

MOTOR-VEHICLE GOODS AND SERVICES PRICED IN THE PRIVATE SECTOR

Report #5 in the series: *The Annualized Social Cost of Motor-Vehicle Use in the
United States, based on 1990-1991 Data*

UCD-ITS-RR-96-3 (5)

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October 2004

ACKNOWLEDGMENTS

This report is one in a series that documents an analysis of the full social cost of motor-vehicle use in the United States. The series is entitled *The Annualized Social Cost of Motor-Vehicle Use in the United States, based on 1990-1991 Data*. Support for the social-cost analysis was provided by Pew Charitable Trusts, the Federal Highway Administration (through Battelle Columbus Laboratory), the University of California Transportation Center, the University of California Energy Research Group (now the University of California Energy Institute), and the U. S. Congress Office of Technology Assessment.

Many people provided helpful comments and ideas. In particular, I thank David Greene, Gloria Helfand, Arthur Jacoby, Bob Johnston, Charles Komanoff, Alan Krupnick, Charles Lave, Douglass Lee, Steve Lockwood, Paul McCarthy, Peter Miller, Steve Plotkin, Jonathan Rubin, Ken Small, Brandt Stevens, Jim Sweeney, Todd Litman, and Quanlu Wang for reviewing or discussing parts of the series, although not necessarily this particular report. Of course, I alone am responsible for the contents of this report.

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LIST OF ACRONYMS AND ABBREVIATIONS AND OTHER NAMES

The following are used throughout all the reports of the series, although not necessarily in this particular report

AER = *Annual Energy Review* (Energy Information Administration)
AHS = *American Housing Survey* (Bureau of the Census and others)
ARB = Air Resources Board
BLS = Bureau of Labor Statistics (U. S. Department of Labor)
BEA = Bureau of Economic Analysis (U. S. Department of Commerce)
BTS = Bureau of Transportation Statistics (U. S. Department of Transportation)
CARB = California Air Resources Board
CMB = chemical mass-balance [model]
CO = carbon monoxide
dB = decibel
DOE = Department of Energy
DOT = Department of Transportation
EIA = Energy Information Administration (U. S. Department of Energy)
EPA = United States Environmental Protection Agency
EMFAC = California's emission-factor model
FHWA = Federal Highway Administration (U. S. Department of Transportation)
FTA = Federal Transit Administration (U. S. Department of Transportation)
GNP = Gross National Product
GSA = General Services Administration
HC = hydrocarbon
HDDT = heavy-duty diesel truck
HDDV = heavy-duty diesel vehicle
HDGT = heavy-duty gasoline truck
HDGV = heavy-duty gasoline vehicle
HDT = heavy-duty truck
HDV = heavy-duty vehicle
HU = housing unit
IEA = International Energy Agency
IMPC = Institutional and Municipal Parking Congress
LDDT = light-duty diesel truck
LDDV = light-duty diesel vehicle
LDGT = light-duty gasoline truck
LDGV = light-duty gasoline vehicle
LDT = light-duty truck
LDV = light-duty vehicle
MC = marginal cost
MOBILE5 = EPA's mobile-source emission-factor model.
MSC = marginal social cost

MV = motor vehicle
NIPA = National Income Product Accounts
NO_x = nitrogen oxides
NPTS = Nationwide Personal Transportation Survey
OECD = Organization for Economic Cooperation and Development
O₃ = ozone
OTA = Office of Technology Assessment (U. S. Congress; now defunct)
PART5 = EPA's mobile-source particulate emission-factor model
PCE = Personal Consumption Expenditures (in the National Income Product Accounts)
PM = particulate matter
PM₁₀ = particulate matter of 10 micrometers or less aerodynamic diameter
PM_{2.5} = particulate matter of 2.5 micrometers or less aerodynamic diameter
PMT = person-miles of travel
RECS = Residential Energy Consumption Survey
SIC = standard industrial classification
SO_x = sulfur oxides
TIA = *Transportation in America*
TSP = total suspended particulate matter
TIUS = *Truck Inventory and Use Survey* (U. S. Bureau of the Census)
USDOE = U. S. Department of Energy
USDOL = U. S. Department of Labor
USDOT = U. S. Department of Transportation
VMT = vehicle-miles of travel
VOC = volatile organic compound
WTP = willingness-to-pay

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5. MOTOR-VEHICLE GOODS AND SERVICES PRICED IN THE PRIVATE SECTOR

5.1 INTRODUCTION

5.1.1 Conceptual background.

In this Report, I estimate the cost of motor vehicle goods and services priced in the private sector: the cost of the vehicles themselves, the cost of fuel and oil, cost of parts and maintenance, and so on. The economic cost of these motor-vehicle goods and services supplied in private markets is the area under the private supply curve: the value of the resources that a private market allocates to supplying vehicles, fuel, parts, insurance, and so on.

We do not observe the supply curve itself, and so cannot estimate the true private-sector resource cost -- the area under the supply curve -- directly. Rather, we must estimate this area indirectly, starting from what we can observe: total price-times-quantity revenues. Thus, the private-sector resource cost under the supply curve is equal to price-times-quantity revenues minus producer surplus and taxes and fees. We deduct producer surplus because it is defined as revenue in excess of economic cost, and hence is a non-cost wealth transfer from consumers to producers¹. We deduct taxes and fees assessed on producers and consumers because in no case are they marginal-cost prices that can be used in a price-times-revenue calculation of costs².

The relation between supply cost and producer surplus and taxes and fees is illustrated in Figure 5-1. In that figure, the supply curve (the private sector marginal-cost production curve), in the absence of fees and taxes, is S . A per-unit fee, such as the \$/barrel charge for the oil spill trust fund, shifts the supply curve up by a constant

¹However, a net (equilibrium) transfer from U.S. consumers to foreign producers is a real cost to the U.S.

²Recall that the point here is to estimate private-sector resource cost. The cost of the private-sector resources devoted to, say, making gasoline, does not include the federal and state gasoline tax, because that tax is a charge for the use of the roads, not part of the marginal-cost price of making gasoline. But, one might ask, why not then use the gasoline tax as an estimate of the cost of the roads, just as one uses price-times-quantity payments (less producer surplus) to estimate private-sector resource cost? There are two reasons. First, we have data on expenditures on road construction and maintenance anyway, and so do not need to use price-times-quantity to approximate cost.

Second, even if we did want to use price-times-quantity to approximate the infrastructure cost, we would not use the gasoline tax for price, because it is not a marginal-cost price, but rather is a charge that bears no obvious resemblance to an efficient price. We can use price-times-quantity data to estimate cost (the area under the supply curve) only if we know the relationship between price and cost. Because we do not know the relationship between the gasoline tax and cost, gasoline tax data are useless information in an analysis of cost.

\$/quantity amount, to S_f . A fixed-percentage tax, such as the sales tax, further shifts and also rotates the supply curve up, to S_{ft} , such that at any Q the ratio of P at S_{ft} to P at S_f is a constant.

Given the demand curve D and the final market supply curve S_{ft} (with the fees and taxes levied), Q_{ft} units are sold at price P_{ft} to consumers and marginal cost P_s to producers. As mentioned above, we observe directly P_{ft} and Q_{ft} , or their product $P_{ft} \cdot Q_{ft}$, but not P_s or the total cost as area under the private no-tax supply curve S (this last area being what we wish to know). To get from the observed revenues $P_{ft} \cdot Q_{ft}$ to the area under the supply curve ($0-P_0-a-Q_{ft}$), we must subtract the revenues that are transferred to the government, and the revenues that are non-cost transfers from consumers to producers, as producer surplus. The government collects the difference between P_{ft} and P_s as taxes and fees, in the amount $Q_{ft} \cdot (P_{ft}-P_s)$. Producers with costs lower than the marginal cost P_s collect producer surplus, equal in aggregate to the area P_0-P_s-a .

Note that the result of this calculation is the cost actually incurred given prices and quantities as they were, not the cost that would have been incurred had there been no taxes in the first place. If there were no taxes and fees, the market price (P^*) to consumers would be lower, the marginal supply cost (P_8) would be higher, and the marketed quantity (Q^*) would be higher than in the actual case with taxes and fees. The resource cost in this case would be $0-P_0-a^*-Q^*$.

To worry, for example, about producer surplus is not merely a theoretical twiddle: it bears directly on comparisons of alternatives. For example, in comparing the cost of oil with the cost of alternative energy sources, it will not do to count all price-times-quantity revenues as the cost, because the true private resource cost is much less than this, on account of the enormous producer surplus that accrues to some oil producers.

The prices and quantities that obtain in private markets rarely are optimal -- that is, the actual prices (P) paid rarely satisfy $MSV = P = MSC$ -- not only because of distortionary taxes and fees, but because of imperfect competition, standards and regulations that affect production and consumption, price controls, subsidies, quotas, externalities, and poor information. For example, the market for crude oil is not always competitive. The reason, of course, is that the Organization of Petroleum Exporting Countries (OPEC) sometimes manages to restrict oil output and thereby raise oil price above marginal cost. This is inefficient because it cuts off production of oil that could be produced for less than the [formerly] prevailing market price and hence from a social-efficiency standpoint *should* be produced and consumed³ (see Figure 5-2). One also can

³This also results in an increased transfer of wealth from consumers to producers (who are receiving a price above their marginal cost), and can be a real loss to heavy oil importers like the U.S. Note, though, that this extra wealth transfer is not in addition to price-times-quantity payments; to the contrary it already is part of price-times-quantity payments. Rather, the extra wealth transfer is with respect to the total transfer in a competitive market (see Greene and Leiby, 1993). The total resource cost of fuel use to

argue that other industries, such as the automobile manufacturing industry, at times look oligopolistic⁴.

Standards and regulations also can be economically inefficient. For example, the cost of vehicles and fuels includes items, such as catalytic converters and airbags and perhaps lightweight materials, used to meet government standards for emissions, safety, and fuel economy. Now, if the government standards are not the most efficient corrective, then the corresponding resources (for catalytic converters, air bags, etc.) are not efficiently allocated. Of course, it is well known that, transaction costs and uncertainty aside (and these admittedly are *big* asides), Pigovian taxes indeed are more efficient than are standards. However, Pigovian taxes can be more expensive to administer, less predictable, and more difficult to change on short notice, to point that standards might be preferable in some and perhaps many situations (Baumol and Oates, 1988). It thus is not necessarily always the case that in the real world standards and regulations are less efficient than Pigovian regulations⁵.

Finally, consumers can be ignorant and irrational. For example, some and perhaps many people routinely underestimate the probability that they will be in an accident, and as a result undervalue safety equipment in motor vehicles.

In sum, we certainly do not have a dichotomous world of prices, in which private-sector prices are perfect and can be left alone, and all other prices (or non-prices) need to be fixed. Rather, there are a variety of imperfections, in every sector, including the most competitive, unregulated private sectors, and hence a range of issues pertaining to pricing, taxation, regulation, and so on. We can be as concerned about the price of tires as the price of roads or the non-price of motor-vehicle emissions.

Price effects ignored. Note that my estimates of cost do not account for the affect on consumption of changes in price brought about by a hypothetical change in motor-vehicle use. For example, I in effect assume that if one reduces motor-vehicle use by 10%, the corresponding savings in motor-fuel will on average be 10%. However, the savings in motor-fuel actually will be less, because the price of motor-fuel will drop and

the U.S., competitive market or not, is equal to price-times-quantity payments less *domestic* producer surplus, which is a non-cost transfer from U.S. consumers to U.S. producers.

⁴In light of this, one might distinguish those resources provided in occasionally non-competitive markets, and place them in a separate column labeled "subject to non-competitive pricing: $msv = p \neq msc$ ". For simplicity, I have not.

⁵I emphasize that the question here is not whether the resources required by government standards should be counted as a cost of motor-vehicle use -- they should be -- but whether they are efficiently allocated. Catalytic converters certainly are a cost of motor-vehicle use today, and barring unforeseen changes in regulations, will continue to be a cost of motor-vehicle use, regardless of whether or not there would be catalytic converters in a Pareto-optimal world. Furthermore, regardless of whether standards or taxes are used to address an externality, the relevant total cost is the resource cost of whatever control measures are used (including "defensive" behavior broadly construed) plus the estimated cost of the residual (uncontrolled) effects, such as emissions.

thereby stimulate additional fuel consumption for the remaining 90% of motor-vehicle use. In principle, this problem arises no matter what the posited change in motor-vehicle use. For example, if one is estimating the total cost of all motor-vehicle use, one in principle should allow that the contraction in demand for steel would reduce its price and stimulate steel consumption in non-motor-vehicle sectors.

5.1.2 Cost items not usually included in GNP-type accounts of the cost of motor-vehicle transportation

Most of the cost items considered in this report show up in estimates by other analysts of the cost of owning and operating motor vehicles, or in the costs of motor-vehicle transportation in the National Income Product Accounts of the GNP. However, this analysis includes several items that most other analysts and most GNP-type accounts usually do not include. For example, the "User Operated Transportation" categories of the National Income and Product Accounts (NIPA) of the United States (e.g., Bureau of Economic Analysis, 1990; *Survey of Current Business*, July, 1992), the FHWA's *Cost of Owning and Operating Automobiles, Vans, and Light Trucks* (1984, 1992a), the U. S. Department of Labor's Consumption Expenditure Surveys (e.g., Bureau of Labor Statistics, *Consumer Expenditures 1991, 1992*), Runzheimers' (1992) *Survey & Analysis of Business Car Policies and Costs 1991-1992*; and the financial profile of automobiles in *National Transportation Statistics* (1992; their data are from the NIPA and the FHWA's *Highway Statistics*) do not include in their accounts the following costs: compensated work travel time; the overhead expenses of business, commercial, and government fleets; accident costs paid for by responsible party, but not through automobile insurance; vehicle inspection by private companies; or the cost of legal services and security devices. They do not include them either because they have overlooked them, or because (in the case of the NIPA and Consumer Expenditure Surveys) they classify them elsewhere, as legal costs, medical costs, housing costs, and so on, rather than as personal transportation costs.

There is no doubt, however, that these are costs of motor-vehicle use: for example there were no motor vehicles, there would be no vehicle inspection costs, and accident costs paid out of out pocket. The efficiency issue is whether or not motor-vehicle users *recognize* that these are costs of motor-vehicle use. That is, even though these costs are explicitly priced, they might be overlooked and omitted from the decision calculus. The out-of-pocket costs of motor-vehicle accidents *might* be an example of this sort of unaccounted-for cost.

5.1.3 Description of primary data sources

There are four primary aggregate estimates of ownership and operating costs of motor vehicles: 1) "Personal Consumption Expenditures" (PCEs) on "User Operated Transportation," in the National Income and Product Accounts (NIPA) of the United States, estimated by the Bureau of Economic Analysis (BEA) from basic data on economic activity in the U.S. (*Survey of Current Business*, July 1992); 2) "Consumer Expenditures" (CEs) on transportation, estimated from a national survey of households,

administered by the Bureau of Labor Statistics (BLS) (BLS, *Consumer Expenditure Survey: Integrated Survey Data*, 1989; Division of Consumer Expenditure Surveys, 1993a); 3) The “Nation’s Freight Bill, Highway” estimated by F. Smith (*Transportation in America, A Statistical Analysis of Transportation in the United States*, , 1993), using data from the American Trucking Association, the Bureau of the Census, the Government Services Administration, and the Federal Highway Administration; and 4) The Census Bureau’s *Motor Freight Transportation and Warehousing Survey: 1991* (1993), which surveys the revenues and operating expenses of firms that provide commercial motor-freight transportation⁶.

PCEs and CE for 1990 and 1991 are presented in detail in Table 5-1. Table 5-1 also shows Smith’s (1993) estimates of personal and business expenditures for transportation. His estimates mainly are based on the PCEs but do include some original calculations. The PCEs are included in this table for comparison. Smith’s analysis of the “Nations Freight Bill” is presented in Table 5-2, and the results of the Census’ survey of trucking firms are presented in Table 5-3.

The data of Table 5-3 suggest that Smith (1993) might underestimate the nation’s freight bill. As shown in Table 5-3, the total operating cost in SIC 421 (trucking and courier services except air), excluding costs for purchased transportation, was \$90 billion in 1991. (We exclude all purchased transportation because purchased non-highway transportation is not relevant and purchased highway transportation would be double counted.) This however, covers only a fraction of commercial (non-personal-use) trucking. If we assume that the ratio of the total operating cost to the fuel cost for all non-personal trucks is equal to this ratio in SIC 421, then we can scale the \$90 billion in operating expenses in SIC 421 by the ratio of fuel purchased in SIC 421 to total fuel

⁶The General Services Administration (GSA) of the U.S. Government also reports the operating costs of trucks (in this case, trucks in large Federally owned fleets) (GSA, *Federal Motor Vehicle Fleet Report, for fiscal year 1990, 1993?*), but because the total costs for each vehicle class are not broken down by type of cost, I cannot use the GSA data as the basis of any of my detailed cost estimates. However, the total operating costs can be compared with the equivalent total costs calculated from the Census data, in Table 5-3.

In fiscal year 1991, Federally owned civilian light-truck fleets (8,500 lbs or less GVW) had a total operating cost of \$0.25/mile and Federally owned civilian heavy-truck fleets (24,000 lbs or more GVW) had a total operating cost of \$1.03/mile, and (GSA, *Federal Motor Vehicle Fleet Report, for fiscal year 1991, 1994?*). The GSA operating cost includes depreciation cost, fuel cost, maintenance costs, and indirect costs of large Federally owned motor-vehicle fleets. The depreciation cost is estimated by GSA; the other costs are reported by fleet managers on Standard Form 82, “Agency Report of Motor Vehicle Data (Frisbee, 1994). On that form, maintenance costs include repair costs, preventative maintenance, motor oil, fluids, lubricants, replacement parts, and equipment (such as cargo covers and fire extinguishers) needed to meet special operating requirements, and indirect costs include salaries of administrative and custodial staff, office supplies, building rental, utilities, tools and equipment, and capital improvements. Insurance is not included because the Federal government is self-insured, and registration fees are not included because the Federal government does not pay state registration fees.

In Table 5-3 I calculate that the equivalent operating cost of trucks in SICs 4212 and 4213 is just over \$1.00/mile -- very close to the GSA’s figure of \$1.00/mile for heavy trucks.

consumed by all non-personal-use trucks. In 1991, firms in SIC 421 purchased 8 billion gallons (Table 5-3). On the basis of data in the 1987 *Truck Inventory and Use Survey* (Bureau of the Census, 1990) and FHWA's *Highway Statistics 1992* (1993), we estimate that all non-personal-use trucks consumed 33 billion gallons of fuel in 1991⁷. This suggests that all non-personal-use trucks had operating expenses on the order of $\$90 \times 4.1 = \370 billion, or about \$100 billion more than estimated in Table 5-2.

(An alternative analysis, in which we separately scale local trucking (SICs 4212 and 4214) and non-local trucking (SICs 4213 and 4215), yields a similar result.)

BLS Consumer Expenditures. The Bureau of Labor Statistics (BLS) surveys households across the U.S. to determine their expenditures on user-operated transportation. The surveys comprise an interview, in which householders report major purchases during the preceding three months, and a diary, in which householders record minor purchases (BLS, 1988). The CE survey is administered to households only, not to any institutions, businesses, or government agencies. Expenditures include the full amount paid by consumers, including sales taxes and excise taxes. In the quarterly interviews the interviewer asks household members what percentage of transportation expenditures or vehicle mileage are for business use (Bureau of Labor Statistics, *Quarterly Interview Survey, 1991 Forms, Consumer Expenditure Survey, 1991*), a question that suggests that transportation expenditures for business use are not counted.

BEA Personal Consumption Expenditures. The Bureau of Economic Analysis (BEA) estimates Personal Consumption Expenditures (PCEs) by type of expenditure, for "User-Operated Transportation," in the National Income and Product Accounts (NIPA) of the United States (*Survey of Current Business, "National Income and Product Accounts, 1992*). According to the BEA, "persons" consist of individuals, nonprofit institutions, private noninsured welfare funds, and private trust funds, and PCEs include goods and services purchased by individuals, the operating expenses of nonprofit institutions, and the value of food, fuel, clothing, rent, and financial services received in kind by individuals (BEA, *Personal Consumption Expenditures, 1990*; Byrnes et al., 1979). PCEs exclude the following: expenditures by businesses and by the government, including reimbursable business expenses by persons and expenses related to the business use of motor vehicles purchased for both business use and personal use; traffic fines, parking fines, motor-vehicle registration fees and driver's-license fees, which are included under "Personal Tax and Nontax Payments" in the

⁷Our analysis of the 1987 *Truck Inventory and Use Survey* (Bureau of the Census, 1990) indicates that personal-use trucks consumed 43% of total fuel consumed by all non-public trucks (the Census TIUS data do not include public vehicles). In 1991, all trucks, including public trucks, consumed 56.8 billion gallons of fuel (FHWA, *Highway Statistics 1992, 1993*). Comparing FHWA estimates of VMT in 1987 with the TIUS estimates (the FHWA estimates include public trucks), we estimate that public trucks constituted 4% of all truck VMT (FHWA, *Highway Statistics 1992, 1993*). Assuming that they also constituted 4% of total truck fuel consumption, then all non-public trucks consumed about 54.6 billion gallons in 1991. If 57% of this amount was for non-personal use, then private commercial (non-personal-use) trucks consumed about 31 billion gallons of fuel. Adding the 2 billion gallons consumed by public trucks yields a grand total of 33 billion gallons of fuel consumed by all non-personal-use trucks.

NIPA; finance charges, which are counted as “Interest paid by Consumers to Business”; and transactions between individuals, such as the sale of a car from one person to another (such transactions cancel out); (BEA, *Personal Consumption Expenditures*, 1990; Byrnes et al., 1979). Generally, the BEA makes detailed estimates of PCEs every five years when the Census publishes its quinquennial economic censuses of agriculture, transportation, manufactures, wholesale trade, retail trade, service industries, construction industries, mineral industries, and governments. These detailed estimates are called “benchmarks”. In non-benchmark years the estimates are less complete, and are made partly by extrapolation, interpolation, and judgment. The BEA uses data from the Bureau of the Census, other government agencies, trade organizations, and other sources, as well as its own judgment, to estimate total expenditures on transportation and to allocate the total to business, government, and personal use. For details, see Byrnes et al. (1979) and especially the BEA (*Personal Consumption Expenditures*, 1990).

The PCEs are meant to include all sales taxes paid, including local taxes on parking (Key, 1993), but it is possible that in some cases, unbeknownst to BEA, the source data that the BEA uses do not include relevant taxes.

Discussion. These capsule descriptions indicate that the coverage of the BLS’ CE differs from the coverage of the BEA’s PCEs in at least one way: the PCEs include expenditures by non-profit organizations, whereas the CE does not. Differences in definition and estimation of individual expenditure items are discussed below. (See also the Division of Consumer Expenditure Surveys, 1993b).

The PCEs and the CE are estimates of personal or household expenditures on transportation, and Census and the TIA estimates are of costs or revenues of motor carriers. This distinction between personal, business, and commercial transportation is unfortunate for me, because in most cases it is irrelevant to the classification and analysis of the economic costs of motor-vehicle use. Whether or not a particular vehicle carries people instead of goods, or is “personal” or for “business” or “commercial” purposes has nothing to do with the amount of pollution it generates, the amount of road damage it causes, the amount of public service that it “consumes”, and so on. It also has little to do with the amount of taxes and fees it is assessed. On the other hand, the kind of fuel that a vehicle uses, the amount that it weighs, and whether or not it is a truck, have a lot to do with the costs that it engenders and the taxes and fees that it pays (Federal Highway Administration [FHWA], *Highway Taxes and Fees*, 1991). Therefore, I eschew the personal/commercial distinction, and instead distinguish between gasoline and diesel fuel, and between three size classes of classes of vehicles, ending up with six vehicle types⁸:

⁸Those interested in seeing a breakdown of travel by household vehicles, business-use vehicles, commercial light and heavy trucks, government vehicles, buses, and other vehicles, see Table 4-1 of Report #4. My analysis there, and in the table presented below, indicates that business-use VMT is about 30% of personal-use VMT. One can get a rough idea of the extent of business-use travel by comparing data on personal use of passenger cars in 1991 with total travel by passenger cars in 1991:

- **Light-duty gasoline automobiles:** passenger vehicles, including station wagons and motorcycles, that use gasoline as a fuel. In some cases I ignore motorcycles, which account for but a tiny fraction of highway travel (FHWA, *Highway Statistics* 1992, 1993) and emissions (EPA, *National Air Pollutant Emission Trends, 1900-1994, 1995*).
- **Light-duty gasoline trucks:** trucks, vans, minivans, jeeps, and utility vehicles, that run on gasoline and have a gross vehicle weight rating of 8,500 lbs or less and a curb weight of 6,000 lbs or less. (The FHWA' annual *Highway Statistics* annual report uses a slightly different category, "two-axle, single-unit" trucks.)
- **Heavy-duty gasoline vehicles:** all other trucks, and buses, that run on gasoline. In some cases I ignore buses, which in the U.S. account for a tiny fraction of highway travel (FHWA, *Highway Statistics* 1992, 1993).
- **Light-duty diesel automobiles:** same as light-duty gasoline automobiles, except that they use diesel fuel.

	Number of passenger cars in 1991 (millions)	VMT by passenger cars in 1991 (billion)	Gallons used by passenger cars in 1991 (billion)
Personal use (RTECS, 1991)	108.3	1,150.0	54.5
Personal use (NPTS 1991)	122.6	1,135.2	not reported
All uses (FHWA 1991)	142.6	1,533.6	70.6

The triennial Residential Transportation Energy Consumption Survey (RTECS) measures VMT and energy consumption by households for personal transportation (EIA, *Household Vehicles Energy Consumption* 1991, 1993). It covers only vehicles that are kept at home and are available for "some" personal use (p. 164). It excludes motorcycles, mopeds, large trucks, and buses, but includes company-owned vehicles that are "ordinarily" kept at home and "regularly" available for personal use (p. 221). It also includes household vehicles used for job-related activities. The latest data (shown here) are for 1991.

The *Nationwide Personal Transportation Survey* (NPTS), conducted every seven years, surveys personal travel in the United States. It includes cars, trucks, vans, RVs, motor homes, motorcycles, and mopeds "owned, or available for regular use" by household members (Federal Highway Administration, *User's Guide for the Public Use Tapes, 1990 Nationwide Personal Transportation Survey, 1991*; survey form p. 4). Thus, the coverage of the NPTS probably is very similar to the coverage of the RTECs. The latest data (shown here) are from 1990; I have extrapolated to 1991, using 1991/1990 ratios from FHWA VMT data.

The Federal Highway Administration (FHWA, *Highway Statistics*, annual) reports total VMT by all passenger vehicles, regardless of use, on the basis of traffic counts on roads. The data shown are for 1991.

Again, these data, and the similar analysis of Table 4-1, indicate that business use of motor vehicles (which is not the same as commercial use) is at least 30% of personal use.

- **Light-duty diesel trucks:** same as light-duty gasoline trucks, except that they use diesel fuel.
- **Heavy-duty diesel vehicles:** same as heavy-duty gasoline vehicles, except that they use diesel fuel.

Because the published primary-source estimates of ownership and operating costs (mentioned above) pertain to personal-use or commercial use vehicles, rather than to my six classes of vehicles, I must adapt the published estimates to my six vehicle classes, or dig deeper into the underlying source data. In the following sections I detail my estimates of the cost of vehicles, finance charges, fuel and lubricants, maintenance and repairs, parts, and insurance, in each of the six classes described above.

5.2 THE ANNUALIZED REPLACEMENT COST OF THE MOTOR-VEHICLE CAR AND TRUCK FLEET

5.2.1 The annualized replacement cost

We estimate the annualized replacement cost of the motor-vehicle fleet as:

$$ARC = \frac{i \times I}{1 - (1+i)^{-t}} \quad \text{eq. [5-1]}$$

$$I = Q \times C$$

where:

ARC = the annualized replacement cost (\$/year)

I = the total investment, or complete replacement cost (\$)

i = the annual interest rate for investment in motor vehicles

t = the term of the investment in motor vehicles (years)

Q = the present quantity of motor vehicles (unregistered as well as registered)

C = the present cost per motor vehicle (excluding producers surplus, taxes, and fees)

Note that equation 5-1 annualizes the entire replacement value at $t=0$, which means conceptually that the entire vehicle stock is replaced overnight. Of course, we do not really replace the vehicle stock overnight, or all in one year; rather, we replace it gradually, as vehicles retire. But in the long run, the annualized cost of replacing the existing fleet gradually is the same as the annualized cost of replacing it all at once. If vehicles have a life of n years, and every year $1/n$ th of the vehicle stock is replaced, then the cost, calculated today, of each future $1/n$ th fleet replacement is an annualized cost stream equal to $1/n$ th the annualized cost of replacing the entire stock. These yearly annualized cost streams accumulate for n years, at which point we will have turned

over the entire stock and will have accumulated n annualized cost streams each $1/n$ th the annualized cost of replacing the entire stock all at once.

We may conclude, then, that in this analysis we have estimated either the immediate annualized cost of replacing the entire stock overnight, or the annualized cost in the long run of continuing to replace vehicles as they retire.

Our estimate of the annualized cost is developed in Tables 4 and 5. The estimate excludes sales taxes, but still includes income taxes and charges, such as CAFE fines, leveled on producers. These are deducted *en masse* later. Also, we deduct what essentially is a guess at producer surplus, allowing, as discussed in Report #1, that producer surplus that accrues to foreign producers should not be deducted, because it is a cost to consumers in the U. S.

It also happens, happily, that this estimate of the vehicle stock is exactly equal to my best independent estimate of the actual vehicle stock in 1991. According to FHWA, 188.3 million vehicle registrations occurred in 1991 (FHWA, 1993). However, the FHWA registration data double count vehicles that were registered twice in the same year (say, in different states), and hence overestimate the number of vehicles in use. R. H. Polk provides a better estimate of vehicles in use, because it counts only vehicles registered as of July 1 of any year. For 1991, Polk estimates that there were 181.4 million registered vehicles (Davis, 1995). However, neither FHWA nor Polk account for unregistered vehicles in use. If these are 4% of the total (the rate in California, according to Marowitz, 1991), then the Polk data imply a total in-use fleet (registered plus unregistered) of 189 million -- exactly my estimate here.

Of course, this equality is partly fortuitous, because vehicles sales can fluctuate considerably from year to year. In fact, in 1991, vehicle sales were at their lowest in many years, in part because of the recession (Moran, 1991). If one performed this same calculation with 1989 sales, one would overestimate the 1989 vehicle stock. In general, if the vehicle stock is growing, then current sales multiplied by current life will exceed the current stock.

Salvage value. The present worth of the salvage value of vehicles at the end of their lives should be deducted from the up-front replacement cost before it is annualized. Rather than do that, however, I assume that the salvage value at the end of the life is about equal to the disposal and dismantling cost, and hence ignore both the salvage value and the disposal cost

5.2.2 The cost of transactions involving used cars

The preceding calculation annualizes the replacement-cost of the motor-vehicle fleet, where the replacement cost per vehicle is the present retail cost per new vehicle. This first retail cost naturally includes all the costs of the *first* transaction between dealer and buyer. It does not, however, include the transactions costs of subsequent transfers of the vehicle. Consequently, we must estimate and add separately the cost of transactions involving used cars.

In the case of used-car transactions that involve a car dealer, the cost of the transaction is equal to the dealer's margin. To estimate the dealer's margin on all used-

car transactions, we can use the method that the BEA uses to estimate PCEs on used automobiles⁹: the total dealer margin is equal to total sales of used cars multiplied by the dealer margin as a percent of sales. This estimate (with the deduction of producer surplus) is developed in Table 5-6.

Not all used-car transactions involve a dealer. Individuals and perhaps businesses and governments can transact between themselves. In Report #4, we make a rough estimate of the time cost of transactions between persons. However, we do not estimate the cost of used-car transactions, without a dealer, between businesses or governments.

Disposal cost. There also is a cost to the disposal transaction at the end of the vehicle's life. However, as explained above, I assume that the cost of disposal is about equal to the salvage value of the vehicle. I thus let the salvage value approximately cancel the disposal cost, and treat neither explicitly.

5.2.3 Deduction for external replacement costs due to accidents

The cost of replacing a vehicle totaled in an accident that is an externality should be classified as an monetary external cost, not a private cost. This is handled here by deducting the cost of all accidental property damage, whether private or external (section 5.10.4).

⁹The BEA's estimate of PCEs on used automobiles -- which as noted in Table 5-1 is equal to the dealer's margin on automobiles purchased by individuals plus net transactions (purchases less sales) between persons and other sectors -- is not the same as the dealer's margin on all used-car transactions, because it is limited to transactions involving persons. That is, it does not include the dealer's margin on used cars and trucks purchased by governments and businesses, which we wish to include, and it inappropriately (from our standpoint) includes net transactions between persons and other sectors, which we do not wish to include because we are considering all used-car transactions.

5.3 THE COST OF MOTOR FUEL AND LUBRICATING OIL, EXCLUDING EXCISE AND SALES TAXES AND THE COST OF EXTRA FUEL USED BECAUSE OF TRAVEL DELAY

5.3.1 Model of the cost of motor fuel

The total cost of motor fuel is equal to the price of the fuel, excluding taxes and fees, multiplied by the quantity consumed, less the portion of the price-times-quantity revenues that is producer surplus (accrued to U. S. producers) rather than resource cost.

In this analysis, we separate the total fuel cost into the portion that is an externality due to traffic congestion, and the remainder that is not an externality. Traffic congestion causes an externality of additional fuel consumption because the fuel economy of vehicles is less during congestion than during free flow. The cost of excess fuel consumed during congestion that would not have been consumed had traffic been free flowing is a monetary externality, estimated here but included with the monetary externalities of Report #8. The cost of the remaining fuel is a private cost, estimated and included here.

Formally, we estimate the cost of fuel as follows:

$$FC_t = FC_i + FC_e$$

$$FC_e = G_e \cdot P_e - P_{Se} = G_e \cdot P_e \cdot \left(1 - \frac{P_{Se}}{G_e \cdot P_e}\right)$$

$$\text{Assume: } P_e = P_a \quad \text{and} \quad \frac{P_{Se}}{G_e \cdot P_e} = \frac{P_{St}}{G_t \cdot P_a}$$

$$\text{and let: } \frac{P_{St}}{G_t \cdot P_a} = PSF$$

$$\text{Then: } FC_e = G_e \cdot P_a \cdot (1 - PSF)$$

eq. [5-2a, b]

$$\text{and similarly: } FC_i = (G_t - G_e) \cdot P_a \cdot (1 - PSF)$$

where:

FC_t = the total fuel cost (10^9 1991\$)

FC_e = the fuel-cost externality, due to traffic delay (10^9 1991\$)

FC_i = the private-sector (internal) fuel cost (10^9 1991\$)

G_e = the motor-fuel-consumption externality: excess fuel consumed due to traffic delay (10^9 gallons) (estimated below and shown in Table 5-7)

G_t = total motor-fuel consumption (10^9 gallons) (Table 5-7)

P_e = the price of the excess motor-fuel consumed due to traffic delay, excluding taxes and fees (\$/gallon)
 P_a = the average price of all motor-fuel consumed, excluding taxes and fees (\$/gallon) (estimated below and shown in Table 5-7)
 PSe = the domestic producer surplus associated with the excess price-times-quantity payments (for the excess fuel consumed due to traffic delay) (10^9 1991\$)
 PSt = the total producer surplus associated with all price-times-quantity payments (10^9 1991\$).
 PSF = the average producer-surplus fraction (estimated below and shown in Table 5-7)

This method assumes that the marginal costs (P_e) and marginal producer-surplus shares ($PSe/(G_e \cdot P_e)$) that pertain to the fuel-consumption externality are equal to the average costs (P_a) and average producer-surplus shares (PSF) that pertain to all fuel consumption.

Our estimate of the total fuel consumption, G_t , is shown in Table 5-7, and is based ultimately on FHWA data on VMT and gallons consumed. How accurate are these FHWA data? The data on VMT are derived from traffic counts made by the states, and probably are as accurate as any VMT data could be. The gallonage data are “based on reports from State motor-fuel tax agencies” (*Highway Statistics*, annual). This might be a problem, especially in the case of diesel fuel, because it is likely that there is some cheating to avoid paying taxes¹⁰. (Some researcher believe that 15-20% of diesel fuel is illegally untaxed.) However, I cannot find any evidence that the FHWA’s estimates of gallons consumed underestimate true consumption, for any reason. In the first place, both FHWA and the States [obviously] account for legally untaxed gallonage: the FHWA estimates the use of gasoline by public vehicles, and the states estimate consumption of “special fuels” (mainly diesel fuel) by vehicles that pay a mileage tax and hence are exempt from the gallonage tax. Second, my best independent estimate of total consumption of diesel fuel in 1987 actually is lower than the FHWA’s estimate (Table 5-8). Third, the EIA uses the FHWA data without adjustment in its (the EIA’s) estimates of diesel-fuel consumption by end use sector (EIA, *Fuel Oil and Kerosene*

¹⁰The FHWA’s estimates of volumes of motor gasoline reported by wholesale distributors to State motor-fuel tax agencies (*Highway Statistics*, annual) are about 3% less than the amounts reported in the EIA’s census of sales of refiners and gas-plant operators (form EIA-782A, *Petroleum Marketing Annual*, annual) (Hallquist, 1994). Hallquist (1994) believes that the FHWA estimates are lower in part because “tax avoidance causes undercounting” in the FHWA data (p. xvii), and in part because of double counting in the EIA form 782A estimates. Also, it appears to me that the FHWA estimates are lower (by about 1%) because they exclude gasoline exported and gasoline used by the military. If (say) one percentage point of the 3% difference is due to double-counting on EIA 782A, and another point is due to the exclusion of military use and exports from the FHWA but not the EIA data, then under-reporting due to tax avoidance is about 1%.

Sales 1991, 1992). I conclude, therefore, that the FHWA has not seriously underestimated consumption of diesel fuel by motor vehicles¹¹.

We now need to derive or estimate the parameters G_e , P_a , and PSF .

5.3.2 Excess fuel consumption due to traffic delay (parameter G_e)

We estimate G_e , the motor-fuel-consumption externality due to traffic delay, as the difference between the amount of fuel actually consumed during delay, and the amount that would have been consumed had traffic not been delayed:

$$G_e = G_d - G_{nd} = \frac{VMT_d}{MPG_d} - \frac{VMT_d}{MPG_{nd}} \quad \text{eq. [5-3]}$$

where:

G_e is as defined above

G_d = the amount of fuel consumed during any conditions of traffic delay (i.e., any conditions other than free flow) (10^9 gallons)

G_{nd} = the amount of fuel that would have been consumed over the mileage subject to delay had traffic been completely free flowing (10^9 gallons)

VMT_d = vehicle miles of travel subject to delay (10^9 ; estimated below as a fraction of total VMT)

MPG_d = the fuel economy of traffic during conditions of delay (miles/gallon; expression derived below, equation 5-5a)

MPG_{nd} = the fuel economy that would have been obtained over the mileage subject to delay had traffic not been delayed (miles/gallon; expression derived below, equation 5-5b)

¹¹Similarly, estimates of gasoline consumption derived from the 1987 economic Censuses are less than the FHWA's estimate of gasoline consumption in 1987. The FHWA estimates that highway vehicles used 109 billion gallons of gasoline in 1987 (*Highway Statistics 1987, 1988*). Using data from the 1987 *Census of Retail Trade, Miscellaneous Subjects*, (Bureau of the Census, 1990), and the 1987 *Census of Retail Trade, Merchandise Line Sales* (Bureau of the Census, 1990) I estimate that retail establishments sold 86 billion gallons of gasoline in 1987. Bulk plants and bulk terminals sold 93 billion gallons of gasoline wholesale in 1987 (Bureau of the Census, 1987 *Census of Wholesale Trade, Subject Series, Miscellaneous Subjects*, 1991). Although neither the *Census of Retail Trade* nor the *Census of Wholesale Trade* cover all gasoline end use (because, on the one hand, some wholesale and service establishments, which are not covered in the *Census of Retail Trade*, sell to end users, and, on the other, not all gasoline passes through a wholesaler), they clearly cover the great bulk of it, and hence the significant shortfalls between the Census estimates and the FHWA estimate do not support the hypothesis that the FHWA seriously underestimates gasoline consumption.

Of course, it is possible that the FHWA estimates are accurate, but that still, a lot of diesel fuel is illegally untaxed. If this is true, and if in the future the amount of fuel illegally untaxed fuel declines, then user payments for the highways (estimated in Report #17 of this social-cost series) will increase, regardless of what happens to tax rates.

It will be useful to express the fuel economy and VMT parameters in terms of other quantities known or at least easier to estimate. First, we will derive workable expressions for MPGd, and MPGnd, by starting with the proposition that total gallons of fuel consumed equals the gallons consumed during conditions of delay, plus gallons consumed during conditions of no delay. Then we will substitute these expressions back into equation 5-3.

$$G_t = G_d + G_{nd}^{\wedge} = \frac{VMT_d}{MPG_d} + \frac{VMT - VMT_d}{MPG_{nd}^{\wedge}} \quad \text{eq. [5-4]}$$

where:

G_t , G_d , and MPG_d are as defined above.

$G_{nd}^{\wedge}$ = the amount of fuel consumed under conditions of no delay (free flow)
(10^9 gallons)

$MPG_{nd}^{\wedge}$ = the fuel economy of vehicles under conditions of no delay (free flow)

VMT = total vehicle-miles of travel (10^9)

Note that $G_{nd}^{\wedge}$ in equation 5-4 is not necessarily equal to G_{nd} in equation 5-3, and that $MPG_{nd}^{\wedge}$ in equation 5-4 is not necessarily equal to MPG_{nd} in equation 5-3. $G_{nd}^{\wedge}$ and $MPG_{nd}^{\wedge}$ pertain to VMT that at present is not subject to delay, whereas G_{nd} and MPG_{nd} pertain to hypothetical free-flow conditions over mileage that at present actually *is* subject to delay. Generally, because VMT not subject to delay exceeds VMT that is subject to delay, $G_{nd}^{\wedge}$ will exceed G_{nd} . However, unless delay occurs disproportionately on one particular type of road (say, limited-access highways rather than city streets), the fuel economy under actual (present) free-flow conditions generally will be close to the fuel economy that would obtain over presently delayed VMT¹². So, it probably is reasonable, and certainly is analytically convenient, to assume that $MPG_{nd}^{\wedge} = MPG_{nd}$.

We now proceed as follows:

¹²Fuel economy is determined by the grade of the road, the wind speed, the condition of the pavement, traffic density, the maximum allowable speed, the number and nature of intersections, the characteristics of the vehicles, and other factors. Thus, if at present delay occurs mainly on steep, pot-holed roads with lots of intersections, the fuel economy that would obtain over these roads were the delay eliminated still would be relatively low -- lower, certainly, than the fuel economy obtained over the presently undelayed, flat, smooth, uninterrupted roads.

Let: $MPG_{nd} = k_1 \cdot MPG_d$ and $VMT_d = k_2 \cdot VMT$

Assume: $MPG_{nd}^{\wedge} = MPG_{nd}$

Then we have:

$$G_t = \frac{k_2 \cdot VMT}{MPG_d} + \frac{VMT - k_2 \cdot VMT}{k_1 \cdot MPG_d}$$

$$MPG_d = \frac{k_2 \cdot VMT}{G_t} + \frac{VMT - k_2 \cdot VMT}{k_1 \cdot G_t} =$$

$$\frac{k_1 \cdot k_2 \cdot VMT + VMT - k_2 \cdot VMT}{k_1 \cdot G_t}$$

$$MPG_d = \frac{VMT \cdot (k_1 \cdot k_2 + 1 - k_2)}{k_1 \cdot G_t}$$

eq. [5-5a, b]

$$MPG_{nd} = \frac{VMT \cdot (k_1 \cdot k_2 + 1 - k_2)}{G_t}$$

where:

k_1 = the ratio of fuel economy if no delay (for presently delayed miles) to fuel economy under delay (see parameter k below)

k_2 = the ratio of delayed VMT to total VMT (derived below)

Next, we substitute the expressions for MPGd and MPGnd (equations 5a and 5b) into the expression for Ge, from equation 5-3:

$$\begin{aligned}
 Ge &= \frac{VMTd}{MPGd} - \frac{VMTd}{MPGnd} = \\
 &= \frac{\frac{k2 \cdot VMT}{VMT \cdot (k1 \cdot k2 + 1 - k2)}}{k1 \cdot Gt} - \frac{\frac{k2 \cdot VMT}{VMT \cdot (k1 \cdot k2 + 1 - k2)}}{Gt} = \\
 &= \frac{k2 \cdot k1 \cdot Gt - k2 \cdot Gt}{(k1 \cdot k2 + 1 - k2)} = Gt \cdot \frac{k1 - 1}{k1 - 1 + \frac{1}{k2}}
 \end{aligned}$$

Let: $k1 - 1 = k$

$$Ge = Gt \cdot \frac{k}{k + \frac{1}{k2}} \quad \text{eq. [5-6]}$$

where:

Gt, Ge, and k2 are as defined above

k = the fractional increase in fuel economy, over presently delayed miles, that would result were the delays eliminated.

Finally, we can express the parameter k3 in terms of other parameters that are easier to estimate:

$$\begin{aligned}
 k2 &= \frac{VMTd}{VMT} \\
 VMTd &= VHT \times Fd \times Sd \\
 VMT &= VHT \times Fd \times Sd + VHT \times (1 - Fd) \times R \times Sd \\
 k2 &= \frac{VHT \times Fd}{VHT \times Fd + VHT \times (1 - Fd) \times R} \\
 k2 &= \frac{1}{1 + \left(\frac{1}{Fd} - 1 \right) \times R} \quad \text{eq. [5-7]}
 \end{aligned}$$

where:

VMT_d = vehicle miles of travel subject to delay (not in final equation)
 VHT = total vehicle hours of travel (not in final equation)
 F_d = fraction of total vehicle hours of travel subject to delay (discussed below)
 S_d = average vehicle speed during delay (not in final equation)
 R = ratio of average speed when not delayed to average speed during delay
 (discussed below)
 VMT = total vehicle miles of travel (not in final equation)

Leaving us with our final expression for the excess fuel consumed (G_e):

$$G_e = G_t \cdot \frac{k}{k+1 + \left(\frac{1}{F_d} - 1\right) \cdot R} \quad \text{eq. [5-8]}$$

The parameters F_d and R are estimated as follows:

LDGAs, LDDAs	LDGTs, LDDTs	HDGVs, HDDVs
Use the values for "Private vehicles, personal purposes, daily travel," in Table 4- 1 of Report #4	$F_{dLDT} = \frac{PHT1 \cdot F_{d1} + PHT2 \cdot F_{d2}}{PHT1 + PHT2}$ F_{dLDT} = the parameter F_d for light-duty gasoline and diesel-fuel trucks PHT1 = person-hours of travel in LDTs as personal household vehicles (31% of total person-hours in "Private vehicles, personal purposes, daily travel" in Table 4-1; 31% based on data in Hu and Young, 1992) PHT2 = person-hours of travel in "Light-duty trucks, no paid drivers" in Table 4-1 F_{d1} = the parameter F_d for "Private vehicles, personal purposes, daily travel," in Table 4-1 F_{d2} = the parameter F_d for "Light-duty trucks, no paid drivers" in Table 4-1	Use the values for "Heavy-duty trucks, paid drivers" in Table 4-1 of Report #4

The value R_{LDT} is calculated analogously.

Note that when we partition total cost to its external and internal components, we will designate the “high” cost case that which results in high external costs (and hence low internal costs).

5.3.3 The pre-tax cost of gasoline and diesel fuel (parameter Pa)

For our price-times-quantity estimate of cost, in this section, we need to know the average *pre-tax* price of gasoline and diesel fuel. In other sections of this report, we need to know the final retail price, including taxes. Now, the EIA reports the sales-weighted retail price of gasoline, but not diesel fuel. It also reports the pre-tax price of gasoline and diesel fuel at refinery-owned stations, but not the price at all stations. (The price at refinery-owned stations probably is less than the price at all stations, because the refinery-owned stations sell to bulk customers, who customarily are charged less per unit than are smaller volume customers.) The data situation is thus:

	gasoline	diesel
<i>pre-tax price at all stations</i>	estimate from pre-tax price at refinery-owned stations (which is reported by EIA)	estimate from pre-tax price at refinery-owned stations (which is reported by EIA)
<i>retail price (including taxes) at all stations</i>	reported by EIA	estimate as pre-tax price, above, plus all taxes

These estimates of prices are derived in Table 5-9. The pre-tax price of gasoline and diesel fuel at all stations is equal to the pre-tax price at refinery-owned stations multiplied by an adjustment factor, shown in Table 5-9. The adjustment factor is estimated such that the factor multiplied by the pre-tax price of gasoline at refinery-owned stations, plus all estimated gasoline taxes, is equal to the retail gasoline price reported by the EIA. The retail price of diesel fuel is estimated as the pre-tax price at all stations (which as mentioned is equal to the pre-tax price at refinery-owned stations multiplied by the adjustment factor) plus Federal and state excise taxes and state sales taxes.

The estimated adjustment factor of 1.08 (Table 5-9) means that, if my estimates of taxes are correct, and if the EIA’s estimate of the actual sales-weighted selling price is correct, then it must be that the true pre-tax sales-weighted price of gasoline at all stations is 8% higher than the pre-tax price of gasoline at refinery-owned stations. This is plausible, because as mentioned above refinery-owned stations sell some fuel to bulk customers.

Note that the estimate of the true pre-tax price of diesel fuel at all stations, and hence the estimate of the retail price of diesel fuel, uses the adjustment factor derived from the gasoline data. That is, I assume that the pre-tax price of diesel fuel at refinery-owned stations underestimates the price of diesel fuel at all stations by the same factor that the pre-tax price of gasoline at refinery-owned stations underestimates the pre-tax price of gasoline at all stations. That the adjustment factor for gasoline appears to be

absolutely constant over time (as shown in Table 5-9, it was identical in 1987, 1991, and 1992) suggests that there is a systematic difference between refinery-owned outlets and all outlets, and gives me confidence that the factor can be applied to diesel fuel.

5.3.4 Producer surplus associated with motor fuels (parameter PSF)

Many oil firms own relatively low-cost oil reserves, and hence earn sizeable producer surplus. In order to estimate this surplus, we need to estimate the supply curve and subtract the area under it (the resource cost) from total price-times-quantity revenues.

Leiby (1993) estimates the following nonlinear marginal cost function for oil supply:

$$P = a + \frac{b}{c - Q}$$

where:

P = the price of supplying quantity Q (\$/bbl)

a = the price below which nobody producer will supply the market

c = the upper bound on supplies (the price asymptote)

b = shape parameter

Q = the quantity of oil supplied (million barrels/day)

Given this, producer surplus PS can be estimated as:

$$\begin{aligned} PS &= P^* \times Q^* - \int_0^{Q^*} \left(a + \frac{b}{c - Q} \right) dQ \\ &= P^* \times Q^* - \left[aQ - b \times \ln(c - Q) \right]_0^{Q^*} \\ &= P^* \times Q^* - (aQ^* - b \times \ln(c - Q^*) + b \times \ln(c)) = \\ &= P^* \times Q^* - aQ^* + b \times (\ln(c - Q^*) - \ln(c)) \\ &= Q^* \times (P^* - a) + b \times (\ln(c - Q^*) - \ln(c)) \end{aligned}$$

We estimate this for U. S. production only, because any producer surplus in price-times-quantity payments from U.S. consumers to foreign producers is a real net loss of wealth to the U.S. Using Leiby's (1993) parameter values, we estimate that for U. S. oil producers PS is about 40% of price-times-quantity receipts. However, since on the order of half of all motor-fuel may be assumed to be either imported or made from imported crude oil, we want to deduct the 40% PS from about half of total fuel

consumption, which means that in effect we can assume that about 20% of price-times-quantity payments for the crude oil used to make motor-fuels is PS accruing to U. S. producers.

This, however, gives us the producers surplus in the oil industry only. We still should estimate PS in the downstream refining and marketing industries. Presumably, though, the downstream producers earn less surplus than do the oil producers, because unlike the oil producers, the refiners and marketers all probably have similar cost structures. Considering this, and allowing for uncertainty in the estimates of the domestic PS surplus fraction of crude oil in all motor-fuel, we assume that 20% to 30% of the pre-tax retail cost of gasoline and diesel fuel is PS accruing to domestic producers.

5.3.5 The cost of automotive lubricants sold at retail

I estimate the cost of automotive lubricants on the basis of retail sales reported by the Bureau of the Census.

Automotive lubricants are sold in the retail sector (SICs 52, 53, 54, 55, 58, 59), in the automotive service sector (SIC 75), and elsewhere. However, in this analysis, lubricants sold by service establishments, such as repair or lube shops, are included with the cost of parts, supplies, maintenance etc., estimated on the basis of sales in SIC 75. Therefore, the relevant total sales of lubricants, not covered elsewhere in this analysis, are those in the retail sector, reported in the Bureau of the Census *Merchandise Line Sales* series and those not covered in either the SIC 5- or SIC 75 sales data. I estimate data for 1991 by interpolating between 1987 and 1992 data (10⁹ dollars):

	1987	1992
Sales of automotive lubricants (merchandise line 730) in SICs 52, 53, 54, 55, 58, 59 (Bureau of the Census, <i>1987 Census of Retail Trade, Merchandise Line Sales</i> , 1990; <i>1992 Census of Retail Trade, Merchandise Line Sales</i> , 1995)	3.02	3.50
Sales of automotive lubricants outside of SICs 5- and 75 (my estimate, based on data in the NIPAs [Key, 1994])	0.19	0.21

Assuming that 25% of this is producer surplus (the same percentage assumed for gasoline), and interpolating linearly, the resulting cost is \$2.7 billion in 1991.

5.4 PARTS, SUPPLIES, MAINTENANCE, REPAIR, CLEANING, STORAGE, RENTING, TOWING, ETC., EXCEPT EXTERNAL COSTS OF ACCIDENTS

Our estimate of the cost of parts, supplies, maintenance, repair, and so on consists of:

- The cost of automotive services, which comprises:
 - receipts for automotive services in SIC 75

- receipts for automotive services in SIC 55
- in-house m&r expenditures by fleets
- The cost of parts and supplies, which comprises:
 - receipts for sales of new and rebuilt parts and supplies in SIC 55
 - sales of used auto parts, mainly SIC 5015
 - expenditures on merchandise used for motor vehicles but not classified as automotive merchandise
- Deductions for:
 - services in SIC 75 unrelated to motor-vehicle use
 - receipts for parking (which are estimated separately)
 - U. S. producer surplus
- An estimate of the annualized cost of long-lived repairs

Since the Census estimates of receipts exclude sales taxes, we do not have to make any adjustments for sales taxes. In the following sections we discuss each of these items.

Note that the resulting estimate will include the cost of repair and replacement due to vehicle accidents as well as costs not due to accidents. Because we estimate and separately classify and list repair costs of accidents, we must deduct from the total estimate here whatever accident costs we estimate separately, in order to avoid double counting. This deduction to avoid double counting is accomplished in the section on accident costs (5.10.4).

5.4.1 The cost of automotive services

We begin with revenues received in 1991 in SIC 75, automotive services. This SIC includes only automotive service industries: automotive rental and leasing (SIC 751), automobile parking (752), automotive repair shops (753), and automotive services except repair (754). The last includes washing, emissions testing, inspecting and diagnosing, lubricating, towing, wrecking, tinting, and rustproofing. The Census classifies establishments and presents data according to the Standard Industrial Classification system (SIC) of the Office of Management and Budget (OMB, 1987), as follows:

<i>Auto service provided by:</i>	<i>SIC grouping:</i>	<i>Sales data:</i>
establishments that	Major industry	published for the whole SIC, in the
primarily provide auto	group 75	U.S. Census' quinquennial <i>Census of</i>
services to the general		<i>Service Industries</i> and annual <i>Service</i>
public		<i>Annual Survey</i>

new-car dealers, used-car dealers, auto parts stores, and gasoline stations	Part of major group 55	included under “non merchandise receipts” in the quinquennial <i>Census of Retail Trade, Merchandise Line Sales</i>
businesses, government for their own fleets	auxiliary establishments	not available (I estimate separately below)

This is a mutually exclusive and exhaustive categorization of automotive services. Let’s address each of these in turn.

i) SIC 75. In 1991, firms subject to the Federal income tax in SIC 75 received \$71.5 billion in revenues (Bureau of the Census, *Service Annual Survey*: 1994, 1996). Apparently, there were no tax exempt firms in SIC 75.

ii) SIC 55. Some retail firms, in SIC 55, also provide automotive services. In 1987, firms in SIC 55 received \$22.24 billion for automotive services (Table 17-14 of Report #17). (I count as automotive service all “nonmerchandise receipts” in SIC 55, except sales of “parts installed in repair,” “credit life insurance and financing commissions,” and “miscellaneous merchandise”. I count parts installed in repair separately, in the next section.) This was 43.3% of the \$51.423 billion received in SIC 75 in 1987 (Bureau of the Census, *1987 Census of Service Industries, United States*, 1989). Thus, I add 43.3% to the receipts, reported above, in SIC 75 in 1991.

iii) In-house work at business and government fleets. Some business and government fleets perform maintenance and repair in house. If an in-house maintenance and repair shop does not qualify as a separate establishment in the SIC, then the cost of the work at the shop will not be included in the receipts in SIC 75 or 55.

It is difficult to estimate the cost of maintenance and repair work done in-house at government and business fleets. In Table 10-7 of Report #10, I estimate that in SIC 4212, local trucking, the \$/gallon maintenance and repair cost *excluding* the cost of in-house labor¹³ is the same as the \$/gallon cost for personal automobiles. Assuming that LDTs in SIC 4212 should have the same \$/gallon maintenance and repair cost as do personal LDAs, the estimated equality might suggest that in-house expenditures in SIC 4212 are not significant. This, however, would be an incorrect assumption, because as estimated in Report #4, people spend a lot of their personal time repairing and maintaining their cars. Thus, it is possible that there are significant in-house expenditures on maintenance and repair in SIC 4212.

On the assumption that the maintenance and repair cost per mile of travel for fleet vehicles with in-house maintenance and repair is the same as the maintenance and repair cost per mile for vehicles repaired outside, I estimate the expenditures for in-house maintenance and repair, *Mih*, as follows:

¹³The maintenance and repair expenditures reported by the Census for SIC 421 include only the amounts paid to *other firms* (Bureau of the Census, *Motor Freight and Transportation Warehousing Survey*: 1993, 1995).

$$\text{Let: } Fih = \frac{Mih}{Mih + Mo} \quad \text{eq. [5-9a]}$$

$$\text{Then: } MRih = \frac{Fih}{1 - Fih} \cdot MRo$$

Estimate Fih as

$$Fih = FMih \cdot \frac{\sum VMT_v \cdot FVMT_v}{VMT_t} \quad \text{eq. [5-9b]}$$

where:

$MRih$ = expenditures for in-house maintenance and repair (\$)

Fih = of total maintenance and repair expenditures, the fraction that is in-house
 MRo = expenditures for outside maintenance and repair (\$; revenues in SICs 75 and 55, as discussed above)

$FMih$ = of total maintenance and repair expenditures *at fleets*, the fraction that is in-house (in the absence of any data, I assume 25% to 50%)

VMT_v = total vehicle miles of travel in category v of Table 4-1 (private vehicles for personal purposes, private vehicles for business purposes, etc.)

$FVMT_v$ = of VMT in each category v , the fraction that is by fleet vehicles (I assume 1.00 for all buses, government vehicles, and private heavy-duty vehicles, 0.00 for private vehicles used for personal purposes, 0.80 for private LDTs used for business purposes, and, on the basis of data in Miaou et al. (1992), 0.60 for VMT by private LDAs used for business purposes)

VMT_t = total VMT in 1991 (Table 4-1).

iv) Personal time spent maintaining and repairing vehicles. This I classify as a personal nonmonetary cost, and estimate in Report #4.

v) One more item. Note that all motor-vehicle damage to buildings that is paid for by the responsible party is included below, under "Accident costs paid for by responsible party, but not through automobile insurance..." That is, I distinguish properly priced vehicular damage from properly priced damage to buildings in part because most analysts consider the former but not the latter, which admittedly is very small.

5.4.2 The cost of parts and supplies

New and rebuilt parts and supplies. Next, we must add in receipts for parts, supplies, tires, accessories, and the like. In Table 17-15 of Report #17, we estimate that receipts for automotive parts and supplies, including parts installed in repair in SIC 55, were \$61.7 billion (excluding sales taxes) in 1991.

Used parts and supplies. According to the Census' *Classification Manual* (Bureau of the Census, 1992), the auto and home supply stores of SIC 553 sell new and rebuilt -- but not used -- automobile parts and accessories. In support of this, the Census *Merchandise Line Sales* (Bureau of the Census, 1995), shows \$11.5 billion in sales of new and rebuilt parts in SIC 55, and only \$68 million in sales of used parts. In the Census system, sales of used parts are classified as "wholesale," and occur mainly in SIC 5015, "motor vehicle parts, used". In 1992, sales of "used automotive parts, accessories, and equipment" (commodity line 0240) were \$3.571 billion (Bureau of the Census, 1992 *Census of Wholesale Trade, Subject Series, Commodity Line Sales, United States, 1995*). I assume that in 1991 sales were 2% less.

Parts and supplies sold in non-auto stores and not classified as automotive merchandise. Finally, I account for expenditures on items, such as all-purpose tools, that are used for motor vehicles but or not sold in automotive stores or classified as automotive merchandise. I assume that expenditures on such items are 1% to 2% of the expenditures on new automotive parts classified as such.

5.4.3 Deductions

Services unrelated to motor-vehicle use. We deduct from total receipts in SIC 75 those that were for services unrelated to motor-vehicle use. Naturally, this is a very small fraction of the total. The Bureau of the Census 1992 *Census of Service Industries, Subject Series, Sources of Receipts or Revenue* (1996) breakdowns receipts in SIC 75 by source. The categories "all other receipts from customers" and "all other receipts" appear to comprise mainly non-motor-vehicle services, because all major motor-vehicle services, as well as a category "all other motor vehicle services," are listed separately. In 1992, "all other receipts from customers" and "all other receipts" were 1.7% of total receipts in SIC 75. I assume, therefore, that 1.5% of total receipts in SIC 75 were unrelated to motor-vehicle use.

Parking. We also deduct receipts in SIC 752, parking, because we count those separately in this report (section 5.8).

Producer surplus. Finally, we deduct the producer surplus that accrues to U. S. producers. I assume that most firms in this industry have a similar cost structure, and hence that producers surplus is relatively small. I assume 5% to 10% for all producers. However, foreign producers of automotive parts earn about 1/3 of all of the revenues earned from the sale of automotive parts in the U. S. (International Trade Administration, 1995). This foreign producer surplus is a real cost to the U. S. Therefore, I assume that the producer surplus that accrues to U. S. producers is 3% to 8% of total revenues.

5.4.4 Estimating the annualized cost of long-lived repairs

The cost of any long-lived repairs -- i.e., the cost of replacing any major, long-lived components of the vehicle, but not the whole vehicle -- must be annualized, just as the cost of the vehicle fleet itself is annualized. For example, the cost of replacing an engine or transmission probably should be annualized over the life of the vehicle. To annualize the cost of replacing long-lived components, I first estimate annual expenditures for major, long-lived capital replacement (as distinguished from expenditures for short-lived, operational repairs), and then annualize the fleetwide expenditures over their life¹⁴. With this method, the total cost of maintenance and repair is equal to annual expenditures on short-lived maintenance and repair plus the annualized fleetwide cost of long-lived repair and replacement.

The estimate of the annualized fleetwide cost of long-lived repairs thus begins with an estimate of annual expenditures on long-lived repairs. Here, I distinguish four kinds of expenditures:

- i) replace vehicles damaged in motor-vehicle accidents
- ii) replace major long-lived components of the vehicle damaged in motor-vehicle accidents
- iii) replace vehicles worn out at the end of their of normal life
- iv) replace major long-lived components of the vehicle worn out at the end of their normal life

I distinguish the replacement of the vehicle (items i and ii) from the replacement of major components (items iii and iv) because the former is part of the annualized cost of the vehicle fleet, already estimated as annualized cost in section 5.2.1, whereas the latter is part of the annualized cost of maintenance and repair, to be estimated in this section. I distinguish the replacement of parts damaged in accidents from the replacement of parts worn out at the end of their normal life because I estimate the annualized cost of property damage in accidents as part of my overall estimate of the cost of motor-vehicle accidents. However, I first estimate accident and non-accident component replacement costs (iii and iv) together in this subsection, and then make a separate estimate of the accident-related components in Report #19 and section 5.10.4 of this report.

¹⁴ There are two differences between an annual expenditure and the annualized fleetwide cost. The annual expenditure applies to only a portion of the fleet (because only a portion incurs the cost every year), and is capital value only, with no interest (opportunity-cost-of-money) component. The fleetwide annualized cost is the accumulated capital value of all replacements over the entire fleet over all years, converted to an equivalent annual stream that includes an interest component. On the assumption that every year the annual replacement expenditure is made on $1/L$ of the fleet, where L is the life of the replacement in the annualization calculation, then the annualized cost is equal to the annual expenditure multiplied by a factor that accounts for the opportunity cost of money.

In this subsection, we are interested in items ii) and iv), the expenditures to replace major components damaged in accidents or worn out at the end of their normal life. First we estimate the annual expenditures, and then we estimate the annualized fleetwide cost. We estimate the annual expenditures on replacing long-lived components as follows:

$$COM = CAPA \cdot COMAF \cdot (1 + COMWF) \quad \text{eq. [5-10]}$$

where:

COM = annual expenditures to replace major long-lived components (10^9 \$/year)

CAPA = annual expenditures to replace *all* long-lived capital, including complete vehicles, damaged in motor-vehicle accidents (10^9 \$/year) (section 5.10.4 and Report #19)

COMAF = of expenditures to replace all capital damaged in motor-vehicle accidents, the fraction that is for replacing long-lived vehicle components (e.g., transmissions) rather than complete vehicles themselves (I assume 0.30 to 0.40)

COMWF = expenditures to replace major components worn out at the end of their life, as a fraction of expenditures to replace major components damaged in accidents (I assume 1.5 to 2.0)

This method of relating the total capital-replacement expenditure to the expenditure to replace capital damaged in accidents ensures that the estimates of i), ii), iii), and iv) are consistent.

With these assumptions and data, I estimate that COM in equation 5-10 is about \$16 to \$26 billion. By comparison, in 1992, some \$30 billion worth of motor-vehicle parts were sold in the retail trade sector (including parts installed in repair) (Bureau of the Census, *1992 Census of Retail Trade, Merchandise Line Sales*, 1995), and some \$45 billion worth of repair and maintenance services were sold by automotive service establishments (Bureau of the Census, *1992 Census of Service Industries, Subject Series, Sources of Receipts or Revenue*, 1996).

The annualized fleetwide cost is estimated given these annual expenditures. The annualization method annualizes the value of the entire “stock” of long-lived capital replacements, for the entire fleet, over the average life of the replacement, using the standard amortization formula (equation 5-1). The capital value of the stock of long-lived replacements for the entire vehicle fleet (parameter I in equation 5-1) is assumed to be equal to annual expenditures multiplied by the average life L of the replacement, on the assumption that the yearly annual expenditure replaces $1/L$ of the fleetwide stock. The average life is assumed to be the average life of the entire vehicle fleet (Table 5-4), and the relevant interest rate (parameter i in equation 5-1) is assumed to be the fleetwide average used to annualize the cost of the vehicle fleet (Table 5-4).

5.4.5 Allocation to six classes of vehicles

The costs estimated in the preceding two sections are for the entire vehicle fleet. Unfortunately, the available data do not make it easy to allocate these costs for different vehicle classes. As a rough guide, one can use the maintenance and repair allocation factors of Table 10-3 in Report #10 of this social-cost series. These factors are estimated on the basis of personal-consumption expenditures on maintenance and repair of automobiles, and purchased maintenance and repair of trucks in SIC 421. (Note that the maintenance and repair costs of Table 10-3 are defined more narrowly than are parts, supplies, maintenance, repair, and so on here, and hence come to much lower grand total.)

5.5 AUTOMOBILE INSURANCE: ADMINISTRATIVE AND MANAGEMENT COSTS, AND PROFIT

5.5.1 An estimate of the cost

The actual resource cost of automobile insurance is the administrative and management cost of providing the insurance service. There are at least four kinds of insurance to consider:

- i) Insurance provided by private insurance companies
- ii) "self-insurance" by government
- iii) self-insurance by private companies
- iv) private insurance by posted bond

Insurance provided by insurance companies. A reasonable estimate of the administrative and management cost of automobile insurance companies is the total underwriting and claims adjustment expenses. Data on these expenses are available.

The primary source of data on premiums and expenses in the insurance industry is A. M. Best's *Aggregates and Averages, Property-Casualty*. (The Bureau of Economic Analysis uses Best's data in its National Income Product Accounts.) Table 5-10 shows Best's (1992) estimates of premiums and expenses for liability insurance and collision damage insurance for private passenger vehicles and commercial vehicles in 1991. The total expenses were \$35 billion.

Because this estimate of cost is based on company-reported expenses, rather than price-times-quantity revenues, there is no need to deduct producer surplus.

Self insurance by government and private companies. Although governments presumably are large enough that they can afford to pay automobile accident costs as they go and so do without auto insurance altogether, they still will incur some insurance-like administrative and management costs when they process payments and claims. Similarly, some large commercial fleets, such as those at universities, car rental

companies, and utility companies, are self insured, but still will incur some insurance-like administrative and management costs.

I estimate the administrative and management costs of motor-vehicle self insurance on the basis of travel by self-insured vehicles relative to travel by other insured vehicles, and the administrative and management cost of self-insurance, per VMT, relative to the administrative and management cost of other insured vehicles, per VMT.

In 1991, the VMT of government vehicles was about 1.9% of total VMT, or probably around 2.2% of VMT by all insured vehicles (Report #4). According to the EIA (1996), in the early 1990s there were 10.5 to 12.3 million vehicles in non-governmental fleets of 10 or more vehicles, including 1.1 million in utility fleets, 0.140 million taxis, and 1.75 million rental vehicles. If one-quarter of the 11 or so million vehicles in large non-governmental fleets were self insured, and if self-insured vehicles had 1.5 times the VMT/vehicle of other vehicles, then VMT by self insured non-government fleet vehicles was about 2.2% of VMT by all vehicles (based on 190 million vehicles), or about 2.6% of VMT by all insured vehicles.

Thus, I estimate that VMT by self-insured government and non-government fleet vehicles was about 4.8% of VMT by all insured vehicles, or 5% of VMT by all vehicles insured by a motor-vehicle insurance company.

Presumably, the administrative and management cost of self-insurance, per VMT of travel by self-insured vehicles, is less than the administrative and management cost of private motor-vehicle insurance companies, per VMT of travel by vehicles insured by a motor-vehicle insurance company. The self-insured do not incur the sizable brokerage and commission expenses of motor-vehicle insurance companies, and do not have to write and administer policies. Also, they probably have lower costs of claims adjustment, and perhaps even lower general overhead costs (because of shared building costs, for example). I will assume that the administrative and management cost per VMT for the self insured is one-half the cost for those insured by a motor-vehicle insurance company. With this assumption, the administration and management costs of self insurance are 2.5% of the of the actual insurance administration and management costs of automobile insurance companies.

Private insurance by posted bond. In at least some states, it is permissible to post a bond as automobile insurance. (In California, the minimum amount is \$35,000.) Because these bonds can earn interest at normal market rates, and do not require the administrative services of an insurance company, they have essentially no cost. In any case, it is likely that very few vehicles are insured by bond. For example, in California in 1989, only 126 personal passenger vehicles were insured by cash bond (Marowitz, 1991)

5.5.2 Our estimate vs. the “net premiums paid by persons” in the NIPA

Our estimate of the administrative and management cost of providing motor-vehicle insurance is not the same as the BEA’s estimate of net personal consumption expenditures on motor-vehicle insurance. In its estimate of PCEs in the NIPA, the BEA uses the A. M. Best data to calculate what it calls the “net insurance premium” paid by

persons. The net insurance premium is the difference between total premiums paid out by persons and claim reimbursements received back by persons. The BEA calculates this as follows:

- i) net premiums earned for private passenger liability insurance and private passenger collision damage insurance (Table 5-10), less
- ii) losses incurred for same (Table 5-10), less
- iii) dividends paid for same (which are a tiny amount, and not shown in Table 5-10), less
- iv) the small portion of “private passenger” insurance, as defined by Best, that is written for businesses rather than persons (Key, 1994).

Thus, the BEA estimates the net personal expenditure on automobile insurance (\$22.7 billion in 1991), not the cost of running the automobile insurance industry. Compared with our estimate, they exclude certain kinds of costs, and of course all costs of insurance for commercial vehicles.

5.5.3 Are automobile insurance prices optimal?

Although automobile insurance is provided in a reasonably competitive market, insurance prices are not necessarily optimal. The economic efficiency of the present insurance system perhaps can be improved. How much the system can be improved depends on how costly it is to get accurate, detailed information about people, vehicles and trips, and to administer a detailed, sophisticated pricing scheme. Ideally, insurance --or any charge for expected damage inflicted on others -- would be a function of the number of miles actually driven (if you did not drive, you would be charged for expected damages), the time and location of the trip, the route taken, the characteristics of the road, expected traffic conditions, the up-to-the-minute characteristics of the driver and vehicle, and other factors. (See Edlin [2002] for a discussion and analysis of related issues.) In this ideal world the driver also would be able choose at any time to purchase any type of insurance against damage to herself and her property. In the real world, however, it is too costly to set and enforce prices based on all of the determinants of expected damage cost, and so prices are based on a few key determinants, such as the age and marital status of the driver, distance from home to work, and home location. Any simplified system will omit some important determinants of expected damage. The current system, for example, does not charge per mile of actual driving. By contrast, a scheme to add a universal liability charge to the price of gasoline (see Tobias, 1993; and the *Quad Report*, 1993) would have the great advantage of making the expected-damage premium a continuous real-time function of the amount of travel, but the considerable disadvantage of failing to distinguish drivers according to the expected riskiness of their behavior.

5.7 PRICED PRIVATE COMMERCIAL AND RESIDENTIAL PARKING, EXCLUDING THE PARKING TAX

Although the vast majority of parking is unpriced (see Report #6), motor-vehicle users do pay several billion dollars per year to private parking operators. These price-times-quantity payments, less taxes and producer surplus, are the resource cost of priced private-sector parking in the U.S.

There are in principle three kinds of priced private parking to consider in this report:

- priced private on-street parking
- priced private off-street residential parking
- priced private off-street commercial (nonresidential) parking

I address each of these in turn. (The cost of unpriced or bundled private parking, such as an attached 2-car garage or free parking at a shopping center, is estimated in Report #6, and the cost of all public (municipal and institutional) parking is estimated in Report #7.

5.7.1 Priced private on-street parking

There may be some priced parking spaces on privately owned streets (for example, on streets in a gated community), but the total amount of such parking must be insignificant. I assume that the cost of parking in this category is zero. (Alternatively, one can assume that the cost of this parking is included already in the estimates of the costs of private roads, which estimates are broad and loosely defined enough to include any on-street private parking. See Report #6.)

5.7.2 Priced private off-street residential parking

As shown in the notes to Table 5-1, consumers reported spending some \$200 million on residential parking in 1991. Before I count this expenditure as a separate cost of privately owned parking, however, I must be sure that it does not double count other parking costs estimated in this report, to wit:

1). Is priced residential parking (Table 5-1) already counted in this analysis as private, off-street, unpriced residential parking? Most likely not: in Report #6, the cost of private, off-street, bundled residential parking is estimated as the average cost per space multiplied by the quantity of spaces, and the estimate of quantity specifically excludes parking spaces that are *not* included with the house or in the rent.

2). Are the payments for residential parking already counted as receipts to commercial parking operators (estimated below)? Presumably not: those who charge for residential parking probably are not parking establishments as defined by the Census classification, but rather just property owners who charge for parking separately rather than include it in the rent or ownership fee.

3). Are the payments for residential parking already counted as parking or road expenditures by government? In Report #7, we estimate the cost of public parking on the basis of Census estimates of government expenditures on parking. These government expenditures are for the provision, construction, maintenance, and operation of local government parking facilities -- public parking lots and garages, and parking meters on-street and in lots -- operated on a commercial basis (Bureau of the Census, *Classification Manual*, 1992) . They do not include expenditures for the enforcement of parking regulations, or for parking facilities connected to a specific type of facility, such as a sports stadium (counted as an expenditures for the specific type of facility) (Bureau of the Census, *Classification Manual*, 1992). Thus, unless local governments own and operate commercial residential parking facilities -- and I assume that they don't -- the payments reported in Table 5-1 for residential parking are not counted in Report #7.

However, any consumer expenditures for on-street parking permits will double-count the cost of streets, which is estimated in full in Report #7. I assume that any such double counting is minor, and ignore it.

It appears, then, that I may count most of the \$200 million expenditure on residential parking (less any taxes, which I assume to be zero, and less any producer surplus, as estimated below) as an additional cost.

5.7.3 Priced private off-street commercial parking

The cost of priced private off-street commercial parking is estimated as total revenues to commercial parking operators in SIC 752 (Bureau of the Census, *Service Annual Survey: 1994, 1996*), less my estimate of producer surplus.

The Census estimate excludes revenue from parking lots and garages that are owned and operated by municipalities, from parking lots that are part of another business (mainly airports, hospitals, restaurants, and universities), and from facilities that provide long-term or dead storage of automobiles (McKenzie, 1993; Bureau of the

Census, 1992 *Census of Service Industries*, 1994). I consider all of this excluded parking to be municipal and institutional parking, and estimate the cost in Report #7¹⁵.

As mentioned above, I have assumed that the revenues to commercial parking operators, as reported to the Census, do not include any payments from persons for residential parking. I also assume that any potential double counting or undercounting of municipal parking costs also is small¹⁶.

5.7.4 Total cost of private commercial and residential parking

I thus estimate the total cost as follows:

Payments for on-street private parking	0.00
Payments for off-street private residential parking	0.20
Parking revenues received by commercial parking facilities in 1991 (local taxes excluded) (10 ⁹ \$)	3.305
My estimate of the fraction that is producer surplus	0.10
<i>Estimated cost of priced private commercial off-street parking (10⁹ \$)</i>	<i>3.2</i>

5.8 TRAVEL TIME, EXCLUDING TRAVEL DELAY IMPOSED BY OTHERS, THAT DISPLACES PAID WORK

5.8.1 Background

The value of the time that people spend in their cars and trucks is the single largest item in my cost accounting. In this study, we estimate that all travel time in motor vehicles (including compensation of professional drivers) is worth roughly one trillion dollars annually.

In general, the cost of any travel time, whether monetary or nonmonetary, personal or external, can be estimated simply as the amount of travel time, in hours,

¹⁵Some institutional parking, such as that provided by private universities, arguably should be classified as private parking, and (if priced) included in this report. However, the amounts involved are relatively small, and the distinction in this case between public and private is relatively unimportant.

¹⁶The municipal parking excluded here is not quite the same as the municipal parking included in Report #7. The *Service Annual Survey* estimates of revenues to “commercial” operators include revenue from municipally owned but privately run facilities if the private operator provides the management and operating staff, but not if the private company provides only the management staff (McKenzie, 1993). Given that in its *Government Finance* series, the Census reports local government expenditures for parking facilities, we may conclude that neither the *Service Annual Survey* estimates of private parking revenues nor the *Government Finance* estimates of public parking expenditures cover the cost of private management at publicly owned and operated facilities. It also might be the case that the public expenditures for “ownership” are in essence double counted in the revenues received by facilities publicly owned but privately run.

multiplied by the cost per hour of travel. Total travel time can be estimated in a straightforward manner from data on travel times or data on average speeds and distances (see Report #4). It is not so straightforward, however, to separate the externality of travel delay from the total travel time (see the discussion in Report #4 and Report #9). And the cost per hour of travel time is considerably more difficult yet to define and measure.

In this section of this report, I estimate the value of travel time (excluding travel delay) that displaces paid work, and the cost of driver time in light-duty and heavy-duty commercial trucks. The value of travel time, excluding travel delay, that displaces unpaid activities, is estimated in Report #4. External costs of travel delay are included with the items estimated in Report #8 and Report #9, but actually are detailed in Report #4.

5.8.2 The cost per hour of travel time: concepts.

We may define the cost of travel time as the social willingness to pay (WTP) to have the travel time reduced to zero, all else (including access) equal. In principle, this cost, or social WTP, has two components: an opportunity-cost component, and a hedonic component (Hensher, 1997).

The opportunity cost is the value of activities foregone while in the car. Analytically, it is useful to distinguish monetary, or *paid* activities foregone, from nonmonetary, or *unpaid* activities foregone, because the dollar value of the paid activity is explicit, whereas the dollar value of the unpaid activity has to be estimated by non-market valuation or indirect market methods. Note that, if one is able to do in the car precisely what one would do were travel time reduced to zero, then there is no opportunity cost. Because the magnitude of the opportunity cost depends precisely on what is being foregone, it will vary considerably across individuals and trips. For simplicity, I will consider only two general kinds of foregone activities: leisure, or unpaid activities, and paid productive work. I will estimate the value of both with respect to the individual's income.

The hedonic cost is the pure utility or disutility of the motoring experience itself. The hedonic cost is determined by several factors, including comfort, safety, privacy, available space, amenities, and the amount of effort and attention required to control or in general worry about a vehicle. However, because the hedonic cost is non-monetary, I include the entire amount with our estimates of non-monetary time costs, in Reports #9 and #4. Here, I estimate only the monetary opportunity cost of travel time.

See Report #4 for further discussion.

5.8.3 Categories of travel, by type of vehicle, according to the data.

Because the cost per hour depends on the type of trip and the income of the traveler, I estimate cost per hour and travel time for several different kinds of trips and

trip-makers. In the first instance, I distinguish travel in the following general categories¹⁷:

- Private vehicles, for personal purposes
 - daily travel (LDAs, LDTs)
 - long trips (LDAs, LDTs)
- Private vehicles, for business purposes
 - LDAs (without paid drivers)
 - LDTs, without paid drivers
 - LDTs, with paid drivers
 - HDTs (with paid drivers)
- Buses
 - intercity and transit buses
 - school buses
- Public (government) vehicles
 - federal civilian vehicles (LDAs, LDTs, HDTs)
 - federal military vehicles (LDAs, LDTs, HDTs)
 - state and local civilian vehicles (LDAs, LDTs, HDTs)
 - state and local police vehicles

Within each travel category, I estimate the portion of the total travel time that is due to delay (an external cost), and the portion that is not, and the portion of travel that displaces paid work, and the portion that displaces unpaid activities. The portion that is not due to delay and that displaces paid work is a monetary non-external cost, and is estimated next.

5.8.4 Estimating the cost

In each vehicle travel category, the monetary time cost of travel, excluding delay, is calculated simply as the total travel time, less person-hours of delay (which are externalities, and treated in Reports 8 and 9), multiplied by the fraction of travel time that displaces monetary (paid) activities rather than unpaid activities, and by the cost per hour of the foregone monetary activities:

$$TTC_{im} = (PHT - PHT_d) \cdot \left(\frac{1}{Oc} + \left(1 - \frac{1}{Oc} \right) \cdot Pa \right) \cdot Fm, dr \cdot Cm \quad \text{eq. [5-11]}$$

where:

¹⁷Hensher et al. (1990) distinguish four kinds of trips: 1) private commuting to work in household vehicles; ii) commuting to work in company-supplied vehicles; iii) travel as a part of work; and iv) non-work related personal travel. They distinguished between commuters using private vehicles and commuters using company vehicles because the latter have a higher income than the former, and are willing to pay a higher percentage of that income to save time.

TTCim = the internal, monetary travel-time cost (10^9 1991\$)
 PHT = total person-hours of travel time (10^9 person-hours of travel; Table 4-1, Report #4)
 PHTd = person-hours of delay (the travel-time externality) (10^9 person-hours of delay; Table 4-1, Report #4)
 Oc = average vehicle occupancy (persons/vehicle; Table 4-1, Report #4)
 Fm,dr = the fraction of travel time that displaces monetary (paid) activities rather than unpaid activities, for drivers (Table 4-1, Report #4)
 Pa = the ratio of parameter Fm for passengers to Fm for drivers (Fm,pa/Fm,dr; Table 4-1, Report #4J)
 Cm = the cost of the foregone monetary (paid) activities (\$/person-hour; discussed below; shown in Table 4-1, Report #4)

5.8.5 The cost of foregone monetary activity (parameter Cm).

In Report #4, I assume that Fm,dr is equal to zero for three of the vehicle travel categories: daily travel in private vehicles for personal purposes; long trips in private vehicles for personal purposes, and travel in school buses. Thus, for these three travel categories, there is no need to estimate Cm, the monetary cost per hour. In the following sections, then, I will estimate Cm for the remaining categories.

Private LDAs and LDTs, without paid drivers, used for business purposes, and government vehicles: concepts. As Hensher et al. (1990) note, “the value to the community of an employee spending less time traveling and more time in productive work is...approximately equal to the full wage rate” (p. 154), which in their analysis is the pre-tax salary plus 34% for benefits and other compensation. I will use as an approximation of the value of foregone productivity during business or government travel the present average hourly compensation rate in private industry or in the public sector.

Table 5-11 shows my estimates of average compensation rates by SIC classification. The travel time costs of Table 4-1 are taken from the compensation rates of Table 5-11, as follows:

Table 4-1 category:	Private LDAs and LDTs without paid drivers, used for business	Federal civilian vehicles	Federal military vehicles	State and local civilian vehicles
Table 5-11 value, low:	Private industry	Government: federal non-military	Government: federal military	Government: state and local
Table 5-11 value, high:	Finance, insurance, real estate	Government: federal non-military	Government: federal military	Government: state and local

Note that these average compensation rates are but approximations of the value of the foregone productivity, because there is no reason to believe that the productivity that actually is foregone as a result of business or government travel is the same as the

“average” productivity represented by the average compensation rate. In the first place, it may be that the business people who travel a lot tend to be less productive per hour (when they are not traveling) than is the average private-sector employee. Ideally, in order to estimate the cost of time in business and government travel, I would make a detailed list of occupations, and get data on the amount of employee travel and the specific compensation rate in each type of occupation. Unfortunately, neither travel times nor full compensation rates are known for specific occupations, and so instead I estimate travel time and compensation rates for the broad categories shown in Table 4-1.

Beyond that, even if in every business travel time is the same fraction of total work time, the value of any productivity foregone by travel still is not be equal to the average compensation rate, because the work that actually is foregone at the margin is not necessarily of the same type and value as that done on average. Indeed, if marginal productivity is not constant, and is a function of the amount of work time, then one can presume that productivity foregone during travel generally is of lower value than is the average productivity.

Nevertheless, I ignore these complications, and use average hourly compensation rates as shown. I base the estimate on the full hourly rate of employee compensation -- gross wages and salaries, tips, bonuses, benefits, and employer-paid taxes (about 20% higher than gross wages and salaries) -- and not after-tax take-home pay, because that is the full cost of the employee to the employer, and in principle equals the marginal productivity of the employee (Button, 1993; Hensher et al. 1990).

Private LDAs and LDTs, without paid drivers, used for business purposes, and government vehicles: estimates. My estimates of full hourly compensation, shown in Table 5-11, are derived from data from the National Income Product Accounts of the U.S., for 1990 (NIPA). The NIPA show total employee wages, total compensation, and total hours in industries classified according to the Standard Industrial Classification SIC) (*Survey of Current Business*, July 1992). Table 5-11 shows data from the NIPA for several SIC categories relevant to this analysis: all employment; all private industry; transportation and utilities; trucking and warehousing; finance, insurance, and real estate; services; private household services; federal civilian, federal military, and state and local government. I have included the full compensation in private-household services for comparison with my estimate of the value of personal travel time. I have included the full compensation rate in finance, insurance, and real estate as an alternative (high-cost) measure of the value of business-travel time, on the assumption that employees in those industries travel a lot.

Table 5-11 compares wage and compensation data from the NIPA with data from the BLS's *News*, “Employer Costs for Employee Compensation”, the BLS's *ES-202Employment and Wages Annual Averages*, and the BLS's Current Population Survey (CPS). Of the three BLS data series, only the “Employer Costs for Employee Compensation” reports full employee compensation as well as employee wages. The compensation data in the NIPA are preferable to those from the BLS *News*, “Employer Costs for Employee Compensation,” because the measure of total compensation in the

NIPA appears to be more comprehensive than the measure in the BLS. For example, it appears that the NIPA counts as part of “wages” the cash value of lodging and meals, items which the BLS’ “Employee Costs for Employee Compensation” *News* apparently does not count at all, as a wage or a benefit. Perhaps in part because of this, the average hourly compensation rate reported in the NIPA is higher than the hourly wage reported in the BLS’s “Employee Costs for Employee Compensation” *News* (Table 5-11).

Some of the NIPA data are derived from the ES-202 data collected by the BLS (*Employment and Wages Annual Averages 1990, 1991*). (See the *BLS Handbook of Methods*, 1992, for more information.) As shown in Table 5-11, the NIPA data generally agree with the BLS ES-202 data¹⁸. However, with one important exception, the NIPA data do not agree well with BLS data reported by occupation, from the CPS (Table 5-11, last column). (They do not agree because “wages” in the NIPA are defined differently than are “earnings” in the BLS occupation data, and the SIC categories of the NIPA cover different workers than do the occupation categories of the BLS.) The important exception is that NIPA-reported average wages for trucking and warehousing are nearly the same as BLS-reported average weekly earnings for transportation and material moving occupations (Table 5-11). This agreement is important because, as I explain next, I use the occupational earnings data to estimate the cost per hour of commercial truck driving.

For more details on the data of Table 5-11, see the Appendix to this report.

LDTs and HDTs with paid drivers The cost of an hour of a truck-driver’s time should be analyzed separately from the cost of an hour of a business traveler’s time, because the truck driver produces driving, which is valued directly by the driver’s compensation rate. That is, the full compensation paid truck drivers is a good, direct estimate of the social cost of an hour of a truck-driver’s time.

The cost of truck driving is the social value of whatever else the drivers would do were they not driving. At the margin, the social value of the next best productive alternative is equal to the compensation actually paid the truck drivers. That is, the compensation actually paid the drivers *is* the value of the driver’s next best opportunities.

There are no data on the full hourly compensation rate for truck drivers specifically. However, the Bureau of Labor Statistics does report the 1990 average weekly *earnings* of drivers of light-duty trucks, and the average weekly earnings of drivers of heavy-duty trucks (Bureau of Labor Statistics, unpublished tabulations, 1993). I can derive an estimate of the hourly compensation rate by scaling the weekly earnings of truck drivers by the ratio of hourly compensation to weekly earnings in the whole Trucking and Warehousing SIC. Specifically, assuming that the transportation and materials-moving profession (BLS occupation data of Table 5-11) corresponds to the

¹⁸The NIPA and the BLS disagree on two wage categories: state and local government employees, and private-household employees (Table 5-11). I am unable to explain this discrepancy.

SIC for trucking and warehousing, I estimate the full compensation rate for drivers of trucks as:

$$ACtd = AWEtd \cdot \frac{HCtw}{AWEtm} \quad \text{eq. [5-12]}$$

where:

ACtd = the average compensation rate for drivers of light-duty or heavy-duty trucks (\$/hour)

AWEtd = the average weekly earnings of drivers of light-duty or heavy-duty trucks (\$377/week for drivers of LDTs, \$477/week for drivers of HDTs; Bureau of Labor Statistics, unpublished tabulations, 1993)

HCtw = the hourly compensation rate in the trucking and warehousing industry (\$/hour, from Table 5-11; row: Trucking and Warehousing; column: Data from the National Income Product Accounts (NIPA) of the United States, 1990, \$/hour compensation)

AWEtd = the average weekly earnings of all persons in the transportation and materials-moving profession (\$/week, from Table 5-11; row: Trucking and Warehousing; column: BLS occupation data, \$/week, earnings)

Note that the average weekly wage in the trucking and warehousing industry is virtually the same as the average weekly earnings in the transportation and material moving occupation (Table 5-11). This gives me confidence that the NIPA estimate of total compensation in the trucking and warehousing industry is the appropriate measure of the cost of travel time in the trucking industry.

Note that, because truck drivers are paid to produce driving, they are compensated for all of the personal resources, including attention, that they must devote to driving, and hence are compensated for the pure utility or disutility of the driving experience -- a type of the hedonic cost mentioned above. If driving were much more demanding and stressful than it actually is, drivers would be paid more; if it were virtually effortless, they would be paid much less. (By contrast, the value of the productivity *foregone* by the business traveler does not, by definition, include the disutility of the driving.). This means that the “extra” hedonic cost of driving commercial trucks is zero.

Intercity and transit buses. To estimate the cost of paid travel time of passengers on intercity and transit buses, I assume that the ratio of the paid (monetary) time cost to the unpaid (non-monetary) time cost for travel in buses equals the same ratio for travel in private LDAs used for business purposes (data in Table 4-1; non-monetary time costs are discussed in Report #4). To estimate the cost of the bus driver’s time, I use equation 5-12 but with the variable AWEtd defined to be the average weekly earnings of bus drivers in 1990, as reported by the Bureau of Labor Statistics (\$394/week; BLS, unpublished tabulations, 1993).

Police vehicles. I assume that the value of police activities foregone on account of travel in police vehicles is the full hourly compensation rate for police officers. I estimate the full compensation rate for police officers as I estimate it for truck drivers:

$$ACp = AWEp \cdot \frac{HCa}{AWEa} \quad \text{eq. [5-13]}$$

where:

ACp = the average compensation rate for policeman (\$/hour)

AWEp = the average weekly earnings of police and detectives (\$553/week; Bureau of Labor Statistics, unpublished tabulations from the Current Population Survey, 1993)

HCa = the average full hourly compensation rate of all employees (\$/hour, from Table 5-11; row: all employees; column: Data from the National Income Product Accounts (NIPA) of the United States, 1990, \$/hour compensation)

AWEa = the average weekly earnings of all workers (\$/week, from Table 5-11; row: all employees; column: BLS occupation data, \$/week, earnings)

Deduction to avoid double counting the cost of police-officer time in patrol cars. In Report #7, on government expenditures on motor-vehicle goods and services, I have estimated the cost of all police time -- including time in police cars -- devoted to patrolling highways, enforcing traffic laws, and preventing and investigating motor-vehicle related crimes. The cost of police travel time that is part of the total motor-vehicle police cost of Report #7 double counts some of the cost of police travel time estimated here. But how much is double counted?

Here, we estimate the cost of all police time in motor vehicles. In Report #7, our estimates of police costs related to motor-vehicle use include, implicitly, the cost of police travel time that is related one way or another to the public's use of motor vehicles. Thus, the question becomes: what fraction of total police travel time is related in anyway to the public's use of motor vehicles -- for that fraction already is included in the estimates of Report #7, and hence should be deducted here. In Report #7, I estimate that about 30% of the total expenditures on police (all police activities, for all purposes) can be attributed to the public's use of motor vehicles. On the basis of this, I assume that 30% of the total cost of police time in police vehicles already is counted in my estimate of police expenditures attributable to the public's use of motor vehicles in Report #7 (summarized in Table 1-7 of Report #1). Thus, I here deduct 30% of total police time cost in travel.

I recognize, but do not analyze, the possibility of double counting (once in Table 1-7, and once again in Table 1-9 or 1-4, of Report #1) the time spent in fire vehicles and other public vehicles (e.g., public cars driven by judges) used for motor-vehicle related purposes, such as putting out car fires, or trying cases involving drunken driving.

I also assume, for the reasons discussed above in relation to truck-driver time, that the hedonic cost of time in police cars is zero.

5.9 OVERHEAD COSTS OF BUSINESS, TRUCKING, AND GOVERNMENT FLEETS

Fleets have several kinds of “overhead” costs on top of the costs analyzed in the preceding sections. For example, the total operating costs in SIC 421, “Trucking and Courier Services,” include lease and rental of buildings and non-transportation equipment, fuel for heat and power, salaries of management and office staff, insurance for and maintenance of buildings and nontransportation equipment, and drug and alcohol testing programs (Bureau of the Census, *Motor Freight Transportation and Warehousing Survey: 1991, 1993*). Large Federally owned fleets also have similar overhead costs (Frisbee, 1994). As shown in Table 5-3, these overhead costs are a substantial fraction of total operating costs.

In Table 5-3, the difference between the “net” operating cost, which includes only direct transportation costs (vehicles, fuel, drivers, insurance, maintenance and repair...no overhead), and total cost including overhead (buildings, equipment, electricity..) is \$0.20 to \$0.25 per mile. I assume that all of this difference (\$0.05/mile) is a cost of the motor-vehicle fleet, and then multiply it by total VMT by fleet vehicles (calculated as: $\sum_v VMT_v \cdot FVMT_v$, from equation 5-9b) to obtain an estimate of the total dollar overhead cost of fleets. I also assume that the cost per mile includes any interest charges pertinent to any long-lived capital.

Whether or not a particular overhead cost should be counted as a cost of motor-vehicle use depends on whether or not the cost would be different, by some measure, if a different transportation mode were used. For example, one can argue that any freight-shipping concern, regardless of the mode of shipment that it employs, requires buildings and office supplies and accountants, and hence that the cost of these should be attributed to freight movement in general, not to any particular mode of shipment. I believe, though, that the exact amount of this overhead (measured in dollars per ton or ton-mile shipped, dollars per dollar of revenue, or something similar) probably does vary, if only slightly, from mode to mode, and so technically is a cost of each particular mode. I have included overhead costs in this analysis. (Note that overhead does not include in-house maintenance and repair at business and government fleets; this is counted separately above under “parts, supplies, maintenance...” It also does not include the administrative cost of self-insurance for motor vehicles, which again is counted separately elsewhere in this report.)

5.10 PRIVATE MONETARY COSTS OF MOTOR-VEHICLE ACCIDENTS

5.10.1 Background

In 1991, motor vehicle accidents damaged nearly 30 million motor vehicles, injured nearly 6 million people, and killed 42,000 people (Report #19; based on Blincoe [1996], and Blincoe and Faigin [1992]; see also Miller [1997].) This property damage, injury, and death cost society several hundred billion dollars in medical expenses, lost productivity, vehicle repair and replacement, pain and suffering, and lost quality of life. In our entire social-cost analysis, only travel time is more costly.

As presented in Reports #1 and #19, I distinguish several kinds of costs of motor-vehicle accidents:

- i) *personal (or private) nonmonetary* costs, such as pain and suffering due to injuries from accidents that are not externalities;
- ii) *private monetary (or priced)* costs, such as privately borne vehicle repair and replacement costs;
- iii) *external monetary* costs, such as vehicle repair costs inflicted by uninsured motorists; and
- iv) *external nonmonetary* costs, such as pain and suffering inflicted as an externality

In this major section, I report costs in the second category, private monetary costs. I distinguish two kinds of private monetary costs: user payments for accident costs inflicted on others, and private monetary costs excluding user payments. The user payments consist mainly of payments for motor-vehicle liability insurance. The other private monetary costs are those monetary costs, mainly medical costs and property damage costs, that are not externalities.

5.10.2 Methods used to estimate private monetary costs excluding user payments

This subsection presents an overview of the methods used estimate the non-external monetary costs of motor-vehicle accidents, including user payments for costs inflicted on others. Report #19 in the social-cost series presents a comprehensive analysis of the total and marginal private and external costs of motor-vehicle use in the U. S., including total private monetary costs. Here, I present the bare essence of the social-cost calculation from that report: the number of incidents multiplied by the non-externality fraction and the private monetary cost per incident, plus any appropriate user payments towards costs inflicted on others:

$$\begin{aligned} TCPM &= UP + \sum_i I_i \cdot (1 - EXT_i) \cdot SCIPM_i & \text{eq. [5-14]} \\ SCIPM_i &= \sum_{mc} SCI_{i,mc} \cdot PCF_{i,mc} \\ UP &= (ALI - UIM + OP) \cdot UPF \end{aligned}$$

where:

TCPM = total private monetary cost of motor-vehicle accidents in the U. S. in 1991 (\$)
 UP = appropriate user payments towards accident costs inflicted on others (\$) (discussed below)
 I_i = number of incidents of severity class i (based partly on Blincoe [1996], as documented in Report #19)
 EXT_i = of the total number of incidents of severity i , the fraction that is an externality (see Report #19)
 $SCIPM_i$ = the private monetary social cost per incident of severity i (\$/incident)
 $SCI_{i,mc}$ = the social cost per incident of severity i and monetary cost type mc (\$/incident) (based on Blincoe [2002] as documented in Report #19)
 $PCF_{i,mc}$ = of the total social cost per incident of severity i and monetary cost type mc , the fraction that is a private cost (Report #19)
 ALI = automobile liability insurance payments (\$) (discussed below)
 UIM = payments for coverage against uninsured motorists (\$) (discussed below)
 OP = other kinds of payments (\$) (discussed below)
 UPF = of total ALI+OP payments, the fraction that is (in effect) an efficient user payment for potential external damages inflicted by drivers (see Report #19 and brief discussion below)
 subscript i = the accident severity class, representing one of six types of injuries, or fatalities, or vehicles involved in property-damage-only (PDO) crashes:

PDO	Property damage only
MAIS 0	person uninjured, in an accident in which at least one person is injured or checked for injury (by contrast, a PDO accident is one in which nobody is injured or checked)
MAIS 1	a minor injury (e.g., 1st-degree burn)
MAIS 2	a moderate injury (e.g., major abrasion)
MAIS 3	a serious injury (e.g., multiple rib fracture)
MAIS 4	a severe injury (e.g., spleen rupture)
MAIS 5	a critical injury (e.g., spinal cord injury)
Fatality	Death within 30 days of accident

where MAIS = maximum abbreviated injury scale

subscript mc = the kinds of monetary costs: medical, premature funeral, emergency services, vocational rehabilitation, market productivity, insurance administration, workplace cost, legal/court costs, property damage

The calculation of the unit cost of property damage distinguishes long-lived from short-lived repairs, because the former are annualized over the life of the vehicle (see 5.4.4 for a discussion of the methods used in this annualization calculation). Also, to avoid double counting, the cost of repairing property damaged in motor-vehicle accidents must be deducted from the total cost of vehicle maintenance and repair estimated in section 5.4. Similarly, the administrative costs of motor-vehicle insurance related to motor-vehicle accidents must be deducted from the total administrative costs of insurance estimated in section 5.5. Both of these deductions are discussed below.

5.10.3 Motor-vehicle user payments for the cost of motor-vehicle accidents inflicted on others

In Report #19, user payments are estimated as payments for automobile liability insurance (ALI), less payments for uninsured motorist coverage (UIM), plus other payments such as out-of-pocket payments (OP). Uninsured motorist coverage is excluded because it is a defensive expenditure by the persons who bear the damages, not payments by persons responsible for the costs.

ALI: Payments for liability insurance are equal to liability insurance premiums earned by the insurance industry. In 1991, automobile insurance companies earned \$50.0 billion in premiums for liability insurance for private passenger vehicles, and \$11.9 billion in premiums for liability insurance for commercial vehicles (A. M. Best, 1992).

UIM: In a study of uninsured motorists, Marowitz (1991) estimated that, in California in 1988, 88% of the personal passenger vehicles with liability insurance had uninsured motorist coverage, at an average premium of \$75/year. The average premium for liability insurance, apparently *excluding* the uninsured motorist coverage, was \$370/year. Hence, in California in 1988, premiums for uninsured motorist coverage for personal passenger vehicles were $(75 \cdot 0.88) / (370 + 75 \cdot 0.88) = 15\%$ of total liability insurance premiums (*including* uninsured motorist coverage). Assuming that this 15% applies to all vehicles in the U. S. in 1991, I estimate that national payments for uninsured motorist coverage were $\$61.9 \cdot 0.15 = \9.5 billion.

OP: To estimate out-of-pocket payments, I use the results of a major survey of compensation for accidental injuries in the U. S. (Hensler et al., 1991). The overall results of the survey are presented in Table 5-12 but are analyzed in Report #19. My analysis of that survey indicates that out-of-pocket liability payments are 8% of insurance company payments. Given this, I assume a range of 5% to 10%, or \$3 to \$6 billion in 1991.

UPF. In order for a user payment to eliminate a potential externality and hence be counted here as a private monetary cost of accidents, it must be understood by the user – the driver – to be a cost of the action in question. (This follows immediately from the definition of an externality as an unaccounted for cost of an action.) Now, we have just noted that motor-vehicle users pay liability insurance, which is meant to cover damage inflicted by users on others. However, liability insurance payments generally are paid in a lump sum, and not per trip or per mile of travel, and hence are not necessarily viewed

by drivers as costs of any particular decision to drive¹⁹. In effect, only a portion of liability insurance premiums may function as efficient user payments.

Given this, our method is to estimate efficient user payments as some fraction of payments for liability insurance and other out-of-pocket payments covering accident costs. Specifically: if the application of a true per-mile Pigovian tax on accidents would reduce accident costs by X compared with having no payments for accident costs of any kind, and if actual out-of-pocket payments and payments for liability insurance reduce accident costs by Y miles compared with having no payments for accident costs of any kind, then the efficient user-payment fraction UPF is the ratio of Y to X. It is almost certain that this ratio is greater than zero and less than 1.0, but further narrowing of the range would require simulations, and I am not aware of any that address this issue²⁰. In the absence of such simulations, I assume a broad range of 0.25 (high-cost case) to 0.75 (low-cost case) for the value of this parameter²¹.

5.10.4 Deducting automobile insurance administrative costs and property damage costs counted elsewhere as costs of motor-vehicle accidents

Motor-vehicle insurance administration. In Report #19, the estimate of the cost of motor-vehicle accidents includes an estimate of the administrative costs associated with processing automobile insurance claims resulting from motor vehicle accidents. But this amount also is included in the total management and administration cost of motor-vehicle insurance, estimated in this report. Therefore, to avoid double counting the accident-related administrative costs of automobile insurance companies, I deduct it from the total management and administration cost estimated here. The deduction, along with the deduction for double-counted property damage (next paragraph) is shown in Table 5-13.

Property damage. In Report #19, the estimate of the cost of motor-vehicle accidents includes an estimate of the cost of property damage resulting from motor-vehicle accidents. But this vehicle repair and replacement cost due to accidents also is included in the total cost of all vehicle parts and services (section 5.4) or the total

¹⁹ Edlin [2002] makes this argument, and goes on to estimate the welfare gains of charging insurance per mile rather than as an annual lump-sum amount.

²⁰ Edlin (2002) estimates the benefits of switching from the current system of fixed annual insurance payments to a system of paying per mile, but he does not estimate the benefits of either compared with no payments of any kind. (Indeed, he assumes that the current system has no effect on driving decisions and accidents.)

²¹ The *remaining* fraction of insurance and out-of-pocket payments (the portion that is not an efficient user payment) is ignored here, because it does not cancel potential externalities, and as a private cost that is not balancing a user payment it would double count other damages. The inefficient payments are just transfers from one party to another, with little economic significance. (One might argue that some portion of these non-efficient payments would change a nonmonetary private cost to a monetary private cost, but this is an unnecessary complication and is ignored here.)

replacement cost of the vehicle fleet (section 5.2) Therefore, to avoid double counting the accident-related property damage costs, I deduct them from total “Goods and services priced in the private sector.” The estimated property damage costs are then included with the total private monetary costs of accidents (estimated in this major section) or the total monetary external costs of accidents (Report #8). I also distinguish property damage that results in long-lived repair or replacement from damage that results in short-lived repairs, because the former should be amortized over the life of the repair or replacement.

Thus, we end up with the following mutually exclusive, exhaustive, and properly apportioned accounting of motor-vehicle property-damage costs:

Type of property damage	Treatment in general category “Goods and Services Priced in the Private Sector”	Treatment in general category “Monetary External Costs”
property damage that results in short-lived repair	1) Full amount included in estimates of “Parts, supplies, maintenance, repair...” 2) Non-external-cost portion included in estimates of “Private monetary costs of motor-vehicle accidents...” 3) Full amount included in “Deduction to avoid double-counting property-damage costs..”, to avoid double counting the quantity once under item 1) and again under item 2) or under “Monetary External Costs” general category	External cost portion deducted from “Goods and Services Priced in the Private Sector” general category and included in this general category as part of line item “Accident costs <i>not</i> accounted for by responsible party...” (Report #8)

Property damage that results in long-lived repair or replacement (annualized value of)	1) Full amount included in estimates of "Parts, supplies, maintenance, repair..." or "Annualized cost of the entire car and truck fleet..." 2) Non-external-cost portion included in estimates of "Private monetary costs of motor-vehicle accidents..." 3) Full amount included in "Deduction to avoid double-counting property-damage costs..", to avoid double counting the quantity once under item 1) and again under item 2) or under "Monetary External Costs" general category	External cost portion deducted from "Goods and Services Priced in the Private Sector" general category and included in this general category as part of line item "Accident costs <i>not</i> accounted for by responsible party..." (Report #8)
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The deduction of the cost repairing or replacing vehicles damaged in motor-vehicle accidents, as well as the separately included private cost of motor-vehicle accidents, is shown in Table 5-13

The method of estimating the annualized cost of long-live capital replacements is described in section 5.4.4. Equation 5-10 in that section has a parameter, CAPA , which is expenditures to replace *all* long-lived capital, including complete vehicles, damaged in motor-vehicle accidents. That parameter is estimating by multiplying total property damage costs in each accident severity category by the fraction of the total that represents replacement of long-lived capital. I assume that most accidental property damage results in long-lived replacement, and that this long-lived fraction is higher for crashes with fatalities or serious injuries. In support of these assumptions, I note that in 1991, 73% of vehicles involved in fatal crashes had "disabling damage," and only 2.6% had no damage (NHTSA, 1993). My specific assumptions regarding the long-lived capital fraction in each severity class are:

<u>PDO</u>	<u>MAIS 0</u>	<u>MAIS 1</u>	<u>MAIS 2</u>	<u>MAIS 3</u>	<u>MAIS 4</u>	<u>MAIS 5</u>	<u>Fatality</u>
0.50	0.50	0.60	0.60	0.75	0.85	0.85	0.90

5.11 DEDUCTION OF TAXES AND FEES INCLUDED IN THE PRICE-TIMES-QUANTITY ESTIMATES ABOVE

The estimates above of the supply cost of motor-vehicles goods and services exclude retail sales taxes, and federal, state, and local excise taxes on motor fuels.

However, because they are price-times quantity estimates, they still include taxes “embedded” in the price: namely, excise, income, or property taxes paid by producers. For example, our estimate of the supply cost of gasoline excludes retail sales taxes and the motor-fuel excise tax, but it includes the cost of corporate income taxes paid by oil companies, and environmental excise taxes paid by oil producers. Similarly, our estimate of the supply cost of motor vehicles excludes sales taxes, but includes gas-guzzler taxes and emission-certification fees.

These embedded taxes and fees should not be included in an estimate of the true private-sector resource cost of motor-vehicle goods and services because they either are transfers from the private sector to the government, or else inefficient charges for government services. If they are the latter, then the tax does not properly represent the cost of the service, and the best way to do the accounting is to eliminate the tax from the private-sector ledger and perform a separate estimate of the actual cost of the government services and record the estimated cost in public-sector ledger.

In Report #17, we identify virtually all tax and fee payments, of any kind, related to motor-vehicle use. Below, we reproduce our listing of those tax and fee payments, and note whether or not the tax or fee is embedded in the estimates above of the private-sector supply cost of motor-vehicle goods and services.

<i>Tax or fee</i>	<i>Embedded in supply costs estimated above?</i>
FHWA-estimated federal, state, and local payments by hwy users	The tire tax is embedded, but the others are levied on users, or else paid like sales taxes, and so are not included
Interest earnings on invested payments	No, this is interest on user payments
Taxes and fees dedicated to nonhighway purposes	No, motor-fuel taxes are not included in the estimates above
Special property taxes dedicated to hwys	No, these are separate taxes on users
Other imposts dedicated to hwys	No, these are separate taxes on users
Extra amount due to Oct. 93 \$0.043/gal tax increase	No, motor-fuel taxes are not included in the estimates above
Extra amount due to less tax evasion	No, motor-fuel taxes are not included in the estimates above
Air-quality and other environmental fees on motor vehicles	No, these fees are paid separately by users
Environmental excise taxes on petroleum	Yes, these are embedded in the cost of motor fuel
Gas-guzzler taxes, luxury taxes, and other minor taxes	Yes, embedded in the cost of motor vehicles
Traffic fines and parking fines	No, these are paid separately by users

Public parking fees and parking taxes	No, the estimates above specifically exclude parking taxes
Portion of severance taxes on oil and gas	Yes, these are embedded in the cost of motor fuels
Selective property and sales taxes	No, these generally paid by users and not included in primary data above
Other selective taxes and fees	Yes, these license fees and related presumably are embedded in the cost of vehicles and fuels
Portion of general sales taxes on motor vehicles, fuels, parts, and services	No, sales taxes are not included in the estimates above
Portion of corporate income taxes paid by motor-vehicle related industries	Yes, corporate income taxes paid by motor-vehicle related industries are embedded in the cost of motor-vehicle goods and services
Portion of personal income taxes paid by employees in motor-vehicle related industries	Yes, personal income taxes paid by employees of motor-vehicle related industries are embedded in the cost of motor-vehicle goods and services
Portion of general property taxes paid on motor vehicles and by motor-vehicle related industries	Yes, property taxes paid by motor-vehicle related industries are embedded in the cost of motor-vehicle goods and services

Thus, I must deduct tire taxes, environmental excise taxes²², gas-guzzler and similar taxes, severance taxes, corporate-income taxes, personal-income taxes, and property taxes paid in motor-vehicle related industries. In each case, I deduct the total amount paid to the government. All of these except the tire tax are estimated in Report

²²Note that if the environmental excise taxes were correctly calculated Pigovian taxes, equal to the marginal cost of the associated environmental damages, then one would want either to leave the taxes embedded and thereby have the cost of the damages be part of the private cost (for example, of oil), or else place the taxes and the damages they represent in a separate account, called “properly internalized environmental damages.” One probably would not want to deduct the taxes, and then make a separate estimate of the environmental damages as external costs, because the damages in fact would not be externalities. (And, of course, one should not count both the taxes, as a part of the private cost, *and* the marginal damages as external costs.)

Consider, for example, the tax levied for the Oil Spill Liability Trust Fund. If this tax were equal to the marginal expected external costs of oil spills, we could leave it embedded in the cost of highway fuels. Then, we would *not* make an additional estimate of the external cost of oil spills in Report #9, but rather would point out there that the damage cost was included already in the social cost of fuel, via the Pigovian tax on oil. However, if we doubted the calculation used to set the tax, we would want to unembed and discard the tax, and then make our own estimate of the marginal external damages, in Report #9. This is what we actually do here, because we doubt that the tax is equal to the expected marginal external costs of oil spills.

#17, to which the reader is referred for details. (In 1991, the Highway Trust Fund received \$0.357 billion from the tire excise tax [FWHA, 1995].) The largest of these are corporate-income taxes, personal-income taxes, and property taxes, which are summarized here (see Report #17 for details).

Note this simple of subtraction of taxes does not leave us with the private resource cost that we would have estimated for 1991 had there been no income taxes, because had there been no taxes market prices and quantities would have been different. What we are left with, rather, is the private-resource cost portion of the actual with-tax price-times-quantity payments in 1991 -- the supply cost that we would have estimated had taxes been zeroed out but quantities remained fixed.

Note also that in the low-cost case here, I deduct the high estimate of embedded taxes, and vice versa in the high-cost case.

5.11.1 Corporate income taxes.

The Internal Revenue Service publishes corporate income taxes paid within SIC groups. In Report #17, we use these data to tabulate actual corporate income taxes paid by every business involved in any aspect of the production and use of motor vehicles, motor-vehicle fuel, and motor-vehicle infrastructure. For each business, we multiplied total corporate income taxes by the fraction of the output of that business that was used by motor vehicles, motor fuel, or motor-vehicle infrastructure in 1990 or 1991. For example, we estimate that motor vehicles used 18% of the primary metals produced in SIC 33 (Report #10 of this social-cost series; see the list at the beginning of this report), and so we assign to motor-vehicle use 18% of the total corporate income taxes paid in SIC 33. Our estimate, detailed in Report #17, is that \$11.9 to \$12.2 billion in corporate income taxes are related to motor-vehicle use.

5.11.2 Personal income taxes.

There are no data on personal income taxes paid by type of occupation or industry. To estimate personal income taxes paid by workers in motor-vehicle-related businesses, we multiplied total wages earned in each SIC by the national average income-tax rate (see Report #17). The national average income tax rate was calculated as total personal income taxes received by all governments divided by total wages and salaries (*Survey of Current Business*, July 1992) -- about 21%. The data on total wages earned in each SIC are from the same source as is most of the data on total wages earned in the U.S. in 1990; namely, the Bureau of Labor Statistics ES-202 program (*Employment and Wages Annual Averages*, 1990, 1991). Our estimate, detailed in Report #17, is that \$38.9 to \$40.1 billion in personal income taxes in 1991 were related to motor-vehicle use.

5.11.3 Property taxes

Report #17 estimates property taxes paid on motor vehicles, property taxes paid in motor-vehicle-related industries, and property taxes paid on personal garages. Of these, only property taxes paid in motor-vehicle related industries should be deducted

here. In Report #17 these are estimated on the basis of data on total property taxes paid, the fraction of the total paid by businesses, and the fraction of businesses that are motor-vehicle related. These data result in an estimate that motor-vehicle-related business paid \$4.4 billion in property taxes in 1991.

5.12 DEDUCTION FOR BUNDLED PARKING COSTS INCLUDED IN COST OF ANY INDUSTRIES ABOVE, BUT COUNTED SEPARATELY HERE AS A BUNDLED PARKING COST

The preceding estimates of the cost of priced motor-vehicle goods and services are meant to include all of the resource costs of making and providing motor vehicles, motor fuels, and motor-vehicle services -- including, in principle, the resources devoted to providing free employee and customer parking at all of the associated manufacturing and retail spots. However, in Report #6 of this social-cost series, we make an independent estimate of the cost of all free (bundled) off-street nonresidential parking -- including any such parking at manufacturing and retail facilities involved in anyway in the motor-vehicle business. To avoid double counting this parking cost, we should deduct it from our estimates here of the cost of priced private-sector motor-vehicle goods and services.

We assume that the cost of free parking at businesses related to motor-vehicle use bears the same relation to the cost of all free off-street nonresidential parking (estimated in Report #6) as personal consumption expenditures related to motor-vehicle use do to all personal consumption expenditures. Consequently, we deduct here the amount:

$$CB \cdot \frac{PCEA + PCEOA}{PCET}$$

where:

CB = the cost of all bundled, off-street, nonresidential parking in 1991 (Report #6)

PCEA = personal-consumption expenditures related to automobile use in 1991, as estimated by the BEA (\$398.3 billion; Table 5-1)

PCEOA = other personal consumption expenditures related to automobile use in 1991, as estimated here (the overhead expenses of business, commercial, and government fleets, in Table 5-13, plus an additional \$25 billion for medical costs of motor-vehicle accidents, and other costs)

PCET = total personal consumption expenditures in the U. S. in 1991 (3,889.1 billion \$; Bureau of the Census, *Statistical Abstract of the United States*, 1992)

5.14 SUMMARY OF THE COST OF MOTOR-VEHICLE GOODS AND SERVICES PRICED BY THE PRIVATE SECTOR

The results of the analyses presented in this report are summarized in Table 5-13. The total estimated cost of motor-vehicle related goods and services priced in the private sector in the U. S. in 1991 is approximately \$830 to \$940 billion. The largest cost items are vehicles, maintenance and repair, and travel time. Costs typically included in GNP-type accounts are on the order of \$430 to \$520 billion, after deductions. Costs typically not included are around \$400 to \$420 billion, which is nearly as large as the costs typically included.

The analysis presented here omits a few undoubtedly minor cost items. For example, I am not able to estimate the cost of any legal expenses that are related to motor-vehicle use but not covered by auto insurance and not related to accidents, such as legal expenses concerning the sale of a vehicle. These sorts of omission are likely to be minor compared with the costs included here.

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TABLE 5-1. DIRECT PAYMENTS FOR PERSONAL TRANSPORTATION, 1990-1991 (10⁹ \$)

Cost item	BLS CEs		BEA PCEs		TIA
	1990	1991	1990	1991	1991
a. New automobiles	83.5	78.4	96.7	79.5	116.0
b. Used automobiles	50.8	56.6	33.7	35.8	35.8
c. New and used trucks, RVs	54.3	58.5	49.6	47.2	47.2
d. Finance charges	29.1	27.6	n.e.	n.e.	32.4
e. Gasoline and oil	101.9	97.8	108.5	105.5	117.2
f. Automobile insurance	54.6	60.2	18.1	21.6	24.0
g. Repair, maintenance, rental, etc.	58.4	65.3	82.5	83.7	93.0
h. Tires, tubes, accessories, other parts	17.7	17.9	22.5	23.0	25.6
i. Bridge, tunnel, ferry, road tolls	1.2	1.4	2.0	2.0	2.2
j. Parking fees (non residential)	2.2	2.2	line g	line g	line g
k. Parking fees (residential)	line j	0.2	n.e.	n.e.	n.e.
l. Vehicle inspection fees	0.6	0.8	line g	line g	line g
m. Vehicle registration fees	6.7	7.1	n.e.	n.e.	6.1
n. Drivers' license and other fees	0.6	0.7	n.e.	n.e.	0.7
o Total	461.5	474.7	413.6	398.3	500.1

Sources: Division of Consumer Expenditure Surveys (1993a, 1993b); Reise (1993); *Survey of Current Business* (July 1992); BLS, *Quarterly Interview Survey, 1991 Forms, Consumer Expenditure Survey* (1991); BEA, *Personal Consumption Expenditures* (1990); BLS (1989, 1988). BLS = Bureau of Labor Statistics; BEA = Bureau of Economic Analysis; CEs = consumer expenditures; PCEs = personal consumption expenditures; TIA = *Transportation in America* (Smith, 1993); n.e. = not estimated.

^aBEA. PCEs on new automobiles are equal to the average purchase price multiplied by the quantity purchased. The price is the full sales price, including sales tax, with no allowance or deduction for trade-in values. Motorcycles are not included (Key, 1994)

The amount shown here for CEs is equal to net expenditures on new automobiles (classified under expenditures on "transportation" in the detailed CE tables; the "net" means net of trade-in allowances), plus my estimate of the trade-in allowance for new-vehicle purchases, plus the value of gifts of new automobiles (classified under "gifts of goods and services" in the detailed CE tables). I have included the value of gifts because I wish to know the value of resources devoted to transportation. (As mentioned above, the estimates of PCEs on transportation include the value of transportation goods and services received in-kind.) Expenditures include sales and excise taxes.

BLS. The CE for new automobiles, as shown in the detailed CE tables under “transportation”, is the net outlay for new automobiles; on average, it is equal to the prices paid less any trade-in allowances. (By contrast, the PCEs do not deduct trade-in allowances; they represent the “gross” outlays by consumers, equal to the average price paid multiplied by the quantity.) Although the trade-in allowances do reduce consumer cash outlays for new vehicles, they do not reduce the overall value of resources consumed for transportation, because they are just a transfer from one party to another. Therefore, in an economic cost accounting, the trade-in allowance should *not* be deducted or offset against costs. As mentioned above, I have added back my estimate of the trade-in allowance. The detailed CE tables report the amount that households receive from vehicle sales and trade-ins together, but do not list separately the value of the trade-in allowances that offset the new-vehicle expenditures in the CE tables. I assume that 25% of the amount that households receive from trade-ins and sales is the value of trade-in allowances against new-purchases, as opposed to receipts from the sale of used vehicles.

TIA. The TIA estimates are equal to PCEs plus business purchases of new and used autos (from the “Auto Output” tables of the NIPA [*Survey of Current Business*, July, 1992]).

^bBEA. PCEs on used automobiles are equal to the dealer’s margin on automobiles purchased by individuals plus net transactions (purchases less sales) between persons and other sectors (namely car dealers, other businesses, government, and scrap dealers), valued at wholesale prices. Transactions between persons are not counted at all in the PCEs.

BLS. The amount shown here for CEs is equal to expenditures on used automobiles (classified under expenditures on “transportation” in the detailed CE tables), plus my estimate of receipts from the sale of used vehicles, plus the value of gifts of used automobiles (classified under “gifts of goods and services” in the detailed CE tables). I have included the value of gifts because I wish to know the value of resources devoted to transportation, as opposed to cash expenditures of households alone (As mentioned above, the estimates of PCEs on transportation include the value of transportation goods and services received in-kind.) I have added back in household receipts from the sale of used automobiles to make the estimate more comparable to PCEs for used autos. The detailed CE tables report the amount that households receive from vehicle sales and trade-ins together, but do not list separately the amount from vehicle sales alone. I assume that receipts from sales of used vehicles constitute 75% of the amount that households receive from trade-ins and sales together.

Although both the CE as calculated here and the PCE are net expenditures on used autos (purchases less sales), there is a subtle difference in the underlying estimation methods. In the CE, net expenditures are calculated with respect to final selling prices; in the PCEs, net expenditures are calculated on the basis of wholesale prices plus estimated dealer margins. In principle, the two estimates should be close, because the wholesale price plus the dealer margin should approximate the retail price. In any event, neither the PCE nor the CE net expenditures measure the net economic (resource) cost of trade in used vehicles, which is equal to the transaction cost (mainly the dealers’ margins) less the value of scrapped vehicles. That is, in broader terms, the grand total economic cost of all vehicle ownership is the value of the resources devoted to manufacturing, marketing, and trading vehicles, less the value of the scrap resource. Apart from that, the used-vehicle market transfers but does not consume resources.

TIA. The TIA estimates are equal to PCEs.

^cBEA and BLS. includes new and used trucks, and new (and used?) recreational vehicles. The methods used to estimate expenditure on these types of vehicles are the same as those used to estimate expenditures on new and used automobiles (notes a and b). It appears that PCEs do not include net expenditures on used recreational vehicles, but that the CEs do. In the detailed CE tables there is a line for expenditures on “motorized camper coaches and other vehicles” under “entertainment”, and a line for sale of “motor camper and other vehicles” under “sources of income and personal taxes”. (The CEs show expenditures on new and used motorcycles, but the PCEs do not. In the PCEs, motorcycles are lumped in with “wheel goods, durable toys, sports equipment, boats, and pleasure aircraft”. For comparability, I have excluded motorcycles from the CEs.)

TIA. The TIA estimates are equal to PCEs.

^dBEA. Finance charges are included not in PCEs but rather in a separate account called “Interest paid by Consumers to Business”.

BLS. The estimate of CEs on finance charges is equal to finance charges on autos, trucks, and other vehicles (classified under expenditures on “transportation” in the detailed CE tables) plus gifts of finance charges on autos, trucks, and other vehicles.

TIA. Smith (*Transportation in America*, eleventh edition and supplement, 1993; personal communication, February 2, 1993) uses data on interest rates on loans for automobiles and total automotive credit outstanding, published in the *Federal Reserve Bulletin* (1992), to estimate interest payments on auto loans to consumers. His estimate excludes interest on automobile debt paid by business. I have verified this estimate independently, using the following method. Note that the ratio of Smith’s estimate of consumer interest paid on debt (\$35.5 billion) to consumer expenditures on new and used cars and trucks (excluding interest on debt; \$180 billion) is 0.197. To check this, I estimated the ratio of total interest payments over the life of a car to the total value of the car, using 1990 data on the average loan-to-value ratio (87% for new cars, 95% for used cars), the average length of the loan (54.6 months for new cars, 46.0 months for used cars), the weighted average interest rates (about 12% for new cars, 16% for used cars) (all this from the *Federal Reserve Bulletin*, 1992), and the percent of people who finance (62% for new cars, according to the MVMA, 1992; I assume 50% for used cars). The resulting interest-to-value ratios were 0.196, for both new and used cars. These ratios are virtually identical the 0.197 implied by the TIA and PCE data.

^ePCEs on gasoline are calculated as the quantity purchased (from the Bureau of the Census’ quinquennial *Census of Manufactures*, for benchmark years, and from FHWA’s annual *Highway Statistics* for other years) multiplied by the average price (from the EIA’s *Petroleum Marketing Annual*, annual). The estimate of CEs on gasoline and oil includes gifts of gasoline and oil. Both the PCEs and the CEs include all Federal, state, and local gasoline taxes.

TIA. The TIA estimate is equal to PCEs multiplied by 1.11, to account for business expenditures. Smith (1993) estimates that business expenditures are 11.11% of personal expenditures, or 10% of total (personal plus business) expenditures. (In earlier editions of *Transportation in America*, Smith assumed 15%.) As noted below, my analysis indicates that business travel is at least 30% of personal travel, which means that it is likely that business expenditures on transportation are much more than 11% of personal expenditures.

^fThe PCE estimate of automobile insurance is equal to premiums paid less claims paid (or, total payments to insurance companies, less total payments received from insurance companies).

The CE estimate is simply total premiums paid. The PCE estimate is a [better] measure of the value added by or real economic cost of automobile insurance.

TIA. See note e.

gBEA. In the PCEs this category is called “repair, greasing, washing, parking, storage, rental, and leasing”. I assume that it corresponds to the following lines in the detailed CE tables: “maintenance and repairs” (under expenditures on “transportation” and under “gifts of goods and services”) excluding “tires” and “parts, equipment, and accessories” and “other vehicle products” (these are counted below); “vehicle rental, leases, licenses, other charges” excluding “aircraft rental”; “towing charges”; “rental of campers and other vehicles on out-of-town trips” and “rental of campers, other rv’s” (under expenditures on “entertainment”); and “automobile service clubs” (under “gifts goods and services”). I have reported CEs on parking on separate lines.

BLS. PCEs on repairs are estimated from Census data (in the Bureau of the Census’ quinquennial *Census of Service Industries*, and the annual *Service Annual Survey*) on receipts in the automotive repair-service industry (part of SIC 75). When the BEA estimates the portion of these receipts that should be attributed to persons (as opposed to businesses or government), it apparently does not exclude personal expenditures that are reimbursed by insurance companies. On the other hand, CEs on automotive repairs do exclude expenses that are reimbursed by insurance companies; they include net or out-of-pocket expenses only. Because of this, PCEs on repair (which include reimbursed expenditures) should be higher than CEs on repair (which do not include reimbursed expenditures).

TIA. See note e.

^hI assume that this PCE category corresponds to the following three lines in the detailed CE tables: “tires,” “parts, equipment, and accessories,” and “other vehicle products” (gifts as well as direct expenditures).

TIA. See note e.

ⁱThe BEA’s estimates of toll payments are based on the toll receipts of collecting agencies, as published in the FHWA’s *Highway Statistics* (various years). It is likely that the government estimates of receipts are more accurate than consumer estimates of expenditures.

TIA. See note e.

jBEA. In the “benchmark” years, the BEA estimates parking expenditures separately, using data from the Bureau of the Census and other sources. However, in non-benchmark years, the BEA apparently does not estimate parking expenditures separately, but rather includes them in higher-level, aggregated estimates of expenditures on maintenance, repair, parking, and other items, as indicated here (Key, 1993). I have separated parking fees because there is a line for “parking fees” in the CEs (shown here excluding fees paid for parking at one’s own residence, which fees are counted elsewhere in the table), and because I make my own detailed analysis of parking expenditures.

BLS. The BLS reports the following CEs on parking fees (\$/household/year):

	1990	1991
Parking at owned dwelling	0.03	0.69
Parking at owned vacation home	0.00	0.09

Parking in home city, excluding residence	in other	20.00
Parking out of town	in other	2.36
Other parking	22.48	1.31

I assume that “other parking” refers to fees paid at rented dwellings. Thus, residential parking comprises “parking at owned dwelling,” “parking at owned vacation home,” and “other parking,” and nonresidential parking comprises “parking in home city, excluding residence,” and “parking out of town”.

Note that the reported expenditures on “parking at owned dwelling” vary considerably from year to year: \$105 million in 1987, \$6 million in 1988, \$36 million in 1989, \$3 million in 1990, and \$69 million on 1991 (Division of Consumer Expenditure Surveys, detailed expenditures, 1993b). Presumably, this is because only a few households in the yearly sample actually pay for residential parking.

^kSee note j.

^lIn the BEA’s PCEs, vehicle-inspection expenses are included under “repair, maintenance, rental, parking, etc.”

^mThe TIA estimates are the payments for motor-vehicle registration and for driver’s licenses reported in the FHWA’s annual *Highway Statistics*.

ⁿSee note n.

TABLE 5-2. DIRECT PAYMENTS FOR HIGHWAY FREIGHT TRANSPORTATION, 1990 AND 1991

Cost item	Revenues or costs (billion \$)	
	1990	1991
ICC-authorized intercity trucks ^a	75.5	78.3
Non-ICC intercity trucks ^a	86.8	89.1
Local trucks ^b	108.4	110.5
Intercity buses	0.126	0.131
Government-owned freight trucks ^c	5.8	5.9
Total	276.7	283.9

Source: From Smith (1992, *Transportation in America*), except as noted. ICC = Intercity Common Carriers.

^aThese are estimates of revenues received by (or, payments for services to) intercity truckers. The payments undoubtedly cover the wages of the truck drivers, and any taxes, tolls, fines, and fees that the shippers must pay. Smith's estimates probably include government payments to ICC truckers for freight services, but not government expenditures on government-owned trucks (Smith, 1993). Hence, I have added government expenditures on government-owned trucks.

^bThis is an estimate of the cost of local trucking services, including the cost of the truck driver. Smith (1993) uses estimates by FHWA (*Highway Statistics*, annual) truck miles on non-interstate urban roads, by class of truck (excluding trucks used primarily for passenger transportation), and estimates by the General Services Administration (*Federal Motor Vehicle Fleet Report*, annual) of the cost-per-mile of different classes of trucks. Note, however, that on the one hand the costs reported to GSA do not include vehicle insurance (because the Federal government is self insured), parking, tolls, fines, and vehicle registration (because the Federal government does not pay state registration fees), but do include salaries for fleet administrators and staff, office supplies, building rental, and capital improvements (Frisbee, 1994). I thus expect that the coverage of the ICC estimates of revenues in intercity trucking (note a) is different from the coverage of the GSA-based estimates of the cost of local trucking.

^cAccording to the NIPA, government spent \$6.3 billion on purchases of trucks in 1990 and \$6.0 billion in 1991 (*Survey of Current Business*, July 1992). I assume that 60% of this was for passenger vehicles, and 40% for freight vehicles, and that the ratio of total expenditures on motor-vehicles to expenditures on vehicle purchases is 2.30 : 1 in 1990 and 2.45 : 1 in 1991 (based on the data of Table 5-1).

TABLE 5-3. EXPENDITURES ON MOTOR FREIGHT TRANSPORTATION IN SIC 421, 1991

	Trucking & courier services	Local trucking, no storage	Non-local trucking	Local trucking w/storage	Courier services except air
	SIC 421	SIC 4212	SIC 4213	SIC 4214	SIC 4215
1. Operating motor-carrier revenue (10 ⁶ \$)	111,526	24,615	66,728	2,952	17,233
2. Operating expenses (10 ⁶ \$)	112,763	25,163	67,756	3,978	15,866
3. Purchased transportation (10 ⁶ \$) ^a	20,191	3,224	15,088	607	1,272
4. Non-transportation exp. (10 ⁶ \$) ^b	17,173	3,832	10,319	606	2,416
5. Expenses net of lines 3 and 4 (10 ⁶ \$)	75,399	18,107	42,349	2,765	12,178
6. Purchased fuels (10 ⁶ \$) ^c	9,080	2,053	5,953	191	883
7. Vehicular fuel/all fuel ^d	0.967	0.967	0.967	0.967	0.967
8. Cost of fuel for vehicles (10 ⁶ \$) ^e	8,781	1,985	5,757	185	854
9. Average fuel price (\$/gallon) ^f	1.14	1.15	1.14	1.15	1.14
10. Amt. of fuel for vehicles (10 ⁶ gal) ^g	7,671	1,725	5,054	161	750
11. Average miles/gallon ^h	9.0	10.7	9.4	10.7	9.4
12. Truck-miles of travel (10 ⁶) ⁱ	69,357	18,390	47,460	1,711	7,040
13. "Net" operating cost: transportation costs only (\$/mile) ^j	1.09	0.98	0.89	1.62	1.73
14. GSA-comparable cost (\$/mile) ^k	1.24	1.11	1.02	1.83	2.00
15. Total cost, including "overhead" (\$/mile) ^l	1.33	1.19	1.11	1.97	2.07

Source: Bureau of the Census (*Motor Freight Transportation and Warehousing Survey: 1993, 1995*), and my calculations. TIUS = 1987 *Census of Transportation, Truck Inventory and Use Survey* (Bureau of the Census, 1990).

^aTrucks and other motor vehicles leased with or without drivers, and transportation purchased from railroads, airlines, water, and other motor carriers.

^bIncludes 10% of annual payroll and employer contributions to social security and other benefits (I assume that 10% of the employees in these SICs have jobs not directly related to transportation); fuels purchased to generate heat and power for buildings; lease, rental, depreciation, maintenance, and insurance of buildings and non-transportation machinery and equipment; and 50% of other operating expenses (I assume that half of these other expenses, which are not defined, are not directly related to transportation).

^cIncludes fuels purchased for heat and power for buildings.

^dIn 1991, firms in SIC 421 spent \$8,781 on fuels for trucks and other motor vehicles, and \$299 on fuel for heating and power. For the lower-level SICs, the Census reports only the total expenditure on fuels for all uses; it does not break down the total into vehicular fuel and fuel for heating and power. I assume that the break down percentage for all of SIC 421 applies to each of the lower-level SICs.

^eLine 6 multiplied by line 7. This is an estimate of expenditures on vehicular fuels.

^fThe volume-weighted average gasoline and diesel-fuel price is calculated with this equation:

$$P_a = P_g \times F_g + P_d \times F_d$$

where:

P_a = the consumption-weighted average price of fuel in 1991

P_g = the sales-weighted average price of gasoline, including taxes, in 1991
(\$1.196/gallon; EIA, *Annual Energy Review* 1992, 1993)

F_g = gasoline consumption divided by total fuel consumption, in each SIC (51.1% for all non-personal truck travel [SIC 421]; 57.5% for local, non-personal use trucks [SICs 4212 and 4214]; 45.5% for non-local, non-personal use trucks [SICs 4213 and 4215]; according to my calculations using data from the 1987 TIUS)

P_d = the average retail price of diesel fuel, including taxes, in 1991 (\$1.10/gallon, Table 5-9)

F_d = diesel consumption divided by total fuel consumption, in each SIC (1 minus the percentage for gasoline [F_g], in each SIC)

This method assumes that the ratio of gasoline to diesel use by trucks in the Census' *Motor Freight Transportation and Warehousing Survey* is the same as the ratio for all non-personal truck -- probably a reasonable assumption.

^gLine 8 divided by line 9.

^hUsing data from the 1987 TIUS, I calculated the average fuel economy of all non-personal-use trucks (which I assume applies to SIC 421), all non-personal local trucks (which I assume applies to SICs 4212 and 4214), and all non-personal non-local trucks (which I assume applies to SICs 4213 and 4215).

ⁱLine 10 multiplied by line 11.

^jLine 5 divided by line 12. This is an estimate of "direct" transportation expenditures only, excluding what might be called "overhead".

^kLine 2 minus line 3 minus insurance and taxes and licenses (not shown here), divided by line 12. This cost-per-mile figure is meant to be compared with the cost-per-mile figures reported by GSA in its *Federal Motor Vehicle Fleet Report, for fiscal year 1990* (1993?). For this comparison I have subtracted insurance and taxes and licenses because the GSA's cost figures do not include insurance (because the government is self-insured) or registration fees, but have

included non-transportation expenses (i.e., not subtracted line 4) because the GSA's estimates include similar non-transportation costs (Frisbee, 1994). The GSA (1994?) reports that trucks with a gross vehicle weight (GVW) of 24,000 lbs and over in large Federal civilian fleets had an operating cost of \$1.03/mile, and that trucks with a GVW of 8,500 lbs or less had an operating cost of \$0.25/mile.

¹Line 2 minus line 3, divided by line 12. This estimate includes "overhead".

TABLE 5-4. THE ANNUALIZED COST OF THE MOTOR-VEHICLE FLEET (1991 \$)

	Gasoline vehicles			Diesel vehicles			Total or ave.
	<i>LDAs</i>	<i>LDTs</i>	<i>HDVs</i>	<i>LDAs</i>	<i>LDTs</i>	<i>HDVs</i>	
U. S. retail sales, 1991 (10^3) ^a	8,164	4,017	40	11	18	290	12,539
Life to scrappage (years) ^b	13.74	17.65	16.00	14.43	18.53	17.60	15.32
Vehicle stock at 1991 life, sales mix (10^6) ^c	112.18	70.89	0.64	0.15	0.33	5.10	189.28
Average price (1991 \$/vehicle) ^d	16,316	15,280	72,742	16,316	15,280	72,742	17,637
Sales tax multiplier ^e	1.026	1.026	1.005	1.026	1.026	1.005	1.023
U. S. producer surplus low (fraction) ^f	0.08	0.08	0.08	0.08	0.08	0.08	0.08
U. S. producer surplus high (fraction) ^f	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Real annual interest rate, low ^g	0.04	0.04	0.05	0.04	0.04	0.05	0.042
Real annual interest rate, high ^g	0.07	0.07	0.09	0.07	0.07	0.09	0.073
<i>Annualized cost, low (10^9 \$/yr)^h</i>	158	78	4	0	0	29	269.3
<i>Annualized cost, high (10^9 \$/yr)</i>	200	103	5	0	1	41	350.4
Price x quantity, 1991 (10^6 \$) ⁱ	133,205	61,385	2,314	173	268	16,737	214,082

LDA = light-duty auto; LDT = light-duty truck; HDV = heavy-duty vehicle.

^aFrom Table 10-3 of Report #10 of this social-cost series.

^bEstimated as follows:

gasoline LDAs: The value is the number of years of life at which a 1990 model-year automobile has a 50% chance of not having been scrapped (interpolated from survival rates presented by Davis, 1995).

gasoline LDTs: The value is the number of years of life at which a 1978-1989 model-year light truck has a 50% chance of not having been scrapped (interpolated from survival rates presented by Davis, 1995), multiplied by 1.1, which is my estimate, made on the basis of data in Davis (1995), of the ratio of the life of a 1990 model-year light truck to a 1978-1989 model-year light truck

diesel LDA and diesel LDT: I assume that these have a 5% longer life than do gasoline LDAs and LDTs, because diesel vehicles generally last a bit longer than do gasoline vehicles.

HDVs: For any given year of life, the survival rate of all trucks is slightly less than the rate for light trucks (Davis, 1995), which suggests that heavy trucks have a

slightly shorter life in years than do light trucks. With this in mind, and assuming that diesel HDVs last 10% longer than do gasoline HDVs, I assumed that gasoline HDVs last 16 years.

Total: The life-time weighted average of all classes

^cEqual to the number of vehicles sold in each class, multiplied by the average years of life for each class, and summed for all classes. This of course is the size and composition of the stock in the long run if sales and life remain at the 1991 levels shown here.

^dEstimated as follows:

LDAs: The value shown is the average expenditure per new 1991 model year auto (not including trucks), including sales taxes, dealer charges, and all other taxes and fees, as estimated by the BEA (Moran, 1991).

LDTs: I chose this figure so that price (including taxes) times quantity summed for all vehicle types (excluding trailers for HDVs) equals the total value of government, business, and personal purchases of new cars and trucks in 1991, as reported in the BEA's National Income Product Accounts (*Survey of Current Business*, July 1992J), and as shown in the last row of this table.

HDVs: The retail unit price of HDVs with trailers in 1991, as estimated in Table 5-5. In our social-cost accounting, we include the value of trailers. However, when we calibrate our estimate of the value of all vehicles to the BEA's reported value of all car and truck purchases (for the purpose of estimating the unit price of LDTs; see immediately above) we exclude the value of trailers because the BEA does.

Total: the price-weighted average of all classes.

^eFrom the analysis in Report #17. For LDAs and LDTs, I use the sales-tax fractions for retail of motor vehicles, from Table 17-15. For HDVs, I use the sales-tax fraction for wholesale of motor vehicles and parts (section 17.6.2), because most heavy trucks are sold by establishments classified as wholesale.

Note that the purchase price, shown above, includes the sales tax. I show the sales tax multiplier here because I wish to deduct the sales tax, which I do by dividing the price above by the sales tax multiplier.

The total (average) sales tax is the tax-weighted average in all classes.

^fThis is my estimate of the fraction of revenues that is producer surplus that accrues to U.S. producers. It appears to me that most of the firms in the auto industry have similar cost structures, and hence that producer surplus (which results from comparative advantages in resource endowment, production efficiency, and so on) is relatively small. Greene's (1978) review of studies of the demand for automobiles provides this barely relevant supporting claim: "thus, the assumption of a flat short-run supply curve for the industry would seem reasonably accurate for an annual demand model". The claim is barely relevant because in this analysis I care about the long-run, not the short run supply curve.

Producer surplus that accrues to foreign producers should not be deducted, because it is a cost to U. S. consumers. Foreign producers earn about 1/3 of all revenues earned from motor-vehicle sales (International Trade Administration, 1995). I consider this qualitatively in my estimate of the U. S. producer surplus fraction.

The total (average) producer surplus is the surplus-weighted average in all classes.

^gSee the discussion in Report #2 of this social-cost series.

^hFor each class, this is the total value of the stock (at 1991\$ prices, excluding the sales tax), annualized over the life of the vehicles in the class at the real annual interest rate shown.

ⁱIn each class, this is equal to the average price in 1991, including sales taxes, multiplied by retail sales in 1991. In the case of HDVs and the total, the number before the slash includes the value of truck trailers, and the number after the slash excludes the value of truck trailers. The estimated total based on HDVs without trailers (\$214.1 billion) equals the total value of government, business, and personal purchases of new cars and trucks in 1991, as reported in the BEA's National Income Product Accounts (*Survey of Current Business*, July 1992J). (The BEA estimates of truck value exclude trailers.) We show the total without truck trailers only to demonstrate that it matches the BEA's total; in our social-cost accounting, we include the cost of truck trailers.

TABLE 5-5. CALCULATION OF THE PRICE OF HEAVY TRUCKS, 1991

	Product code ^a				
	37117, 37118	37119	37132	37130	3715-
Value of factory shipments, 1992 (10 ⁶ \$)	4,685.6	6,321.8	1,521.0	481.6	3,168.1
Fraction pertaining to complete HDVs ^b	1.00	1.00	0.80	0.00	1.00
Retail value/factory value ^c	1.22	1.22	1.22	1.22	1.22
Sales tax multiplier ^d	1.005	1.005	1.005	1.005	1.005
Sales in 1992 (10 ⁶ \$) ^e	5,757.3	7,767.8	1,495.1	0.0	3,892.7
	Sales (10 ⁶ \$)	Unit price (\$/vehicle)			
	1992	1992 ^f	1991 ^g		
Total with 3715- (trailers)	18,913	75,652	72,742		
Total without 3715- (trailers)	15,020	60,081	57,770		

^aThe product codes are as follows (Bureau of the Census, *1992 Census of Manufactures*, 1995):

37117, 37118: truck, truck tractors, and bus chassis, on chassis of own manufacture, 10,001 to 33,000 lbs.

37119: truck, truck tractors, and bus chassis, on chassis of own manufacture, 33,001 lbs or more.

37132: complete truck and bus produced on purchased chassis.

37130: truck and bus bodies not specified by kind.

3715-: truck trailers.

^bI wish here to estimate the value of all complete HDVs. I exclude here LDTs, because I estimate them separately. Product code 37132 apparently includes some LDTs; I assume 20%. Product code 37130 apparently includes only incomplete trucks, which presumably are counted as complete vehicles in 37118 or 37119.

^cThe ratio of sales on own account to cost of goods sold, for the subsector "medium and heavy trucks and tractors (over 14,000 lbs)" in SIC 5012, from the Bureau of the Census, *1992 Census of Wholesale Trade, Subject Series, Miscellaneous Subjects*, (1995). Most medium and heavy trucks are sold by establishments classified as "wholesale" by the Bureau of the Census. Note that the cost of goods reported by the subsector "medium and heavy trucks and tractors (over 14,000 lbs)" in SIC 5012 is about 75% of 80% the value of factory shipments in SICs 37117, 37118, 37119, 37132, 37130, and 3715.

^dFrom Table 5-4, value for HDVs.

^eEqual to the factory value multiplied by the complete HDV fraction multiplied by the retail/factory-value ratio multiplied by the sales tax multiplier.

^fEqual to the total value of factory sales divided by total factory sales of trucks of 10,001 lbs GVW or more, in 1992 (250,000 according to MVMA [1992]).

^eEqual to the 1992 unit prices divided by the 1992/1991 estimated price change factor of 1.04. The price change factor is estimated on the basis of the following: the ratio of the 1992 to 1991 Producer Price Index for “truck and bus bodies” is 1.023; the ratio for “trucks, truck tractors, and truck chasses” is 1.047 (from the Bureau of Labor Statistics data page, www.bls.gov).

TABLE 5-6. CALCULATION OF THE DEALER MARGIN ON SALES OF USED CARS, 1991

	SIC				
	551	552	553	555,6,7,9	All
Used cars: fraction of total sales, 1987 ^a	0.199	0.950	0.000	0.042	n.e.
Total sales, 1991 (10 ⁹ \$) ^b	301.3	23.9	29.6	17.8	372.6
Dealer margin (fraction of sales) ^c	0.160	0.160	0.160	0.160	n.e.
Producer surplus (fraction) ^d	0.05	0.05	0.05	0.05	n.e.
Total dealer margin, 1991 (10 ⁹ \$) ^e	9.0	2.9	0.0	0.1	12.1

SIC = standard industrial classification; n.e. = not estimated.

^aIn SIC 551 (new and used car dealers), this fraction is the ratio of sales in merchandise lines 709 (used passenger cars -- retail) plus 711 (used passenger cars -- wholesale) plus 712 (used vans, trucks, and buses) to total sales, in 1987. In SIC 552 (used car dealers), this fraction is the ratio of sales in merchandise line 700 (cars, trucks, and powered vehicles) to total sales, in 1987. In SICs 553, and 555,6,7, and 9, the fraction is our judgment, estimated on the basis of total sales in merchandise line 700 (only a portion of which will be used-car sales) and total sales in the SIC. Data from the Bureau of the Census, *1987 Census of Retail Trade, Merchandise Line Sales, United States* (1990).

^bData from the Bureau of the Census, *Combined Annual and Revised Monthly Retail Trade*, 1996).

^cFrom 1984 to 1994, the dealer margin in SICs 551, 2, 5, 6,7 and 9, as a group, was about 17% of sales (Bureau of the Census, *Combined Annual and Revised Monthly Retail Trade*, 1996). In 1990 and 1991 it was about 16.0%. I assume that the margin on used-car sales specifically was 16.0%.

^dWe assume that the producers surplus is relatively small in the used-car dealer business, which is relatively competitive and probably has a relatively flat supply curve.

^eEqual to used-car fraction multiplied by total sales multiplied by the dealer-margin fraction multiplied by one minus the producer surplus fraction.

TABLE 5-7. THE COST OF MOTOR FUELS, 1991

	Gasoline vehicles			Diesel vehicles			Total
	<i>LDA</i> s	<i>LDT</i> s	<i>HDV</i> s	<i>LDA</i> s	<i>LDT</i> s	<i>HDV</i> s	
Total fuel consumption (10 ⁹ gallons) ^a	70.23	28.77	3.37	0.65	0.71	24.83	129
Cost of fuel (\$/gallon, excl. excise and sales taxes) ^b	0.856	0.856	0.856	0.700	0.700	0.700	n.e.
Fraction U. S. producer surplus (low-cost) ^c	0.30	0.30	0.30	0.30	0.30	0.30	n.e.
Fraction U. S. producer surplus (high-cost) ^c	0.20	0.20	0.20	0.20	0.20	0.20	n.e.
Increase in mpg, when delay is eliminated (low) ^d	0.40	0.40	0.40	0.40	0.40	0.40	n.e.
Increase in mpg, when delay is eliminated (high) ^d	0.60	0.60	0.60	0.60	0.60	0.60	n.e.
Excess fuel consumed (10 ⁹ gallons) (low) ^e	2.84	1.16	0.14	0.03	0.03	1.00	5.19
Excess fuel consumed (10 ⁹ gallons) (high) ^e	5.54	2.27	0.27	0.05	0.06	1.96	10.15
Cost of excess fuel (10⁹ \$) (low)^f	1.7	0.7	0.1	0.0	0.0	0.5	3.0
Cost of excess fuel (10⁹ \$) (high)^f	3.8	1.6	0.2	0.0	0.0	1.1	6.7
Cost of fuel not due to delay (10⁹ \$) (low)^g	40.4	16.5	1.9	0.3	0.3	11.7	71.2
Cost of fuel not due to delay (10⁹ \$) (high)^g	44.3	18.1	2.1	0.3	0.4	12.8	78.1

VMT = vehicle-miles of travel; n.e. = not estimated.

^aFrom Table 10-3 of Report #10 of this social-cost series. See the brief discussion in the text here on the accuracy of these estimates.

^bFrom Table 5-9. See the discussion in the text for details.

^cSee the discussion in the text..

^dThis is the parameter k1, the ratio of the fuel economy that would have been obtained over the mileage subject to delay had traffic been completely free flowing, to the fuel economy of

traffic during conditions of delay. I assume that if congestion were eliminated, fuel economy would increase by about 50%, and bracket this with a range of 40% to 60%. This assumptions produces estimates of the amount of excess fuel consistent with those estimated by the Texas Transportation Institute (Schrunk and Lomax, 2004).

^eSee equation 5-8, for G_e .

^fSee equation 5-2a, for FC_e .

^gSee equation 5-2b, for FC_i .

TABLE 5-8. OUR ESTIMATE OF TOTAL HIGHWAY DIESEL-FUEL CONSUMPTION IN 1987, COMPARED WITH THE FHWA'S

	Diesel fuel (10 ⁹ gal)
Privately owned trucks ^a	14.7
Publicly owned trucks ^b	0.3
Buses ^c	0.7
Household passenger cars ^d	0.7
Company-owned and publicly owned passenger cars ^e	0.2
<i>Total</i>	<i>16.6</i>
FHWA-based total^f	18.2

^aCalculated using VMT and mpg data from the 1987 *Census of Transportation, Truck Inventory and Use Survey* (TIUS) (Bureau of the Census, 1990). See footnotes a and e to Table 10-5 of Report #10. The TIUS does not cover government trucks or buses (Table 10-1).

^bThis estimate is calculated in three steps using three different data sources. (I). In 1987, there were 1.589 million publicly owned truck and truck tractors in the U.S. (FHWA, *Highway Statistics 1987*, 1988). (II). Miaou et al. (1992) surveyed 4 state fleets and 3 local-government fleets and found that 20.4% of the trucks in those fleets were diesel fueled. I assume that 20.4% of all publicly owned trucks (0.324 million) were diesel-fueled in 1987. (III) Finally, in fiscal year 1988, trucks in large Federally owned domestic civilian fleets consumed an average of 808 gallons of fuel per truck per year (General Services Administration, 1990). I assume that all publicly owned diesel-fuel trucks consumed 808 gallons of fuel per truck, or 0.26 billion gallons total, in 1987.

An alternative calculation yields a somewhat higher number. Comparing TIUS data on VMT by private trucks with FHWA (*Highway Statistics 1988*, 1989) data of on VMT by all trucks in 1987, I estimate that VMT by publicly owned trucks is 4.1% of VMT by privately owned trucks. If diesel-fuel consumption by publicly owned trucks is 4.1% of diesel fuel consumption by privately owned trucks, then publicly owned diesel-fuel trucks consumed 0.6 billion gallons of diesel fuel in 1987.

In any event, these two calculations suggest that publicly owned trucks consumed less than 1 billion gallons of diesel fuel in 1987.

^cIn 1987, transit buses, intercity buses, and school buses consumed 62.2 trillion BTU of gasoline and 94.6 trillion BTU of diesel fuel (Davis et al., 1989; estimated from data from the American Public Transit Association and the Eno foundation).

^dIn 1988, a survey of household energy use found that household passenger vehicles (not counting light-duty trucks) consumed 0.7 billion gallons of diesel fuel (EIA, *Household Vehicles Energy Consumption 1988*, 1990). The survey excluded motorcycles, mopeds, large trucks, buses, and company-owned vehicles unless they "ordinarily" were kept at home and "regularly" were available for personal use (p. 221). It did include household vehicles used for

job-related activities. I assume that household consumption of diesel fuel in 1987 was the same as in 1988.

^eThe 1988 EIA survey (EIA, *Household Vehicles Energy Consumption 1988, 1990*) cited in note d did not include publicly owned or most company-owned passenger vehicles. Given that public vehicles and business-use vehicles have about 32% of the VMT of household vehicles (Table 4-1), I assume that public and company passenger vehicles consumed an additional 0.2 billion gallons of diesel fuel in 1988. I also assume that company-owned and publicly owned passenger vehicles consumed the same amount of diesel in 1987 as they did in 1988.

A separate calculation yields a similar figure. In 1994 in the 13-county area immediately surrounding the city of Atlanta Georgia there were 1,102 diesel-fueled light-duty vehicles (8,500 lbs or less) in private company fleets (EIA, *Monthly Energy Review, December 1994, 1994*). Scaling this amount by the ratio of U.S. population to the population in the Atlanta Metropolitan Statistical Area yields approximately 100,000 vehicles. Assuming 15,000 miles per year and 20 miles per gallon results in 0.1 billion gallons.

^fFrom the Energy Information Administration (*Fuel Oil and Kerosene Sales 1991, 1992*). The EIA estimates that consumption of diesel fuel is more than 98% of the consumption of “special fuels” reported in FHWA’s *Highway Statistics* annual. I assume that the FHWA estimate of “special fuels” includes fuel used by public vehicles, even though the table in which the estimates are presented is called “Private and Commercial Highway Use of Special Fuels by Month”.

TABLE 5-9. GASOLINE AND DIESEL FUEL: COST, TAXES, AND RETAIL PRICE, 1987 AND 1991 (CURRENT-\$/GALLON, EXCEPT AS NOTED)

	Motor gasoline			No. 2 diesel fuel		
	1987	1991	1992	1987	1991	1992
Pre-tax retail price at refinery-owned stations (\$/gallon) ^a	0.669	0.797	0.787	0.551	0.648	0.619
Multiplier to get price at all outlets ^b	1.080	1.080	1.080	1.080	1.080	1.080
<i>Pre-tax retail price at all stations (\$/gallon)^c</i>	0.723	0.856	0.850	0.595	0.700	0.669
Federal excise tax (\$/gallon) ^d	0.091	0.141	0.141	0.151	0.201	0.201
State excise tax (\$/gallon) ^e	0.128	0.175	0.180	0.133	0.177	0.183
State and local sales taxes (multiplier) ^f	1.017	1.017	1.017	1.017	1.017	1.017
Estimated retail price including taxes (\$/gallon)^g	0.957	1.191	1.190	0.894	1.096	1.070
Check: actual average gasoline prices (\$/gallon) ^h	0.957	1.196	1.190	n.a.	n.a.	n.a.

n.a. = not available

^aThe EIA, *Annual Energy Review* 1993, 1994) reports the pre-tax price that service stations owned by refining companies charged to end users, including bulk customers. Number two diesel fuel oil includes the "Type T-T" diesel fuel used by trucks.

^bI use this factor to derive an estimate of the pre-tax price at all outlets, which is the datum that I want, from the pre-tax price at refinery-owned outlets, which is the datum that I have. I pick this factor (1.08) so that the pre-tax gasoline price at refinery-owned outlets, multiplied by the factor, plus Federal and state excise taxes and sales taxes on gasoline, is equal to the actual sales-weighted average gasoline price reported by EIA (see note h).

^cThe pre-tax price at refinery-owned stations, multiplied by the "multiplier to get the price at all outlets".

^dFrom FHWA's *Highway Statistics* 1992 (1993).

^eFrom FHWA's *Highway Statistics* 1991 (1992) and *Highway Statistics* 1987 (1988).

^fFrom Table 17-14.

^gThe pre-tax price plus the federal and state excise taxes, multiplied by the sales-tax multiplier.

^hThe EIA reports that the actual weighted average sales price of all grades of motor gasoline was \$0.957/gallon in 1987, and \$1.196 in 1991, including taxes (*Annual Energy Review 1993*, 1994). Neither the EIA nor anybody else reports the average sales price of highway diesel fuel in 1987 and 1991. (The International Energy Agency [*Energy Prices and Taxes*, 1994] uses the same data on pre-tax price and Federal and state excise taxes that I use here, but different data on sales taxes, to calculate the price of diesel fuel in the U.S.)

TABLE 5-10. AUTOMOBILE INSURANCE PREMIUMS AND EXPENSES, 1991

	Liability ^a			Physical damage ^b			Total		
	<i>PPV</i>	<i>CV</i>	<i>All</i>	<i>PPV</i>	<i>CV</i>	<i>All</i>	<i>PPV</i>	<i>CVs</i>	<i>All</i>
Net premiums written (10 ⁹ \$)	51.2	12.1	63.3	31.6	4.4	36.0	82.8	16.6	99.3
Net premiums earned (10 ⁹ \$)	50.0	11.9	61.9	31.2	4.6	35.8	81.3	16.5	97.8
Losses incurred ^c (fraction of premiums earned)	0.762	0.692	0.749	0.568	0.469	0.555	0.687	0.630	0.678
Claims adjustment expenses ^d (fraction of premiums earned)	0.138	0.136	0.138	0.086	0.077	0.085	0.118	0.119	0.118
Total underwriting expenses ^e (fraction of premiums written)	0.233	0.295	0.245	0.231	0.321	0.242	0.232	0.302	0.244
Total expenses (10 ⁹ \$) ^f	18.8	5.2	24.0	10.0	1.8	11.8	28.8	7.0	35.8

From A. M. Best (1992), except as noted. PPV = private passenger vehicles; CV = commercial vehicles; all = all motor vehicles. "Commercial" vehicles are those used primarily in connection with business, commercial establishments, or activities carried out for gain or profit.

^aCoverage that protects the insured against financial loss because of legal liability for motor-vehicle related injuries or damage to the property of others. Includes uninsured motorist coverage (King, 1998).

^bAny motor vehicle insurance coverage, including collision, vandalism, fire, and theft, that insures against material damage to the insured's vehicle.

^cClaims paid out.

^dCosts of closing out claims. A. M. Best (1992) reports the fractions for PPVs and CVs; I calculate the fractions for all vehicles.

^eCommission and brokerage expenses, other acquisition expenses and general expenses (employee compensation, rent, equipment, advertising, travel, board and association fees, office supplies, utilities, and other expenses), and taxes (mainly state and local insurance taxes; excludes corporate income taxes) (A. M. Best, 1992). A. M. Best (1992) reports the fractions for PPVs and CVs; I calculate the fractions for all vehicles.

^fClaims adjustment expenses plus total underwriting expenses.

TABLE 5-11. DATA ON WAGES AND TOTAL COMPENSATION, BY INDUSTRY AND OCCUPATION, IN THE U.S. IN 1990.

SIC category	Data from the National Income Product Accounts (NIPA) of the United States, 1990						BLS News averages		BLS SIC data	BLS occ. data
	<i>billion dollars or hours</i>			<i>\$/hr.</i>		<i>\$/wk.</i>	<i>\$/hr..</i>		<i>\$/wk.</i>	<i>\$/wk.</i>
	wages ^a	comp. ^b	hours ^c	wages ^d	comp. ^d	wages ^e	wages ^f	comp. ^f	wages ^g	earn. ^h
All employees ⁱ	2,743	3,291	197.0	13.93	16.71	442	n.r.	n.r.	454	492
Private industry	2,228	2,632	163.6	13.62	16.08	443	10.92	15.07	447	n.r.
Transportation & public utilities	179	220	10.7	16.64	20.50	587	14.84	21.63	578	n.r.
Trucking and warehousing	40	49	3.1	13.12	15.94	463	n.r.	n.r.	463	458
Finance, real estate, insurance	208	243	11.8	17.63	20.62	573	13.52	18.29	571	503
Services	640	733	48.2	13.29	15.23	409	10.81	14.48	423	321
Private HH services	9	9	2.1	4.27	4.36	131	n.r.	n.r.	179	177
Government	515	660	33.5	15.37	19.69	435	n.r.	n.r.	488 ⁱ	n.r.
Federal non-military	102	138	4.9	20.59	27.85	583	n.r.	n.r.	582	n.r.
Federal military	58	81	4.7	12.18	17.08	345	n.r.	n.r.	n.r.	n.r.
State and local	356	442	23.8	14.91	18.52	422	n.r.	n.r.	467	n.r.

comp. = compensation; earn. = earnings; n. r. = not reported; HH = household.

^aFrom the National Income and Product Accounts (NIPA) of the United States, for 1990 (*Survey of Current Business*, July 1992). Wages include salary, regular bonuses, tips, and overtime earnings paid to persons, including salaried officers of corporations, on establishment payrolls. They include employee-paid taxes; that is, they are "gross" not net of employee-paid taxes. They do not include irregular bonuses, retroactive items, benefits, payroll taxes paid by employers, earnings from self-employment, farm income, or income to business proprietors.

^bFrom the 1990 NIPA (*Survey of Current Business*, July 1992). Compensation is equal to wages and salaries plus benefits, employer-paid taxes, and employer-paid insurance (including social security). comp. = compensation

^cFrom the 1990 NIPA (*Survey of Current Business*, July 1992). The NIPA show hours worked by all employees, by employees in the transportation industries (which include trucking and warehousing), by employees in finance, insurance and real-estate industries, by employees in service industries (which include private household services) and by government employees. I assume that hours worked by employees in the trucking and warehousing industry is equal to hours worked by employees in the transportation industry multiplied by the ratio of the number of employees in the trucking and warehousing industry to the number of employees in the whole transportation industry. I use the same method to calculate hours worked in private household services, federal non-military, federal military, and state and local government.

^dEqual to total NIPA wages (column 2) or compensation (column 3) divided by total hours worked (column 4). comp. = compensation

^eEqual to total NIPA wages (column 2) divided by the total number of full-time and part-time employees (1990 NIPA, *Survey of Current Business*, July 1992; not shown here) divided by 52 weeks/year.

^fThe BLS's *News*, "Employer Costs or Employee Compensation," reports hourly wages and compensation in private industry in March of each year. Wages are "straight-line earnings," which are before-tax gross wages including bonuses, commissions, and incentives, but not including overtime pay. Overtime pay is included as a benefit, which, along with wages, constitute total compensation. Other benefit items are paid leave, insurance, pensions, and legally required benefits. (See the *BLS Handbook of Methods* (1992) for more information.) The figures are reported by general SIC category. I assume that the average for all of 1990 is equal to: the March 1990 figures (*BLS News*, June, 1991) multiplied by 0.75, plus the March 1991 figures (*BLS News*, June 1992) multiplied by 0.25. comp.= compensation. n.r. = not reported.

^gAverage weekly wage from the BLS's *Employment and Wages Annual Averages 1990* (1991). The BLS reports the data by detailed 4-digit SIC (Standard Industrial Classification) industry category. "Wages" include wages and salaries before payroll tax deductions, overtime pay, the cash value of lodging and meals, tips, bonuses, and employer contributions to deferred compensation, but not employer contributions to Old-age, Survivors', and Disability Insurance, health insurance, unemployment insurance, workers' compensation, and private pension and welfare funds. It appears that these data are used in the NIPA.

^hAverage weekly earnings (not wages) of employed wage and salary workers who usually work full time (from unpublished tabulations from the BLS's Current Population Survey; BLS, personal communication, June 1993). Earnings include gross wages and salaries before payroll deductions, tips, and commissions, and overtime. These data are categorized by Census occupation category, rather than by SIC category. I assumed the following correspondences between SIC categories and occupation classifications: trucking and

warehousing (SIC) --> transportation and material moving occupations (occupation); finance, insurance, and real estate (SIC) --> sales occupations (occupation); service occupations (SIC) --> services (occupation); private households (SIC) --> private household (occupation). n.r. = not reported.

ⁱIn the NIPA, "all" includes salaried officers of corporations, but excludes farmers, the self-employed, and business proprietors. In the BLS SIC tabulations, "all" refers to workers covered by unemployment insurance laws.

ⁱDoes not include the military.

TABLE 5-12. ANNUAL COMPENSATION FROM TORT LIABILITY CLAIMS, CA. 1988 (10⁹ \$)

	All accidents	Work-related accidents	Motor-vehicle accidents ^a	All other accidents
Property damage	0.5	0.0	0.4	0.0
legal fees	2.3	0.4	1.7	0.1
pain and suffering	5.2	0.7	4.2	0.1
personal economic losses ^b	7.7	0.8	5.6	1.2
total	15.7	1.9	11.9	1.4

Source: Hensler et al. (1991), Table 4.20.

^aIncludes uninsured motorist payments, bodily injury liability under commercial auto insurance, and direct payment by the responsible party, as well as payment by private (personal) automobile and other insurance (Hensler et al., 1991, p. 198; Marquis, 1998).

^bAccording to Marquis (1998), this is compensation for medical costs and lost productive time. Marquis (1998) states that tort payments typically don't compensate for lost household production, but that any such compensation would be included as compensation for "personal economic losses".

**TABLE 5-13. SUMMARY OF THE COST OF MOTOR-VEHICLE GOODS AND SERVICES
PRICED IN THE PRIVATE SECTOR, 1991 (BILLION \$)**

<i>Cost item</i>	<i>Low</i>	<i>High</i>	<i>Q^a</i>
<u><i>Usually included in GNP-type accounts</i></u>			
Annualized cost of the entire motor-vehicle car and truck fleet, excluding sales taxes	269.3	350.4	A3
Cost of transactions for used cars	12.7	12.7	A3
Parts, supplies, maintenance, repair, cleaning, storage, renting, towing, etc., including costs related to motor-vehicle accidents	161.7	188.9	A3
Motor fuel and lubricating oil, excluding excise and sales taxes and fuel cost attributable to travel delay	73.9	80.8	A2
Motor-vehicle insurance: administrative and management costs, including costs related to motor-vehicle accidents	36.7	36.7	A4
Priced private commercial and residential parking, excluding parking taxes	3.2	3.2	A3
<u><i>Usually not included in GNP-type accounts</i></u>			
Travel time, excluding travel delay imposed by others, that displaces paid work	190.1	229.1	A2
Overhead expenses of business, commercial, and government fleets	90.3	112.9	A3
Private monetary costs of motor-vehicle accidents, excluding user payments	82.8	67.0	A2/B
Motor-vehicle user payments for the cost of motor-vehicle accidents inflicted on others ^b	41.8	14.7	A4/D
Deduction to avoid double-counting property-damage costs under "parts, supplies..." and "annualized cost of the...fleet..." as private monetary costs (here) and external monetary costs	(45.3)	(54.5)	A2/B
Deduction to avoid double-counting insurance-administration costs under "Motor-vehicle insurance..." as private monetary costs (here) and external monetary costs	(19.1)	(19.1)	A2/B
Deduction for income, property, and other taxes embedded in the price-times-quantity estimates above ^c	(59.8)	(57.6)	A2/A 3

Deduction for bundled parking costs included in cost of any industries above, but counted separately here as a bundled parking cost	(6.4)	(22.4)	D
Total	831.9	942.8	

^aQ = Quality of the estimate (see Table 1-3 in Report #1).

^bThe figure under “Low” might be higher than the figure under “High” because a total estimated accident cost is allocated to the different cost categories on the basis of low and high externality fractions, whereby “Low” means low external cost -- and hence high private or personal cost -- and “High” means high external cost.

^cThe figure under “Low” might be higher than the figure under “High” because a high deduction results in lower total private costs. (See Report 17 for more discussion.) Comprises deductions for corporate-income taxes, personal-income taxes, property taxes, environmental excise taxes, gas-guzzler and similar taxes, and the tire tax.

FIGURE 5-1. SUPPLY COST, PRODUCER SURPLUS, TAXES, AND FEES

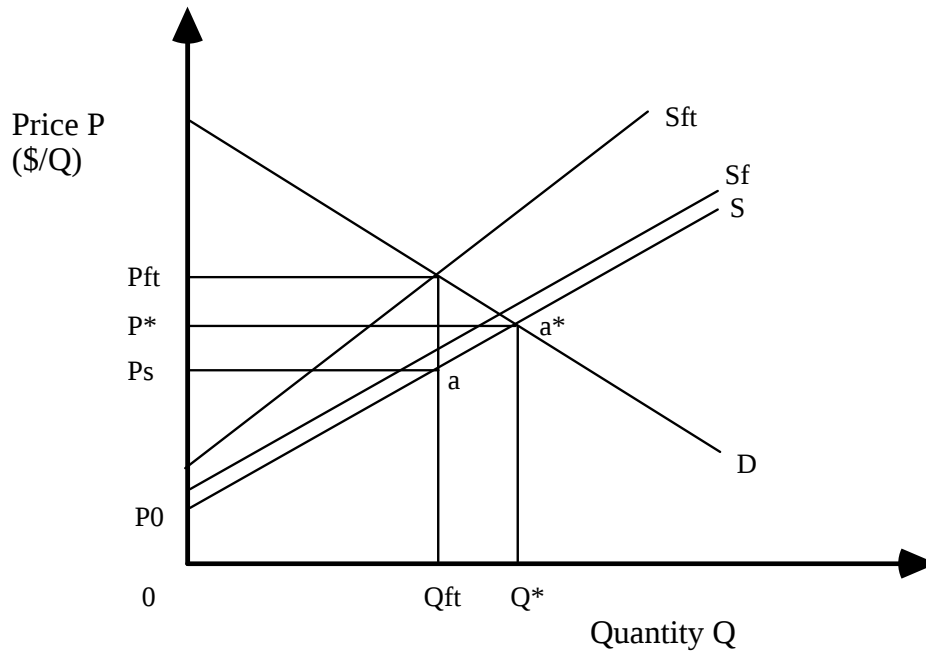
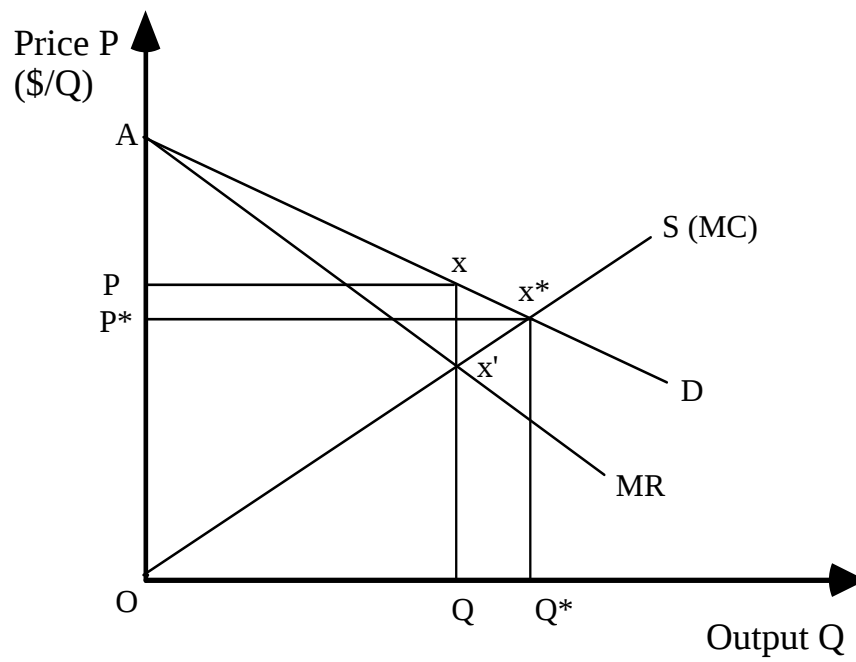


FIGURE 5-2. EFFICIENCY LOSS DUE TO MONOPOLY



APPENDIX 5-A: DATA ON WAGES AND COMPENSATION

The BLS “Employee Costs for Employee Compensation” *News* reports wages and total compensation per hour, by general occupation category and general industry category, from the Employment Cost Index Survey. Wages are “straight-line earnings,” which are before-tax gross wages including bonuses, commissions, and incentives, but not including overtime pay. Overtime pay is included as a benefit, which, along with wages, constitute total compensation. Other benefit items are paid leave, insurance, pensions, and legally required benefits. (See the *BLS Handbook of Methods* (1992) for more information.) Unfortunately, the data are not reported by detailed occupation or industry category. Table 5-11 shows “Employee Costs for Employee Compensation” data for 1990, for the general SIC categories available.

The BLS’s *Employment and Wages Annual Averages 1990* (1991) reports annual average gross wages from the Covered Employment and Wages Program, commonly called the ES-202 program. The ES-202 program collects employment and wage data from the payrolls of all establishments that have employees who are covered by state unemployment insurance, which amounts to virtually all establishments and employees except the self employed. The data are reported by detailed 4-digit SIC (Standard Industrial Classification) industry category (Table 5-11). “Wages” are defined differently in the ES-202 program than in the Employment Cost Index Survey (mentioned above); in the ES-202, wages include wages and salaries before payroll tax deductions, the cash value of lodging and meals, tips, bonuses, employer contributions to deferred compensation, and overtime pay, but not employer contributions to Old-age, Survivors’, and Disability Insurance, health insurance, unemployment insurance, workers’ compensation, and private pension and welfare funds. Hours worked and hourly rates are not reported. These data are used in the estimation of employee wages in the National Income Product Accounts.

The BLS’ *Employment and Earnings* (annual) reports average hourly and weekly wage data for production and non-supervisory workers in the sample of establishments covered in the Current Establishment Survey (CES). The data are reported at the 3-digit SIC level. Wages are defined as they are for *Employment and Wages Annual Averages 1990*. The BLS’ *Employment and Earnings* (annual) also reports average weekly hours by general occupation category, and median (not average) weekly earnings (not wages) by detailed occupation (not SIC) category from the Current Population Survey (CPS). (The BLS also records but does not publish average weekly earnings by detailed occupation category [Table 5-11].) Earnings include gross wages and salaries before payroll deductions, tips, and commissions, and overtime. (Earnings apply to the occupational classification [from the CPS], and wages apply to the industrial classification [from the CES].) The CES data do not include wages of people above the working supervisor level, or benefits for anyone. The CPS data cover all workers, including supervisors, but still do not include benefits.

There are several differences between the data from the CES data of *Employment and Earnings*, and the ES-202 data in *Employment and Wages Annual Averages 1990* (1991). First, the CES data pertain only to production and nonsupervisory workers, whereas the ES-202 data cover all workers, including supervisors and executives. Second, the CES is a sample survey, whereas the ES-202 program covers virtually all establishments. Third, the ES-202 results are reported by 4-digit SIC, whereas the CES results are reported by 3-digit SIC. Finally, the CES records hours and hourly wages, whereas the ES-202 program does not.