The Roads Aren't Free

Clifford Cobb

Americans have not had to pay the way for the use of their cars. That has caused environmental and economic damage, argues the author.

Since World War II, automobile traffic has increased enormously, and per capita ridership on public transit systems has declined. This change in local transportation patterns has given households much greater mobility and freedom than in the past. But it has also created problems. The rise of the car culture has caused environmental, social, economic, and political damage. The reason is quite simple: Private vehicles have not had to pay their own way.

A revenue-neutral tax shift to raise the price of driving and other socially damaging behavior while lowering taxes on productive effort would have an important impact on these problems. Such a policy, for example, would undoubtedly affect urban transportation choices. It would influence how much people drive and the kinds of cars they use, where they choose to live in relation to their jobs, and their willingness to use public transit. In 1998 I wrote a report for Redefining Progress, *The Roads Aren't Free,* which explores these potential effects while estimating to what degree driving is "underpriced." I estimate

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that driving is underpriced by at least $1.60 per gallon of gasoline.

The reason for raising the price of driving as part of the tax shift is to offset, or internalize, some of the costs that driving imposes on society. A cost involves the loss of real resources—time, energy, material, health, and so on—regardless of whether any money actually changes hands. A subsidy, however, exists whenever someone does not have to make payments in direct proportion to the marginal costs he or she imposes on society. Prices should convey information to consumers about the scarcity of the resources used in making a product or a service. If prices fail to reflect that scarcity, the product or service will be overconsumed.

This overconsumption has occurred on a massive scale in the case of driving. Since drivers have not been required to pay the true marginal cost of operating a vehicle, private transportation has appeared to be cheaper than it really is. If the actual marginal cost of driving were determined, it could be reflected in the prices motorists pay, thereby affecting transportation choices through market forces.

When people drive passenger vehicles, both private and social costs are involved. A private cost is one that affects only those directly engaged in a transaction. A social cost is one that involves one or more third parties to the transaction. The costs of operating a vehicle, having access to roads, and protecting petroleum supplies could be deemed private costs. While some of these might seem to be public goods since the government generally provides for them, that is not really the case. Road access is a private good because, in principle, it would be possible for someone to build a road and charge for access to it—just as airlines and railroads charge for access to their facilities. The same is true of the costs of protecting the supply of petroleum used to fuel vehicles. In principle, the oil companies could privatize protection of their supply lines.

The cost of damage to other vehicles and the unseen costs of pollution and congestion—including economic loss—are social costs. The law currently requires motorists to internalize some of these costs by purchasing insurance to cover damage to other motorists and their vehicles. Pollution costs are also internalized in part by laws requiring that vehicles be designed in ways that limit emission of various air pollutants. However, these payments are not sufficient to offset all social costs.

When drivers do not bear the full costs of driving, they are receiving a subsidy—even if the government is not "paying" them anything. If those costs became visible, in the form of taxes or other mechanisms that raised the price of driving, such as auctioned permits for greenhouse-gas emissions or removal of existing subsidies to driving, a variety of consequences might follow. For example, public transit enthusiasts hope that charging a higher price for driving would encourage more people to ride buses, light-rail, or subways. Highway planners hope that it would reduce the amount of driving, thereby somewhat diminishing the problem of congestion. And environmentalists hope that more expensive driving would result in a lower contribution to global climate change, less emission of air pollutants, and more livable cities.

Summary of Findings

The most significant finding of *The Roads Aren't Free* is that the social costs of driving in the United States amount to at least $184 billion per year. This is equivalent to $1.60 per gallon of gasoline. The predominant effect of phasing in such an increased charge on gasoline would be to induce drivers to buy vehicles that are about three times as efficient as those produced today. In other words, Americans would set about taking advantage of the technology that could easily become available if the price incentives were right. Thus more expensive gasoline would not force most people to drive less; rather, they would just drive more efficient vehicles.

For those who imagine that offsetting some of the social costs of driving through a gasoline tax would automatically reduce driving, such results will be disappointing. Higher-priced gasoline would slightly reduce the number of miles driven in the short run; in the long run, however, families would buy more efficient vehicles, incomes would rise, and the income effect would outweigh the effect of higher fuel prices. There would be a minor shift to carpooling and an even smaller shift to transit ridership. The evidence regarding the effects of higher fuel prices on urban form (density and clustering) is mixed.

If state and local governments complement a gas tax increase with measures to encourage efficient use of urban space or to offset localized social costs, they have several policy options. To encourage drivers to shift to transit, local agencies could institute flexible forms of transit and pricing systems that reflect time-of-day costs. When the technology becomes available, they could implement congestion charges in tandem with higher parking fees. States could institute "pay-at-the-pump" auto insurance, so that those who drive more would pay more. Finally, if increasing the density of cities is seen as a method of reducing total driving, measures such as location-efficient mortgages could be of use. *The Roads Aren't Free* looks at some of these complementary local policies.

Estimating the Subsidies to Driving

Part of the calculation to determine the total subsidy to drivers involves making a plausible estimate of the expense of the damage that a society incurs as a result of driving. Any uncompensated damage amounts to a subsidy. There are both *direct* and *indirect* subsidies to driving.

Direct Subsidies

If those who do not benefit from highways and protection of petroleum supplies are paying part of those costs, then drivers are receiving a *direct* subsidy.[1]

Street and Highway Expenditures Minus Fees

Drivers of private vehicles pay a user fee, in the form of fuel taxes, that covers part of the cost of streets and highways. Some states also impose tolls on certain highways. According to the Federal Highway Administration, highway user fees, including tolls, raised $59.6 billion in 1995.[2] Of that amount, light-duty passenger vehicles (cars and light trucks) paid about $42 billion.

The cost of providing state and federal roads and highway services for those light vehicles is approximately $73 billion (the details on how this is arrived at are in the full report). In brief, the $73 billion is a combination of $36 billion in annual replacement costs for existing highway infrastructure plus $37 billion in costs for maintenance and traffic services, administration, research, and law enforcement and safety (Lee 1995, p. 12; U.S. FHWA 1982, p. V-5; U.S. FHWA 1995, Table HF-10 errata sheet; U.S. FHWA 1997, p. V-92). The net effect is that drivers of light vehicles receive an annual direct subsidy of about $31 billion ($73 billion minus $42 billion) for the use of the federal and state highway system.

The costs of driving are also subsidized locally from property taxes and other revenue sources, which pay for paramedic assistance to accident victims and various public works expenses at the local level. This subsidy can be conservatively estimated at $9 billion per year (Hart 1986, pp. 7–9). Thus the combined subsidy to passenger vehicles that results from underpayment of highway and street costs is about $40 billion: $31 billion in federal and state subsidies, and $9 billion in a local subsidy.

Federal Guarantee of Petroleum Supplies

Americans have become very dependent on foreign petroleum. In 1996, about 46 percent of the petroleum consumed in the United States was imported, compared to just 35 percent in 1973 (U.S. EIA 1997). The U.S. government spends large sums to ensure the continued availability of petroleum to American consumers. This amounts to a subsidy to drivers from other taxpayers.

One aspect of this direct subsidy is providing for the Strategic Petroleum Reserve (a federal stockpile of crude oil for emergencies) at home. The reserve's cost is relatively small—about $1 billion per year. Another aspect of this subsidy is the money spent protecting oil supplies overseas. Estimating this cost involves some arbitrary assumptions regarding what should and should not be included, but a critical examination of several past estimates shows that the cost of protecting the Persian Gulf petroleum used by U.S. passenger vehicles is likely between $8 and $10 billion per year. A more comprehensive analysis would also consider the money the United States spends "stabilizing" other regions. Including this, the total cost of U.S. military protection of oil supplies is about $18 billion annually. In total, then, the cost of guaranteeing oil supplies to the users of passenger vehicles in the United States is $1 billion for the Strategic Petroleum Reserve and $18 billion for military services, or $19 billion in total.

Thus, combining the subsidy figures above, the direct subsidy to drivers from general tax revenues amounts to $59 billion: $40 billion for highway costs plus $19 billion for oil security costs.

Indirect Subsidies

Most subsidies of driving fall into the indirect category. These include accident costs not covered by insurance, air pollution, water pollution, noise pollution, climate change, and underpriced parking.

Accident Costs Not Covered by Drivers

Accidents impose a cost on outsiders if the resulting death or injury is suffered by a pedestrian or cyclist, or if the public pays part of the victims' medical costs. This is true only of those costs not covered by private insurance.

The most common approach to analyzing the external costs of accidents is to add up the value of medical expenses, loss of productivity, and other opportunity costs associated with accidents, which involves the morally dubious task of valuing the loss of particular lives (tending to assign a higher weight to high-income individuals). A second approach estimates the statistical value of life according to the premiums required to induce people to accept greater risks. Several recent studies have estimated the value of a statistical life in this way.[3] Based on these studies, the value of a statistical life is here conservatively estimated at $3 million.

There were about 7,000 third-party fatalities in 1995 in the United States, with a total cost of approximately $21 billion. If the cost of a statistical injury is $50,000 (1.6 percent of the value of a statistical life), the cost of the more than 100,000 third-party injuries totals about $5 billion. In addition, the public and hospitals bear an estimated $10 billion in uninsured medical expenses associated with accidents (Lee 1995). Thus the sum of the costs of fatalities, injuries, and public medical costs is about $36 billion per year.

Air Pollution

Heavy reliance on cars and trucks has increased urban air pollution problems, a condition that has been mitigated only partially by emissions controls. The damage imposed by air pollution from motor vehicles comes mostly from emissions of four primary pollutants and their by-products. In the United

States, transportation is responsible for 66 percent of carbon monoxide emissions, 43 percent of nitrogen oxides, and 48 percent of volatile organic compounds (Small and Kazimi 1995, p. 9, citing Ball, Hamilton, and Harrison 1991).[4] Cars and trucks also generate large volumes of coarse and fine particulates. The annual costs of emissions from gasoline-powered vehicles, according to the exhaustive work of McCubbin and Delucchi, are shown in Table 1.

Data from McCubbin and Delucchi have been used to construct a "best estimate" for PM-10 of $50 billion. Adding the other damage estimates yields a total of $56 billion in annual health damage from air pollution due to driving. In addition, air pollution causes about $3 billion in damage to crops and $3 billion in loss of visibility.[5] Combining health damage, crop damage, and visibility loss results in a comprehensive estimate of $62 billion for the damage caused by air pollution from light passenger vehicles.

Water Pollution

Water pollution results from acid rain, runoff of deposited chemicals from pavement, herbicide spraying along rights-of-way, and road salt—all of which damage vegetation and aquatic wildlife. Far less attention has been paid to quantifying the cost of these forms of damage than to the costs of air pollution. The cost of water pollution is estimated in this report to be about $6 billion per year.[6]

Noise Pollution

Building freeways and high-speed arteries to accommodate automobiles has disrupted cities with noise that causes health problems and makes neighborhood life less enjoyable. The value of

Table 1

Annual Costs of Emissions from Gasoline-Powered Vehicles (in 1995 dollars, with geometric means in parentheses)

Pollutant	Estimate ($billions)
Carbon dioxide	1.1–9.3 (3.2)
Nitrogen oxides	1.0–5.3 (2.3)
Ozone	0.2–1.9 (0.6)
PM-10	17–314 (best estimate: 50)

Source: McCubbin and Delucchi 1996.

Note: The geometric mean is the square root of the product of two numbers, an especially useful way to deal with estimates that do not fall within a narrow range.

traffic noise reduction has been estimated in several studies by examining the changes in residential property values as noise levels change. Based on these studies, the cost of traffic noise from light vehicles is estimated here at approximately $8 billion per year.

Global Climate Change

Gasoline consumption by private vehicles is a major reason the United States is the largest source of greenhouse-gas (GHG) emissions in the world. Because carbon dioxide and other GHGs will remain in the atmosphere for a century or more, the effect of these emissions on the world's climate is cumulative and irreversible during the average life span.

The total annual cost of climate change to the world economy is projected by the Intergovernmental Panel on Climate Change at $270–316 billion. The midpoint of that range is $293 billion. U.S. emissions account for about 22 percent of human-generated emissions; consequently, worldwide damage from U.S. emissions would be around $66 billion per year. Since about 20 percent of U.S. GHG emissions come from the combustion of gasoline, the cost assigned to U.S. motor vehicles would be about $13 billion per year.

Underpriced Parking

Underpriced parking imposes an important hidden cost on society and lowers the perceived cost of driving. I have estimated the cost of providing parking spaces at $59 billion per year (Delucchi 1996; Shoup 1992, 1997; and Willson 1995). Since 99 percent of all parking for work and shopping trips is not paid for by drivers, the cost of parking is almost entirely subsidized. But since this subsidy is unrelated to the use of gasoline or the distance traveled on highways, it is not included here in the overall estimate of the subsidy that could reasonably be offset with additional gasoline taxes. However, the parking subsidy may be the single largest subsidy to drivers.

Summary of Subsidies

Based on the estimates outlined above, annual subsidies to driving amount to at least $59 billion in direct subsidies and $125 billion in indirect subsidies, for a total of $184 billion per year.[7]

Setting a Tax Rate to Recoup Costs

Now that the cost of driving has been estimated, the tax that drivers would need to pay to offset the damage they cause can be determined.

In the best case, every form of damage would be offset by a fee that would create a direct link between the amount of damage caused and the amount of fee paid. Not only would there be a specific fee for air pollution, but that fee would distinguish among the amounts of carbon monoxide, volatile organic compounds, nitrogen oxides, and particulates emitted by each vehicle. Fees to cover the cost of highway deterioration would vary according to the vehicle's weight and distance traveled. In reality, however, we are bound by administrative feasibility, which precludes most ideal fees. The various factors that combine in each vehicle to cause damage cannot be monitored easily.

Consequently, we must rely on either a per-mile charge or a gasoline tax to capture the social costs of driving. *The Roads Aren't Free* considers only a gasoline tax, for two reasons. First, a per-mile charge would require government inspection of odometers, which would undoubtedly lead to tampering with those devices and to complaints of government intrusion into the private affairs of citizens. For the time being, the less intrusive gasoline tax is easier to administer. Second, many studies have examined the effects of changes in gasoline prices on behavior; few (if any) have examined the effects of per-mile fees. Thus examination of the effects of per-mile fees would of necessity rely on studies of gasoline prices as a proxy.

Since 115 billion gallons of gasoline were consumed in passenger vehicles (cars and light trucks) in 1995 and the estimated total subsidy was $184 billion, the additional tax rate per gallon of gasoline would be $1.60. This charge would be phased in over a period of ten years to ease transition costs.

The price of gasoline (including state and federal taxes) in the mid-1990s has averaged about $1.25 per gallon, so an additional $1.60-per-gallon charge on gasoline would amount to a 127 percent price increase to consumers after ten years, assuming the base price remained constant. The estimates here and in the following sections assume that all future prices have been adjusted for inflation.

The Direct and Indirect Effects of an Environmental Tax Shift

An environmental tax shift could involve an increase in the tax on gasoline, offset by a cut in taxes on wages and investment in order to strengthen the economy's productive capacity. (See M. Jeff Hamond et al., "Tax Waste, Not Work," *Challenge* [November–December 1997]: 53–62.) Since the net effect would be revenue-neutral, households would, on average, experience no overall increase or decrease in disposable income. The impact on individual households, however, would vary, depending on behavioral responses due to the price change.

Direct Effects of a Tax Shift on Driving

Raising the price of gasoline leads to several direct outcomes. One is a reduction in miles driven. The second is an improvement in the fuel efficiency of new cars, which will use less fuel per mile. The combined effect of these two changes is a reduction in gasoline consumption.

A number of econometric models have estimated the effect of price and income changes on fuel use. When the price of gasoline goes up 10 percent, fuel use decreases by 7.7 percent. However, income growth offsets that effect. When income rises by 10 percent, fuel use rises by 12 percent. We therefore estimate that the net effect of an additional gasoline tax of $1.60 per gallon phased in over a ten-year period (assuming growth of per capita income of 2 percent per year) will reduce fuel use by 71 percent.

Direct Effects of a Gas Tax on Carpools, Vanpools, and Transit

After an environmental tax shift goes into effect, it may not necessarily mean that people will travel less. It may simply mean that people travel together. In order for that to occur, alternatives to traveling in single-occupancy vehicles must be available.

In the past, people have reduced driving by opting for one of two forms of collective transportation: ridesharing or public transit. In the future, this mode shift could include carpools and vanpools as methods of ridesharing, and various forms of public transit, including some (such as jitneys) that are not common today. Based on recent experience, ridesharing is sensitive to the price of gasoline and to incomes. As gasoline prices fell in real terms and incomes rose during the 1980s, ridesharing declined by almost one-third, from 13.8 percent of commute trips in 1985 to 10.8 percent in 1989, according to the American Housing Survey. The Nationwide Personal Transportation Survey (NPTS) records a drop in the average vehicle occupancy of work trips from 1.32 persons per vehicle in 1977 and 1983 to 1.16 in 1990.

Several studies confirm the direct influence of income on carpooling decisions. The 1990 NPTS shows that carpooling declines from about 28 percent in families with incomes below $10,000 to about 15 percent as family income rises to $30,000, then levels off. Other studies have shown that when the cost of driving alone exceeds 5 percent of a worker's family income, he or she is two to three times more likely to carpool than wealthier workers.

Since carpool rates appear to be the inverse of miles traveled per vehicle, it is plausible to expect that carpooling would increase by around 20 percent over a decade as the tax on gasoline rose. The carpool rate would thus rise from around 11 percent of commute trips to between 13 and 14 percent—or approximately the same level as in the early 1980s. Unless the number of vehicles grows much more slowly than in the past, an increase in carpooling of this magnitude would have little effect on congestion.

Another mode shift that would occur as a result of a rise in the cost of driving would be increased transit ridership. This could only be true, of course, for urban and suburban drivers who live in areas served by transit.

In fact, though, the shift to transit in cities would be rather small. Higher incomes and more dispersed cities caused per capita transit ridership to fall by 76 percent in the past few decades: from 116 transit trips per person per year in 1950 to only 28 per year in 1995. Many transit enthusiasts seem to imagine that requiring drivers to pay the full cost of operating a vehicle would dramatically reverse the long downward trend in transit use. Based on the experience in many cities during the oil crises of the 1970s, that might seem plausible, but it is incorrect. The shift to transit from even a large gasoline tax is likely to be small.

Estimates of income elasticities of transit ridership are rather elusive, but it seems fairly clear that the reason for the long-term downward trend in transit ridership in the United States is rising incomes. Data indicate that transit use has decreased at all income levels over time as incomes have increased. Most of the effect of a gasoline tax on transit use will therefore be outweighed by a general rise in incomes, even if the tax is quite large. A 127 percent increase in the real price of gasoline over a period of a decade when incomes rise by 20 percent might therefore translate into only a 12 percent increase in transit trips (Wang and Skinner 1984, p. 38; and Pucher, Hendriksen, and McNeil 1981, p. 466). Since the U.S. population is likely to grow by nearly that much in a decade, transit trips per capita would thus remain at approximately the same level.

This does not mean that other policies to induce a shift from driving to transit cannot succeed. It simply means that even a substantial gasoline tax will not make much difference on its own. For example, an increase in the price of gasoline might have more of an effect on ridership if it were combined with significant changes in transit fare structure. Specifically, local transit authorities should consider raising the price of travel during peak hours and lowering it during the rest of the day. Since price elasticity is lower at peak periods than at off-peak, the price shift would reduce transit deficits by shedding only a few passengers at times of high marginal cost and adding many passengers on trips of low marginal cost.

Indirect Effects on Urban Density and Land Use

Whereas most policies that would bring about denser urban areas involve direct changes in land use, a tax shift that raised the cost of driving would apply indirect pressure to centralize housing and jobs. A tax shift might not noticeably raise urban densities, but it would almost certainly slow the existing rate of population dispersal. The reason for this is simple: If the price of commuting and other urban travel rises substantially, some households will sacrifice the benefits of large dwellings at the urban fringe to live in somewhat smaller units closer to places of work and shopping. Since about half the population moves to a different dwelling every five years, this adjustment process can begin in rather short order if people believe that a rise in costs is permanent.

But the effect of gasoline prices on the geographic dispersal of metropolitan areas could be limited in the future by an increase in telecommuting, teleconferencing, and other uses of information technology. That is, if the rising price of gasoline discourages driving to some extent, the effect might be felt more in the adoption of information technology rather than in physical relocation.

Local Policies to Complement a Tax Shift

Policies could be implemented at the state and local level to reinforce the effects of an environmental tax shift. Some of these policies would reduce the cost or increase the convenience of alternatives to driving, making a tax shift more politically feasible. Others would increase local driving costs where there are external costs specific to particular metropolitan regions. These policies include:

- Promotion of alternative forms of transit, such as jitneys, airport vans, commuter vans, shared-ride taxis, dial-a-ride, and other specialized services.
- Congestion pricing, through traditional tollbooths, automatic vehicle identification (using sensors in or above the road that scan vehicles and charge their owners either by sending a bill in the mail or by debiting a prepaid card), or zone fares (requiring drivers to buy a sticker that serves as a license to use crowded roads at peak periods).
- Parking fees for commuters. Many urban employers pay the cost of employee parking as a fringe benefit, even though the employers often lease the parking spaces they provide, and could immediately cut costs by not offering this service. If employers offered employees a cash equivalent to the cost of providing parking, many employees would carpool, use transit, or perhaps telecommute more often.
- Vehicle insurance to reflect marginal cost, through "pay-at-the-pump insurance" or inspection of odometers at the time of vehicle registration. Through this method, the cost of vehicle ownership would decrease, making it more affordable to low-income families. The cost of driving, however, would increase.
- Location-efficient mortgages (LEMs), which would reward accessibility rather than mobility, encouraging families to trade off the cost of an extra car for the price of a more expensive urban dwelling near transit. With an LEM, a low- or moderate-income family could qualify for a higher-value

house in a densely populated neighborhood served by transit than would be possible under standard banking rules. Some of the money they would ordinarily spend on an extra car could be used to help pay off the mortgage.

- Incentives for brownfields redevelopment. Contamination and abandonment of urban industrial property has been one reason for employment dispersal, which increases commuting distances and generally promotes travel in private vehicles by expanding the geographic size of metropolitan areas. While there appears to be no simple solution to this issue, new incentives for brownfields redevelopment—such as the one passed by Congress in 1997—are a first step toward remedying the problem.
- "Land-value capture," which is based on the principle of recouping part of the windfall to property owners who own buildings or homes in the vicinity of new transit hubs. This tool would not only minimize the need to subsidize transit systems with sales taxes, it would also increase transit use by concentrating employment and residence near transit stops.

Conclusion

The widespread availability of cheap fuel and affordable cars and light trucks has given Americans an unparalleled degree of mobility. That mobility has come with a price—one that motorists have not been required to pay in full. *The Roads Aren't Free* estimates the unpaid cost imposed by motorists on third parties to be $184 billion—or about $1.60 per gallon of gasoline consumed. That cost does not include the subsidy that drivers receive in the form of free parking or the cross-subsidy among drivers that is caused by congestion.

Phasing in an additional gasoline tax of $1.60 per gallon over ten years would offset much of the subsidy that driving now receives and encourage changes in motorist behavior. Above all, it would encourage households to buy more fuel-efficient vehicles, perhaps two-thirds more efficient in the medium to long run. It would also reduce the amount of driving in each vehicle by 15 to 25 percent, but that would ultimately be offset by more vehicles on the road.

More expensive fuel would not significantly alter mobility patterns, although it might reduce total vehicle-miles traveled 14 percent. Transit use might rise slightly before continuing its downward trend, and carpooling would increase by perhaps 20 percent. But, on the whole, a large increase in the price of gasoline would not noticeably change Americans' heavy dependence on cars. Those who hope to encourage a resurgence of reliance on transit should thus focus most of their attention on land-use issues, not on increased subsidies of transit systems.

To reduce the amount of traffic in U.S. cities, other approaches will be needed in conjunction with higher gasoline prices. Congestion charges and parking fees for commuters represent one set of policies that would complement a national tax shift by reducing local congestion. In addition to rationalizing the traffic patterns of a metropolitan area, these policies would generate large amounts of revenue—but they are not policies that can be pursued by the federal government.

Higher-priced gasoline might have some effect on urban density, but not enough to resist the pressure for low density that results from higher incomes. Some local policies could be used to encourage higher urban densities. *The Roads Aren't Free* touches on a few policies that might have this effect. First, the provision of location-efficient mortgages could encourage more people to move into denser neighborhoods where they would not be as reliant on cars as they are in more distant and dispersed suburbs. Second, breaking the logjam surrounding the redevelopment of brownfields would open up large amounts of urban land that is currently bypassed as industries relocate in suburbs or rural areas. The dispersal of housing will continue as long as the dispersal of jobs is taking place. Third, an increase in the price of parking would raise the net cost of driving short distances above the cost of transit. The effect might be to encourage at least some people to live closer to work.

For 100 years, American society has been gradually turning over more and more space and authority to motor vehicles, reducing the potential of streets to serve as public space. The policies discussed in *The Roads Aren't Free* represent only the first steps toward reversing that trend. Taxation and land-use instruments, such as an environmental tax shift, can begin to restore the balance between people and cars and thereby provide ways to address long-term problems such as climate change and congestion through new market mechanisms.

Notes

1. Since the purpose of this report is to estimate the effects of subsidies on driving, only factors that lower the cost of driving are included here, not ones that merely transfer resources among different groups within society. Not included are what some analysts have regarded as implied costs of or subsidies to driving related to (1) oil depletion allowances and other tax credits or deductions given to oil companies, (2) the macroeconomic effects of oil shocks, (3) the cost of the trade deficit due to oil imports, or (4) delays due to traffic congestion. The first and third cases represent transfers (a shift of resources between individuals) rather than costs; the second is not sufficiently demonstrated to include; and the fourth represents a cost internal to drivers.

2. For complete citations and derivations of the figures and statistics in this article, see the complete report. Some references and notes have been omitted in the interest of space.

3. In one survey, the values from studies ranged from $1.6 million to $8.5 million in 1986 dollars (Fisher, Chestnut, and Violette 1989, p. 98). In 1995 dollars, the geometric mean of the endpoints of the range is $5.1 million. In a more recent survey, the mean value of studies since 1987 was $7.0 million and the median $7.45 million (Viscusi 1993, pp. 1926–27). Because some methodological issues remain unresolved, however, I have chosen a value toward the lower end from these surveys.

4. Electricity generation and industrial processes emit most of the remaining air pollution, except for coarse particulates (PM-10 and larger), which come from agriculture and other sources.

5. Delucchi, Murphy, Kim, and McCubbin (1996, p. 51) estimate that net cost of crop damage from motor vehicle emissions is $2.2 to $4.2 billion, of which about 75 percent could be attributed to light passenger vehicles. Delucchi, Murphy, McCubbin, and Kim (1996, p. 27) estimate that the cost of lost visibility from air pollution is between $4 and $26.5 billion if motor vehicles are solely responsible for visibility loss, or between $400 million and $2.5 billion, assuming 10 percent of the loss is due to motor vehicle emissions. The geometric mean of the geometric means of the two ranges is $3 billion, which is the value I assign to visibility loss from vehicles.

6. My estimate of the cost of water pollution, an average of the following three estimates, is $6 billion per year: $2.3 billion (U.S. OTA 1994, Table 4-6, p. 108, midpoint of range); $4.4 billion (Miller and Moffett 1993, p. 50); and $11.1 billion (Lee 1995, p. 12, based on one-half cent per VMT). All estimates have been transformed into 1995 dollars using the Consumer Price Index.

7. The $184 billion estimate is shown in detail in the full report. The major elements in this net subsidy are: $40 billion in costs of streets and highways not paid by drivers, $19 billion spent defending oil supplies, $36 billion in uncompensated accident damage, and $89 billion in environmental damage.

For Further Reading

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