicle classes and road conditions.⁵ They are designed to predict the vehicle cost savings resulting from roadway improvements.

¹ Art Ludwig (2002), *Understatement of Auto Operation Costs by AAA* (www.oasisdesign.net); at www.oasisdesign.net/transport/cars/depreciation.htm

² Barbara McCann (2000), *Driven to Spend; The Impact of Sprawl on Household Transportation Expenses*, Surface Transportation Policy Project (www.transact.org). Values not adjusted for inflation.

³ ORNL, *Transportation Energy Book*, Oak Ridge National Laboratories, U.S. Department of Energy (www-cta.ornl.gov/data), updated annually.

⁴ Kenneth Small (1992) *Urban Transportation Economics*, Harwood (Chur) p. 76.

⁵ TransFund (1998), *Project Evaluation Manual*, TransFund New Zealand (www.transfund.govt.nz); TTI (1997), *MicroBENCOST*, Texas Transportation Institute (<http://tti.tamu.edu>); Earl Klaubert (2001), *Highway Effects on Vehicle Performance*, Turner-Fairbank Highway Research Center, FHWA, FHWA-RD-00-164 (www.tfrc.gov/library/library.htm).

Vehicle costs can vary depending on vehicle type, travel conditions, and market factors such as fuel taxes and vehicle and parking fees. Analyses vary in the scope of costs they consider. For example, when estimating automobile commuting costs, and therefore the savings from improvements to alternative modes and commute trip reduction programs, many calculators only consider fuel and parking costs. Few consider the higher fuel and maintenance costs for driving under congested, urban-peak conditions. Some consider maintenance and tire replacement costs, and a few consider mileage-based depreciation (the incremental decline in the value of a vehicle, or its future operating life, with increased vehicle travel). Fixed and external costs are often ignored. As a result, the full costs of driving, and therefore the full benefits of vehicle travel reductions, tend to be higher than many estimates indicate. Table 5.1.3-1 summarizes various user cost categories.

Table 5.1.3-1 Vehicle Costs Categories

Category	Description	Typical Values
Vehicle operating costs	Fuel, oil and tire wear.	15-20¢ per vehicle-mile. Higher under congested conditions.
Other distance-based costs	Distance-based maintenance and depreciation, mileage lease fees, additional crash and citation risk costs.	10-20¢ per vehicle-mile.
Special fees	Parking fees and road tolls.	Varies.
Vehicle ownership costs	Time-based depreciation, financing, insurance, registration fees and taxes.	\$3,000-5,000 per vehicle-year.
Residential parking	Residential parking costs.	\$200-2,000 per vehicle-year.

Automobiles involve various types of costs. Different types of analysis consider different types of costs.

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Cost Trends

Real (inflation-adjusted) automobile costs declined between 1970 and 1985, but have tended to increase since 1985. Fuel prices are expected to increase in the long-run due to rising demand and declining production (called *peak oil*), as discussed in Chapter 11.⁶

5.1.4 Automobile Cost Estimates

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Table 5.1.5-1 Automobile Cost Estimate Summary Table – Selected Sources

Publication	Costs	Cost Value	2007 USD
NCTR (2008) – <i>Shift in Household Transportation Spending</i>	Marginal cost savings in USA from a shift to transit from private automobiles in 2006.	Annual cost to households per additional vehicle averaged about \$3,500 and \$0.20 per mile.	Annual cost per additional vehicle averaged about \$3,600 and \$0.21 per mile.
AAA – 2008 Vehicle Cost Estimates	Fixed and variable costs for various types of vehicles in the US for the first five years of operation.	Average cost per mile for a medium sedan ranges from \$0.47 to \$0.72 per mile and \$7190 to \$9369 per year depending on distance driven.	Original is in 2007 USD
CAA – 2007 Driving Costs	An estimate of the cost of operating specific vehicles for the first four years in Canada.	Cost per kilometer for a 2.2L sedan range from \$0.36 to \$0.72 per Km.	USD \$0.54 to \$1.08 per mile
Barnes & Langworthy (2004). <i>Per Mile Costs of Operating Automobiles and Trucks</i>	Cost estimates for passenger cars, light trucks and commercial trucks	Per mile: Automobiles - \$0.17, Light trucks \$0.22, Commercial Trucks \$0.49.	Costs reported in 2007 USD
<i>US Consumer Expenditure Survey 2004</i>	Reports actual expenditures of the actual vehicle fleet, not just newer vehicles.	Average cost per mile was \$0.26 and the average per-vehicle cost was \$4,532	Costs reported in 2007 USD
<i>Transport Canada Full-Cost Investigation project</i>	Analyzes the costs for vehicles by age class in Canada in 2000. Shows how costs and distance traveled decline with vehicle age.	Average cost per km ranges from \$0.26 to \$0.40. Average is \$0.32 (\$0.51 per mile).	Average cost per km ranges from \$0.24 to \$0.37. Average is \$0.30 (\$0.48 per mile).

This table summarizes cost estimates of various studies. Results vary depending on the analysis perspective, including the types of costs and vehicles considered.. Detailed descriptions of each cost estimate study are discussed in this chapter.

⁶ S. Donovan, et al. (2008), *Managing Transport Challenges When Oil Prices Rise*, Research Report 357, New Zealand Transport Agency (www.ltsa.govt.nz); at www.ltsa.govt.nz/research/reports/357.pdf.

- The National Center for Transit Research analyzed vehicle expenses in *Exploration of a Shift in Household Transportation Spending from Vehicles to Public Transportation* (Polzin, Chu and Raman 2008) www.nctr.usf.edu/pdf/77722.pdf. The accompanying spreadsheet model calculates marginal savings that result from reductions in household vehicle ownership; for example, due to transit oriented development or other travel option improvements. They find the annual cost to households per additional vehicle averaged about \$3,500 in 2006, but conclude that marginal annual savings per reduced vehicle are probably somewhat less since households are likely to shed lower value vehicles. In the model they use a marginal cost of \$0.20 per mile, but suggest that this value be adjusted to reflect specific situations. Average household vehicle expenditures are shown below in Table 5.1.5-2, and marginal savings per reduced vehicle are shown in Table 5.1.5-3

Table 5.1.5-2 Vehicle Expenditures Including Rental Cars (Polzin, Chu and Raman 2008)

(2006 Dollars)		Adults per Household				
Vehicles per HH	1	2	3	4	5+	
0	\$355	\$847	\$743	\$764	\$680	
1	\$3,102	\$3,748	\$3,832	\$3,949	\$5,481	
2	\$9,972	\$7,289	\$7,723	\$7,411	\$7,198	
3	\$10,891	\$15,826	\$11,084	\$10,976	\$10,481	
4	\$10,862	\$17,470	\$19,057	\$15,078	\$14,307	
5+	\$11,208	\$20,001	\$25,726	\$26,729	\$29,324	

Spending varies depending on household composition and vehicle ownership. In this study, vehicle travel expenses include car rentals, but excludes taxi and public transit expenses. Note that vehicle costs do not decline to zero with zero vehicle ownership. Source: Figure 15, p. 33.

Table 5.1.5-3 Household Savings by Vehicle Ownership (Polzin, Chu and Raman 2008)

Savings per Relinquished Vehicle (2006 Dollars)		Adults per Household				
Vehicles per HH	1	2	3	4	5+	
1	\$2,747	\$2,901	\$3,089	\$3,185	\$4,801	
2	\$6,870	\$3,540	\$3,892	\$3,462	\$1,717	
3	\$919	\$8,537	\$3,361	\$3,565	\$3,283	
4	-\$29	\$1,644	\$7,973	\$4,101	\$3,827	
5+	\$346	\$2,531	\$6,669	\$11,651	\$15,016	

Reduction in cost per vehicle relinquished varies considerably depending on household composition and number of vehicles owned. Note that the data is from a fairly small sample, the general trends indicated may be more reliable than specific values. Source: Figure 16, p. 34.

- The American Automobile Association publishes estimated costs of owning and operating various vehicle types as summarized in Table 5.1.5-4. This reflects costs during the first five years of a vehicle's life and so has relatively high depreciation and insurance costs, and almost no repair costs. Note that depreciation is now adjusted for mileage, unlike earlier AAA data.

Table 5.1.5-4 American Automobile Association 2008 Vehicle Cost Estimates⁷

	Small Sedan	Medium Sedan	Large Sedan	SUV	Van
Gas & oil	8.21¢	10.54¢	11.51¢	14.39	12.16
Maintenance	4.26¢	4.51¢	4.92¢	4.94	4.87
Tires	0.61¢	0.87¢	0.82¢	0.95	0.74
<i>Operating costs/mile</i>	<i>13.08¢</i>	<i>15.92¢</i>	<i>17.25¢</i>	<i>20.28¢</i>	<i>17.77¢</i>
Insurance	\$948	\$957	\$1,022	\$948	\$897
License & registration	\$419	\$572	\$711	\$727	\$602
Depreciation	\$2,430	\$3,401	\$4,551	\$4,619	\$3,818
Financing	\$553	\$786	\$998	\$1,023	\$832
<i>Ownership costs/year</i>	<i>\$4,350</i>	<i>\$5,716</i>	<i>\$7,282</i>	<i>\$7,317</i>	<i>\$6,149</i>
Total for 12,500 annual miles	\$5,985	\$7,706	\$9,438	\$9,852	\$8,370
Average cost per mile	\$0.35	\$0.46	\$0.58	\$0.59	\$0.49

This table summarizes vehicle cost estimates published by the American Automobile Association. It represents typical costs during the first six years of vehicle operation, and so tends to overestimate depreciation and financing costs and underestimate repair costs. It also ignores incidental costs, such as user parking fees and road tolls.

- The Canadian Automobile Association (www.caa.ca) also publishes a version of *Driving Costs*. One vehicle covered is summarized in Table 5.1.5-5 below.

Table 5.1.5-5 Annual Costs for 2.2 L Cobalt Sedan (2006 Canadian Dollars)⁸

Kilometers Driven per Year	Annual Operating Costs (variable)	Annual Ownership Costs (fixed)	Total Cost	Cost per Kilometer
12,000 km	\$1,500.00	\$7,081.00	\$8,581.00	\$0.715
16,000 km	\$2,000.00	\$7,081.00	\$9,081.00	\$0.568
18,000 km	\$2,250.00	\$7,081.00	\$9,331.00	\$0.518
24,000 km	\$3,000.00	\$7,261.00	\$10,261.00	\$0.428
32,000 km	\$4,000.00	\$7,501.00	\$11,501.00	\$0.359

This table summarizes estimated costs for relatively new (first 4 years) 2007 Chevrolet Cobalt LTZ four-door sedan — 2.2 litre 4-cylinder. Note that 'fixed' costs increase slightly with increased mileage because depreciation is adjusted for mileage, as in the AAA data above.

- The U.K. Automobile Association (www.theaa.co.uk) provides ownership and operating costs for gasoline and diesel powered cars in a similar format to the AAA and CAA data above. Annual reports since 1998 are available at www.theaa.com/motoring_advice/running_costs/index.html.

⁷ AAA (2008), *Your Driving Costs 2008*, American Automobile Association (www.aaa.com); at www.aaexchange.com/Assets/Files/20084141552360.DrivingCosts2009.pdf.

⁸ CAA (2007). *Your Driving Costs 2007*, Canadian Automobile Association (www.caa.ca); at www.caa.ca/documents/2007-04-27_DrivingCostsBrochure2007.pdf.

- The 2013 American Household Survey includes information on average household expenditures on transportation, as summarized below.

Table 5.1.5-6 Average Household Transportation Expenditures⁹

	Per Year	Per Vehicle
Fuel	\$2,400	\$1,263
Auto insurance	\$1,440	\$758
Car payments	\$4,800	\$2,526
Car maintenance	\$600	\$316
Parking	\$360	\$189
Public transportation	\$432	NA
Totals	\$10,032	\$5,053

- Barnes and Langworthy use various sources to estimate vehicle operating costs, as summarized in the table below. This report provides a model for calculating these costs under different driving conditions. Costs are estimated to increase about 25% under city driving conditions, and about 17% on roads with poor quality pavement. The report suggests methods to determine how operating costs will change in the future. Data below has been adjusted for inflation by CPI.

Table 5.1.5-7 Baseline Vehicle Operating Costs (2007 Cents Per Vehicle-Mile)¹⁰

Cost Category	Automobile	Pickup/Van/Light Truck	Commercial Truck
Fuel	5.8	8.8	24.2
Maintenance/Repairs	3.5	4.2	11.9
Tires	1.0	1.1	4.0
Depreciation	7.0	7.6	9.0
Totals	17.3	21.7	49.0

- Table 5.1.5-8 summarizes actual average household transportation expenditures from the annual *Consumer Expenditure Survey*, which provides detailed data on what consumers actually spend on their vehicles by demographic and geographic group since 1984.¹¹ Note that this is significantly lower than most other published vehicle cost estimates because it includes old as well as new vehicles.

⁹ U.S. Census (2013), "Table S-O4C-AO," 2013 American Housing Survey; at www.census.gov/programs-surveys/ahs/data/2013/national-summary-report-and-tables---ahs-2013.html.

¹⁰ Gary Barnes and Peter Langworthy (2004), "Per Mile Costs of Operating Automobiles and Trucks," *Transportation Research Record 1864*, Transportation Research Board (www.trb.org), pp. 71-77.

¹¹ Piyushimita Thakuria and Yihua Liao (2005), *An Analysis Of Variations In Vehicle-Ownership Expenditures*, TRB 84th Annual Meeting (www.trb.org).

Table 5.1.5-8 Average US Vehicle Expenditures, 2004 (2007 Dollars)¹²

	Per Household	Portion of Household Total	Per Vehicle Year	Per Vehicle Mile
Vehicle Purchases	\$3,975	7.8%	\$2,092	\$0.16
Fuel and oil	\$1,870	3.7%	\$984	\$0.08
Financing charges	\$378	0.7%	\$199	\$0.01
Maintenance and repairs	\$763	1.5%	\$401	\$0.04
Insurance	\$1,127.88	2.2%	\$593.19	\$0.05
Other vehicle expenses	\$498.42	1.0%	\$262.08	\$0.02
<i>Total vehicle expenses</i>	\$8,611.20	17%	\$4,532.58	\$0.36
Public transport expenses	\$515.97	1.0%	NA	NA
Total transport expenses	\$9,127.17	18.0%	NA	NA

“Public Transport” includes intercity air, rail, bus transport and local transit services.

- Transport costs increased as a portion of household budgets during the last century, indicated in the table below. This reflects increased vehicle ownership and use during this period, and reductions in other expenditures, particularly food and clothing.

Table 5.1.5-9 Average Household Expenditures¹³

Component	1917–19	1950	1960–61	1972–73	1986–87
Food	41.1%	32.5%	26.0%	22.6%	19.4%
Housing	26.8%	26.0%	29.2%	29.3%	33.7%
Transportation	3.1%	13.8%	15.1%	24.1%	25.7%
Clothing	17.6%	11.6%	10.3%	8.4%	5.2%
Health care	4.7%	5.1%	6.6%	4.7%	4.0%
Other	6.7%	11.0%	12.8%	10.9%	12.0%

This table indicates the portion of expenditures devoted to various categories of goods by single wage earner urban households for various periods during the Twentieth Century. Transportation expenditures increased significantly during this period, reflecting increased motorized travel.

- Table 5.1.5-10 summarizes Transport Canada’s *Estimates of Light Road Vehicles Financial Cost in Canada*. This study analyzes costs for vehicles of various ages in Canada in 2000; these values have been adjusted by CPI to 2007 dollars.

¹² *Consumer Expenditure Survey*, BLS (www.bls.gov), annual reports.

¹³ David S. Johnson, John M. Rogers and Lucilla Tan (2001), “A Century Of Family Budgets In The United States,” *Monthly Labor Review* (www.bls.gov/opub/mlr/2001/05/art3full.pdf), May, pp. 28-46.

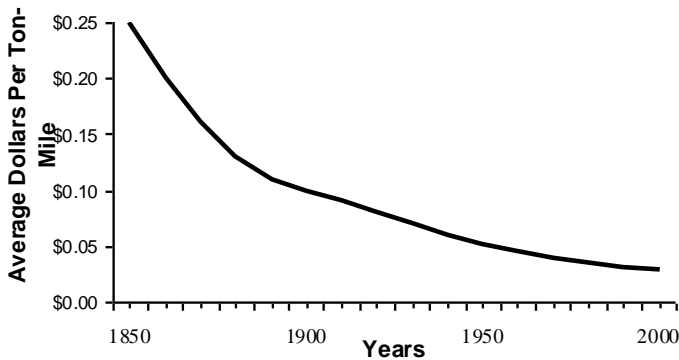
Table 5.1.5-10 Average Vehicle Cost by Vintage – (2007 Canadian Dollars)¹⁴

Vehicle Age	Portion of Fleet	Average Annual Kilometers	Average cost per vehicle	Average cost per km
0 to 2	19%	23,130	9,319	0.40
3 to 5	19%	21,547	7,780	0.36
6 to 8	19%	18,592	5,825	0.31
9 to 11	19%	14,623	4,176	0.29
12 to 14	14%	12,839	3,475	0.27
15 +	10%	9,545	2,459	0.26
<i>Sum or Weighted Average</i>	<i>100%</i>	<i>17,562</i>	<i>\$5,883</i>	<i>\$0.32</i>

Both total and average financial costs tend to decrease with vehicle age. Note that vehicles between 9 and 14 years old made up 33% of the Canadian automobile fleet in 2000. Canadian \$0.32 per km was USD \$0.48 per mile based on 2007 exchange rates.

Figure 5.1.5-1 illustrates the large reduction in shipping costs that occurred between 1850 and 2000 due to technological improvements, including larger and more efficient vehicles, more efficient loading and transfer systems (such as containerization) and economies of scale (more shipping volumes).

Figure 5.1.5-1 Railroad Freight Costs¹⁵



Shipping costs per ton-mile declined significantly during the last 150 years.

¹⁴ TC (2007), *Estimates of Light Road Vehicles Financial Cost in Canada*, Full Cost Investigation Project, Transport Canada (www.tc.gc.ca/pol/en/aca/fci); at www.tc.gc.ca/pol/en/Report/FullCostInvestigation/Road/r005/r005.pdf.

¹⁵ William L. Garrison and David M. Levinson (2006), *The Transportation Experience: Policy, Planning, and Deployment*, Oxford University Press (www.us.oup.com), p. 290.

5.1.6 Other Vehicles

Hybrid and Electric Cars

Hybrid vehicles are more costly to purchase but more fuel efficient in urban conditions than standard models.¹⁶ For example, the 2009 Camry Hybrid lists for about \$6,600 more than a non-hybrid version, a 9¢ per vehicle-mile premium if depreciated over 5 years at 8% interest and 15,000 annual miles.¹⁷ It is rated at 33 miles-per-gallon (MPG) in city driving, 50% better than a standard Camry's 22 MPG, but only achieves a 10% gain (31 vs. 34 MPG) in highway driving. The Toyota Prius achieves 48 MPG in city driving and 45 MPG in highway driving. A 2008 GMC Yukon four wheel drive hybrid is rated at 20 MPG in both city and highway conditions, which is not very fuel efficient but significantly more efficient than the standard model's 15 MPG city driving rating.

The US DOE reports that electric cars require new battery sets every 20,000-30,000 miles costing \$2,000-\$3,000 (averaging 6-15¢ per vehicle-mile), and consume 0.25 to 0.5 kWh per mile, so energy costs average 2-5¢ per mile based on typical residential energy rates.¹⁸ Electric cars and plug-in hybrids will likely have a similar cost profile to present hybrids, with significant variable cost benefits in urban commercial fleets.

Rideshare Passengers

A rideshare passenger using an otherwise empty seat generally incurs minimal incremental vehicle costs, estimated to be a 5% increase in fuel consumption and other variable costs, so adding 2 passengers increases variable costs 10%.

5.1.7 Motorcycles

Although motorcycles are less expensive than a car to purchase and operate, their costs per passenger-mile tend to be relatively high due to low annual mileage and occupancy. An average motorcycle is driven only 2,500 miles annually and travels 50 miles per gallon of fuel.¹⁹ Over 2,600 annual miles the average cost per mile is about \$1.35.

5.1.8 Transit

Table 5.1-9 summarizes U.S. transit expenses and revenues. Expenditures are divided into *capital* (facilities and vehicles) and *operation* (labor, maintenance and fuel). Revenues are divided into *fares* (user payments) and *subsidies* (other revenues). Transit fares and operating costs vary depending on conditions and perspective.²⁰ Urban peak

¹⁶ Based on EPA fuel efficiency data at www.fueleconomy.gov.

¹⁷ Data from Carsdirect.com (www.carsdirect.com); at www.carsdirect.com/research/compareresults?acodes=USB90TOC201A0,USB90TOC021A0.

¹⁸ USDOE *Alternative Fuels Data Center* (www.afdc.doe.gov) and *Fuel Economy Website* (www.fueleconomy.gov/feg/hybrid_sbs.shtml).

¹⁹ BTS, *National Transportation Statistics*, Bureau of Transport Statistics (www.bts.gov), annual report.

²⁰ Todd Litman (2004), *Evaluating Public Transit Benefits and Costs*, VTPI (www.vtpi.org); Brian D. Taylor, Hiroyuki Iseki and Mark Garrett (2000), *How Much Does A Transit Trip Cost?*, University of California Transportation Center (www.uctc.net); at www.uctc.net/scripts/countdown.pl?702.pdf.²⁰ William Vickrey (1994). *Pricing in Urban and Suburban Transport, Public Economics; Selected Papers by William Vickrey*, Cambridge University Press (www.uk.cambridge.org).

travel tends to have high costs and high revenue, while off-peak and rural travel has lower costs and revenues. Revenue per-mile is highest for short trips and lower for longer-distance trips. Transit service experiences economies of scale: unit costs decline with increased ridership, so routes with high load factors have low costs per passenger mile and high cost recovery. Marginal costs tend to be lower than the average costs (a 10% ridership increase increases costs less than 10%).²¹

Table 5.1.8-1 U.S. 2002 Public Transit Expenses and Revenues (2007 Dollars)²²

	Bus	Trolley Bus	Heavy Rail	Commuter Rail	Demand Response	Light Rail	Other	Totals
Capital Expenses (m)	\$3,543	\$220	\$5,340	\$2,774	\$202	\$2,016	\$296	\$14,392
Operating Expenses (m)	\$14,726	\$219	\$4,994	\$3,504	\$1,914	\$910	\$535	\$26,799
Total Expenses (m)	\$18,267	\$438	\$10,333	\$6,278	\$2,117	\$2,927	\$831	\$41,191
Average Fare Per Trip	\$0.83	\$0.60	\$1.09	\$4.10	\$2.74	\$0.78	\$1.33	\$1.08
Fare Revenues (m)	\$4,365	\$70	\$2,917	\$1,695	\$216	\$264	\$154	\$9,682
Subsidy (Total Exp. - Fares)	\$13,902	\$369	\$7,417	\$4,583	\$1,900	\$2,663	\$675	\$31,509
Vehicle Revenue Miles (m)	1,864	13	604	259	525	60	102	3,427
Passenger Miles (m)	19,527	188	13,663	9,450	651	1,432	1,034	45,944
Avg. Veh. Occupancy	10.5	14.1	22.6	36.5	1.2	23.9	10.1	13.4
Avg. Trip Distance (miles)	2.8	8.7	4.5	1.6	0.2	5.6	1.1	2.6
Unlinked Trips (m)	5,268	116	2,688	414	79	337	116	9,017
Total Exp. Per Pass. Mile	\$0.94	\$2.33	\$0.76	\$0.67	\$3.25	\$2.05	\$0.81	\$0.90
Fare Rev. Per Pass. Mile	\$0.22	\$0.37	\$0.21	\$0.18	\$0.33	\$0.19	\$0.15	\$0.21
Subsidy Per Pass. Mile	\$0.71	\$1.97	\$0.54	\$0.48	\$2.93	\$1.86	\$0.66	\$0.69
Percent Subsidy	76%	84%	72%	73%	90%	91%	81%	76%

m=million

5.1.9 Bicycling, Walking and Telecommuting

A good bicycle with accessories typically costs \$500-1,000, or \$50-100 annually over a ten-year operating life, plus \$50-200 annually for maintenance if ridden 2,000 annual miles, averaging 5-15¢ per mile. Many households own bicycles for recreational purposes so the incremental costs for using them for utilitarian trips is small. Shoes typically last 500-5,000 miles of walked. Walking and cycling burn calories that may increase food requirements, although most North Americans benefit from losing weight, so increased energy consumption is often considered a benefit rather than a cost (i.e., a weight loss strategy or an opportunity to eat more enjoyable foods). If utilitarian bicycling or walking substitutes for other exercise activities they can be considered to have negative costs (i.e., if bicycling or walking reduce the need to pay health club dues or medical costs associated with sedentary living they provide benefits and save money).

²¹ Donald J. Harmatuck (2005), "Cost Functions and Efficiency Estimates of Midwest Bus Transit Systems," *Transportation Research Record 1932*, TRB (www.trb.org), pp. 43-53.

²² *Public Transportation Fact Book Statistics*, American Public Transit Association (www.apta.com); *National Transit Database*, Federal Transit Administration (www.ntdprogram.gov/ntdprogram/data.htm).

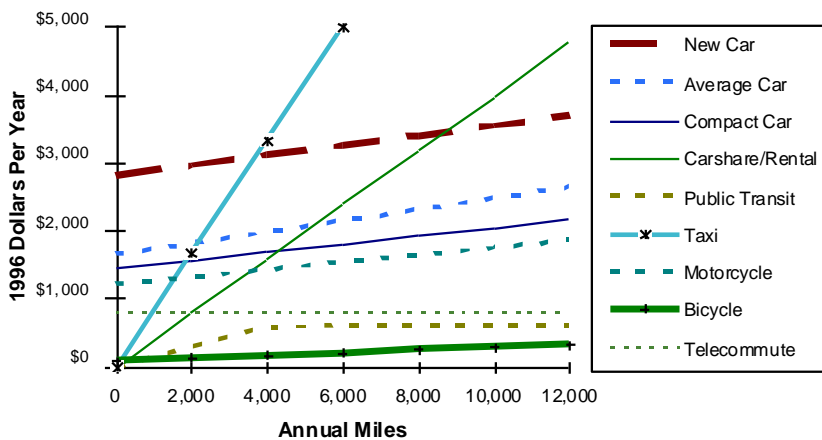
Telework

Telework often uses home office space, telecommunications equipment and services that can cost hundreds or thousands of dollars annually, but many households make such investments for personal use, and these costs can be partly offset by savings in business office space. The incremental equipment cost of telework is therefore likely to average \$500-1,500 annually for a typical part-time teleworker.

5.1.10 Comparison of Vehicle Costs

Figure 5.1.10-1 illustrates the differences in vehicle costs for various modes. It shows how some modes (such as automobile) have relatively high fixed costs and relatively low variable costs, as least as they are normally perceived (as described above, a portion of depreciation costs are actually variable, but this is not always recognized by users), while other modes such as taxi and carsharing have minimal fixed costs but higher variable costs. Walking, cycling and transit have relatively low vehicle costs.

Figure 5.1.10-1 User Expenses for Various Modes²³



Automobile travel has high fixed costs and low variable costs, taxi and carshare have low fixed costs and high variable costs, while transit and cycling have low financial costs.

There is considerable variation in vehicle costs depending on the vehicle and its use. An old but reliable, uninsured automobile may cost only a few hundred dollars a year, while an expensive vehicle can cost ten times as much. Walking, cycling and transit incremental costs also vary depending on the situation and perspective.

²³ Based on estimates in this chapter; \$50 monthly transit pass; \$1.25 per mile average taxi fares; \$0.40 per mile average rental car charges; “New Car” from *Your Driving Costs*, AAA.

5.1.11 Equity and Efficiency Issues

Vehicle costs are internal (paid directly by users). The main equity issue is [Transportation Affordability](#), the ability of lower-income people to afford basic mobility (travel to medical services, school, work, etc.). Higher vehicle costs and transit fares are often considered regressive. Many vehicle costs are inefficiently priced. For example, insurance claims and road wear tend to increase with annual vehicle mileage, but this is not reflected in insurance premiums or vehicle registration fees. This results in cross-subsidies from lower-annual-mileage to higher-annual-mile motorists.

5.1.12 Conclusions

Ownership and operating costs for average car, vans and light trucks are calculated using published vehicle cost estimates, adjusted to represent lifecycle costs (rather than just the first six years of operation). Electric and Hybrid car costs are calculated as described in section 5.1.6, but data is preliminary and should be used with caution. Rideshare passengers impose no additional fixed cost and a 0.4-mpg reduction in fuel efficiency. Fixed costs are applied equally to all driving conditions; variable costs are assumed to represent Urban Off-Peak driving, and are increased 15% for Urban Peak travel and decreased by 15% for Rural travel.²⁴ Transit is considered to have no fixed costs from a user perspective. Motorcycles purchase and fuel costs are lower than automobiles, but average per mile costs are high due to very low average miles traveled.

Table 5.1.12-1 Estimate US Fixed Vehicle Ownership Costs

Vehicle Class	Urban Peak	Urban Off-Peak	Rural	Average
Average Car	0.272	0.272	0.272	0.272
Compact Car	0.239	0.239	0.239	0.239
Electric Car	0.341	0.341	0.341	0.341
Van/Light Truck	0.354	0.354	0.354	0.354
Rideshare Passenger	0.000	0.000	0.000	0.000
Diesel Bus	0.000	0.000	0.000	0.000
Electric Bus/Trolley	0.000	0.000	0.000	0.000
Motorcycle	0.333	0.333	0.333	0.333
Bicycle	0.066	0.066	0.066	0.066
Walk	0.000	0.000	0.000	0.000
Telework	0.264	0.264	0.264	0.264

(2007 U.S. Dollars per Vehicle Mile)

²⁴ Based on fuel efficiency ratings which indicate that urban driving incurs about 30% higher fuel costs per mile than highway driving. These same ratios are assumed to apply to other variable costs.

Table 5.1.12-2 Estimate Variable Vehicle Operating Costs

Vehicle Class	Urban Peak	Urban Off-Peak	Rural	Average
Average Car	0.1940	0.1690	0.1439	0.1637
Compact Car	0.1412	0.1228	0.1043	0.1188
Electric Car	0.2732	0.2376	0.2020	0.2310
Van/Light Truck	0.2732	0.2376	0.2020	0.2310
Rideshare Passenger	0.0040	0.0040	0.0026	0.0026
Diesel Bus	6.9300	1.3860	1.3860	2.4948
Electric Bus/Trolley	11.8800	3.1680	3.1680	4.9104
Motorcycle	0.0818	0.0713	0.0660	0.0713
Bicycle	0.0264	0.0264	0.0264	0.0264
Walk	0.0528	0.0528	0.0528	0.0528
Telework	0.0000	0.0000	0.0000	0.0000

(2007 U.S. Dollars per Vehicle Mile)

Transit cost and subsidy data should be used with caution since there is great variation between countries, transit systems and specific routes. It can be difficult to allocate cost responsibility between peak and off-peak transit use. Peak trips tend to set capacity requirements and so incur high capital costs, particularly for rail transit, but have higher load factors and therefore fare revenues. As a result, urban-peak transit runs often recover their full operating costs and sometimes their full capital costs (a transit company that only provides such service could be profitable). Such runs can be considered to subsidize off-peak and rural transit operating costs, or at least require less subsidy per passenger-mile. For this analysis we assign subsidies costs equally to all trips.

As previously described, marginal transit costs tend to be lower than average costs, particularly for off-peak transit travel. We estimate that a 10% increase in transit use increases costs by 7%.

US Automobile Cost Range: The Minimum value is a rounded lower estimate and the Maximum is based on the Automobile Association estimate.

	<u>Minimum</u>	<u>Maximum</u>
Fixed	\$0.21	\$0.37
Variable	<u>\$0.12</u>	<u>\$0.18</u>
Total	\$0.33	\$0.55

5.1.13 Information Resources

Information sources on vehicle costs are grouped by subject below.

Vehicle Purchase Cost and Depreciation: The Black Book (www.blackbookusa.com and www.canadianblackbook.com), and the *Kelley Blue Book* (www.kbb.com and www.cars.com) provide price estimates for new and used vehicles, taking into account model, age, condition, mileage, accessories and geographic location.

FHWA (2001), *Highway Economic Requirements System*, U.S. Federal Highway Administration (www.fhwa.dot.gov); at <http://isddc.dot.gov/OLPFiles/FHWA/010945.pdf>. Highway costing system designed to evaluate highway improvement needs and benefits, provides information on vehicle operating costs and fuel consumption rates.

Fuel prices and projections are available from the *International Energy Agency* (www.iea.org), the *American Petroleum Institute* (www.api.org), and *International Fuel Prices* (www.internationalfuelprices.com) and GTZ (www.gtz.de/en/themen/29957.htm).

5.1.14 Bibliography – Vehicle Costs

AAA (annual reports), *Your Driving Costs*, American Automobile Association (www.ouraaa.com/news/library/drivingcost/driving.html), based Runzheimer International data.

Gary Barnes and Peter Langworthy (2003), *Per Mile Costs of Operating Automobiles and Trucks*, Humphrey Institute of Public Affairs, University of Minnesota (www.hhh.umn.edu).

BAW (no date), *The Real Costs of Car Ownership Calculator*, Bikes at Work Inc. (www.bikesatwork.com/carfree/cost-of-car-ownership.html).

CAA (annual reports), *Driving Costs*, Canadian Automobile Association (www.caa.ca), provides estimates of typical annualized ownership and operating costs for several types of vehicles.

EC (annual reports), *Statistical Pocketbook: Mobility and Transport*, European Commission (www.ec.europa.eu) ; at http://ec.europa.eu/transport/facts-fundings/statistics/pocketbook-2014_en.htm, provides information on total household expenditures on transportation by country.

FHWA (2002), *Highway Economic Requirements System: Technical Report*, Federal Highway Administration, USDOT (www.fhwa.dot.gov/infrastructure/asstmgmt/hersindex.cfm); at <http://isddc.dot.gov/OLPFiles/FHWA/010945.pdf>.

GIZ (2009), *International Fuel Prices* (www.giz.de/expertise/html/4282.html) provides gasoline and diesel retail prices in more than 170 countries.

Intellichoice (www.intellichoice.com), provides new and used vehicle price estimates.

Earl Klaubert (2001), *Highway Effects on Vehicle Performance*, Turner-Fairbank Highway Research Center, FHWA, FHWA-RD-00-164 (www.tfhrcc.gov/library/library.htm).

NMRA (annual reports), *Operating Costs Calculator*, NRMA Motoring & Services (www.mynrma.com.au); at www.mynrma.com.au/mynrma/operating-costs-calculator.aspx.

ORNL (annual reports), *Transportation Energy Book*, Oak Ridge National Laboratories, U.S. Department of Energy (www.cta.ornl.gov/data). Provides information on average vehicle mileage and fuel use, and how this is affected by factors such as vehicle speed.

Steven E. Polzin, Xuehao Chu and Vishaka Shiva Raman (2008), *Exploration of a Shift in Household Transportation Spending from Vehicles to Public Transportation*, Center for Urban Transportation Research (www.nctr.usf.edu); at www.nctr.usf.edu/pdf/77722.pdf. Also see, *The True Cost of Driving and Travel Behavior*, Planetizen (www.planetizen.com/node/56493).

Xiao Qin and Chase E. Cutler (2013), *Review of Road User Costs and Methods*, South Dakota State University, Mountain-Plains Consortium University Transportation Center (www.mountain-plains.org); at www.mountain-plains.org/pubs/pdf/MPC13-254.pdf.

Ray Barton Associates (2006), *Estimation of Costs of Cars and Light Trucks Use per Vehicle-Kilometre in Canada*, Analysis Policy Group, Transport Canada (www.tc.gc.ca); at www.bv.transports.gouv.qc.ca/mono/0965382.pdf.

Ray Barton Associates (2006), *Estimation Of Costs Of Heavy Vehicle Use Per Vehicle-Kilometre In Canada*, Transport Canada (www.tc.gc.ca); at www.bv.transports.gouv.qc.ca/mono/0965385.pdf.

Runzheimer International (www.runzheimer.com), sells estimates of typical ownership and operating costs for several vehicle types, which is the basis for automobile association estimates

SCCRTA (2008), *How much does it REALLY cost you to drive? The True Cost of Driving Online Calculator*, Santa Cruz County Regional Transportation Commission (www.commutesolutions.org/calc.htm).

StatsCan (annual reports), *Survey of Household Spending*, Statistics Canada (www.statcan.ca).

TRISP (2005), “Sources of Vehicle Operating Costs,” *Economic Evaluation Notes*, UK Department for International Development and the World Bank (www.worldbank.org); at <http://go.worldbank.org/ME49C4XOH0>. Summarizes transport project evaluation methods suitable for developing country applications.

Vehicle Cost Calculator (www.agric.gov.ab.ca/app24/costcalculators/vehicle/getvechimpls.jsp), by the Alberta Department of Agriculture, Food and Rural Development, calculates ownership and operating costs for eleven vehicle types, and can be modified to reflect specific conditions.

VTPI, *Online TDM Encyclopedia*, VTPI (www.vtpi.org), chapters:
“Driving Costs” (www.vtpi.org/tdm/tdm82.htm).
“Transportation Affordability” (www.vtpi.org/tdm/tdm106.htm).

World Bank (2006), *Road Software Tools*, The World Bank Group (www.worldbank.org/transport/roads/tools.htm). Provides information on various computer programs that calculate vehicle operating costs under various roadway conditions.