Economic Incentives and Mode Choice

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Economic incentives are an important determinant of mode choice. Nonmotorized and mass transit modes are placed at a particular disadvantage in the United States and elsewhere by the subsidies provided in the form of the externalities of private motorized travel, which are not included in user fees. In addition, there are transfers at the local government level in the form of property and other taxes used to pay for roads under local jurisdiction. The nature and magnitude of these incentives for private motorized travel are described on the basis of existing literature. The literature on the social costs of highway use is limited. Few comprehensive treatments exist that attempt to include all social costs. Research on specific areas of social costs is also uneven. Some areas, such as the costs of highway crashes, are well treated (although without distinction between societal and social costs), and others, such as the costs of water pollution, are quite limited. Research recommendations are proposed to better understand these incentives and to develop economically efficient user fees that would encourage greater use of nonmotorized modes.

Nonmotorized transport has begun to attract the attention of transportation professionals and the lay public in the United States and internationally. Evidence to support this assertion ranges from growing interest in local governments in the United States to interest at the World Bank. The secretary designate of the U.S. Department of Transportation has signaled his interest in nonmotorized modes in press reports.

There are several reasons for this interest. Local governments are struggling with the problems posed by increasing vehicle-kilometers being traveled and the concomitant congestion. Many local governments are also faced with severe air pollution problems, which are gaining attention under the Clear Air Act Amendments of 1990. National governments are contending with the emerging issue of greenhouse gases and global climate change. The traditional solution to congestion of adding capacity is giving way to more sophisticated strategies with multiple elements, including demand management, land use planning, provision of alternative modes, as well as added capacity. The dynamics of community development have shown the traditional "build two more lanes" solution to be ineffective or even counterproductive in many instances. Traditional solutions are becoming less affordable as costs continue to be transferred to local governments.

If nonmotorized modes and mass transit are to play important roles within a multimodal transportation context, it is important to understand the basis for mode choice. It is particularly relevant that nonmotorized mode use decreases in importance with income. The industrialized nations tend to have the greatest dependence on motorized, particularly private, transport. Similar trends toward motorized transport are evident in developing countries where urbanization and incomes are both increasing. These trends raise the question, Are these trends inexorable, or can economic growth be consistent with maintaining a significant role for nonmotorized transport?

This paper considers some of these questions by exploring the economic incentives in the United States for private motorized travel. It critiques the role of government in influencing modal choice, particularly subsidies and transfers to private motor vehicle users. The general finding of this research is that the patterns of subsidies and transfers, along with the mix of transportation infrastructure, are heavily skewed in favor of private motorized travel over nonmotorized modes and mass transit. It is apparent that market forces are often prevented from playing their normal role in choice of transportation mode.

ECONOMIC FACTORS IN MODE CHOICE

Traditional models of transportation behavior focus heavily on out-of-pocket costs and time. Other determinants include safety, prestige, comfort, convenience, physical fitness (i.e., in the course of walking or biking), and pleasure whether derived from walking, biking, or driving. Residential location, which in turn is influenced by transportation infrastructure, is an important determinant of available transportation options and the costs associated in using those options. An important issue in nonmotorized mode use is the provision of safe rights-of-way. For example, in other parts of the industrialized world, such as northern Europe, where provision is made for bicycle use on separated right-of-way, there is considerably greater use of bicycles.

Government policy plays a dominant role in the determination of the transportation infrastructure provided and in the incentives for the modes and type of travel. The incentives are structured through the transportation funding, management, and expenditure processes. In the case of roadway funding, user fees often provide only half of the funding required. The remaining costs are provided by transfers from other revenue sources, such as the local property tax (*1,2*). In addition, extensive externalities are not accounted for in user fees, although some regulations such as emissions control requirements limit the extent of environmental and safety externalities. Whereas subsidies are also provided for mass transit and to a lesser degree for nonmotorized modes, aggregate subsidies are considerably less than for private roadway use.

Since highway users do not face appropriate user fees, they receive incorrect economic signals and, by implication, make inferior travel and land use choices. New highway and other investments, in turn, are based on travel and associated traffic counts and congestion levels resulting from the underpricing

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of roadway use. In other words, there is more travel and land use dispersal than is efficient. It is notable that average cost or marginal cost principles are used in pricing other basic infrastructure, such as electricity, natural gas, water, sewer, and telecommunication services. Transportation, however, is not held to the same market standard.

There is a growing interest in bringing to transportation the same set of principles and incentives used in the privately operated economy. In a paper on congestion pricing, Orski (*3*) cites a report by the Bay Area Economic Forum contending that market-based approaches would bring about a more efficient and less costly means of achieving air quality standards than the current regulatory approaches of Southern California. Orski goes on to contend that the awakening interest in private market mechanisms is responsible for the revival of interest in congestion pricing.

The interest in market-based approaches to transportation-related problems correlates with the growing interest in the broader issue of the social costs of highway use. It also appears that parallel developments in planning methods in electric utility planning (integrated least-cost planning) are influencing the field of transportation planning.

Long-standing government policies that skew economic incentives and infrastructure in favor of private motor vehicle travel have resulted in exaggerated levels of private motor vehicle travel and diminished use of nonmotorized modes and mass transit. It is not known how much travel patterns have been distorted, and it is impossible to estimate with existing methods and models the magnitude of the effect. It is hypothesized, however, that considerably more nonmotorized travel and mass transit use would occur with pricing based on full cost. A different mix of infrastructure and land use patterns less adapted to private motor vehicles would be expected. It has been argued that establishing a pricing system that reflects the true cost of travel is a straightforward way of improving transportation efficiency (*4*).

Although the magnitude of distortion in travel is not amenable to estimation, it is possible to estimate the magnitude of many of the economic incentives in favor of private motor vehicle use.

The focus of this paper is on the nature and magnitude of the incentives, in the form of social costs and transfers, in the United States. Government policy to encourage motorized travel and discourage nonmotorized travel is also common in many industrialized as well as developing countries.

NATURE AND MAGNITUDE OF SOCIAL COSTS OF ROADWAY USE

The literature discussing the nature and magnitude of social costs of highway use is surprisingly limited in certain respects and extremely broad in others. However, the total volume of literature that explicitly adopts the formalism of economics in treating social costs of transportation is small considering the magnitude of the social costs and the importance of the highway system to the U.S. economy and to the fabric of contemporary American society.

Where social costs are explicitly addressed in economic terms, the focus is usually on particular aspects or impacts of the transportation system. For example, the Urban Institute recently completed a far-reaching but focused study that addresses both societal and social costs of highway crashes (*5*). The literature pertaining to some basic environmental areas is limited. There are very few cost estimates of the highway damage to surface water and groundwater resources despite widely acknowledged impacts resulting from storm water runoff (including oils and greases, road salt, and sediment loadings) and deposition of airborne pollutants.

The societal cost of highways includes all of the cost categories shown in Figure 1, whereas the social costs are those noted under the externalities branch of Figure 1. Few studies attempt to integrate all the different aspects of highway social costs into a comprehensive analysis of the social costs of highway use.

The literature that does not follow a formal economic treatment is immense, and the coverage is very broad. The difficulty raised by this literature is that, although it treats a wide range of issues pertinent to social costs, the material is not amenable to summarization, particularly in terms that measure social costs or lead to the establishment of efficient user fees. Efficient fees are "those which would ensure that the price paid by the roadway user is equal to the increment of social and private costs resulting from the highway use" (FHWA, statement of work for Contract DTFH61-91-01345).

This paper focuses primarily on the literature treating the social costs of highways in economic terms. The approach used follows "taxonomies" of the costs of highways shown in Figure 1. The literature is summarized and assessed in qualitative terms. It would be useful to systematically update the social costs of highway use on the basis of the literature reviewed and ongoing work, but such an effort is beyond the scope of this paper. A brief compendium of aggregated cost estimates provides a range of values.

Definitions

An efficient user fee that would alter existing incentives favoring private motorized travel, such as a highway toll, would include social costs as conventionally defined plus other transfer payment costs that are external to the market transactions of highway use but that are currently paid for out of pocket. Road construction paid for by public funds such as property taxes is an example of a transfer payment cost that is paid for out of pocket, as shown in Figure 1.

It is also important to distinguish between externalities imposed on individuals not using the highway system versus externalities imposed on individuals using the system coincidentally. Conventional external costs, as shown in Figure 1, include loss of aesthetics, odor, noise, water pollution, air pollution, climate change, and so forth. An externality that is primarily imposed on other coincidental users of the roadway system is congestion, as is shown by the separate branch under externalities in Figure 1. However, congestion costs, such as interference with pedestrian movement, may also affect non–system users, as shown in Figure 1.

Completing the externalities portion of Figure 1 is the category "external cost to nonbenefitting public." This distinction is drawn to bring attention to the fact that some impacts, such as acid deposition and climate change, may affect populations that do not benefit from the mobility that is the source

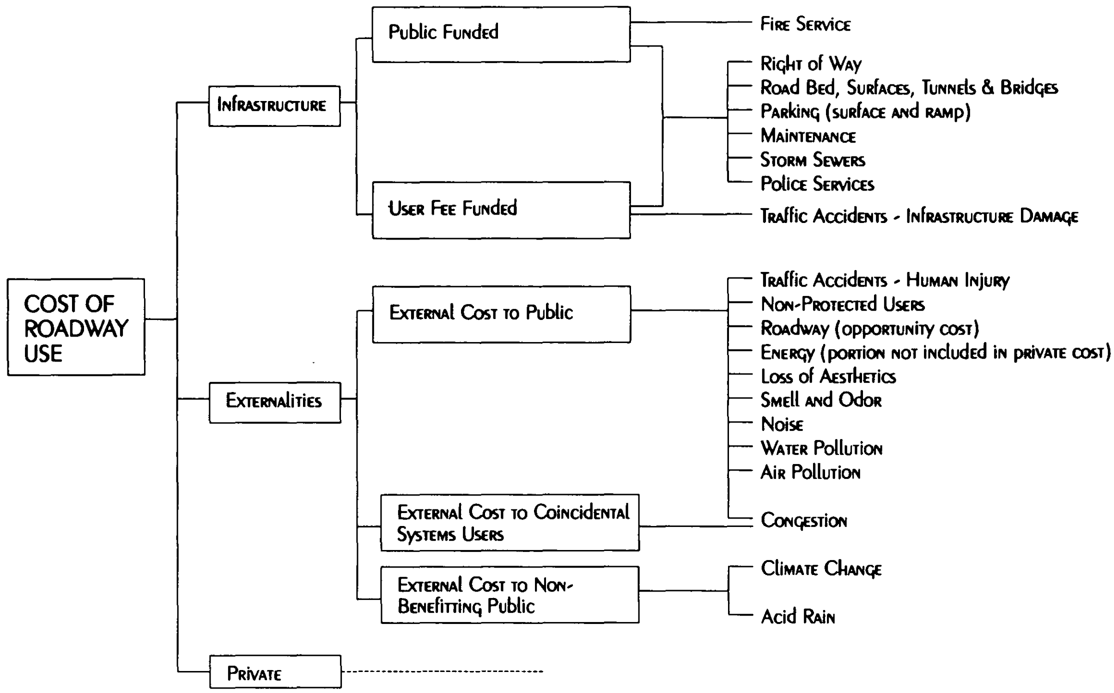

FIGURE 1 Taxonomy of costs of roadway use.

of the externality. Within the urban area, it can be plausibly argued that urban residents benefit, at least indirectly, from the travel of others. (If the social costs of highway use are considered, say at a national level, the boundary between the public benefitting and not benefitting changes. However, in a world where the vast majority of households do not own a motor vehicle, the issue of impacts on the nonbenefitting public remains, particularly for climate change.)

The social costs included under the "externalities" branch of Figure 1 are the primary focus of this paper. The establishment of efficient prices, however, will require the inclusion of other costs of the highway system that are not currently included in highway use prices. In Figure 1, these subsidies or transfers include those identified as "public funded" costs under the "infrastructure" branch. These costs include road construction, bridge construction, signalization, repair, maintenance, storm sewer construction and maintenance, police services, right-of-way acquisition, and various planning and administrative costs associated with these services. The payment of these costs currently comes from both user fees and other, general revenue sources such as the property tax.

The "private" cost branch of the diagram is not delineated but is included to indicate the complete picture of the societal costs of roadway use. Private costs include insurance costs and the pain and suffering of injuries and deaths, which amount to enormous societal costs. The fact that these private costs are as large as they are and individuals still travel at their current rates is indicative of the benefits to society of highway use. Whereas health costs and human pain and suffering are largely private costs, two aspects are considered social costs in this paper. The first relates to impacts on "nonprotected" individuals such as pedestrians and bicyclists. The second is the loss to society of individuals' work-related and non-work-related production. These two social costs are included under externalities in Figure 1.

Summary of Literature on the Nature and Magnitude of Social Costs

A summary evaluation is presented in two parts. The first is an overall assessment of the state of the literature. This is followed by a category-by-category review following the structure of Figure 1.

Overall Assessment

The state of knowledge of the social costs of highway use as reported in the literature is only fair at best. This conclusion reflects in part the size, numerous facets, and complexity of the topic. The definition and measurement problems are enormous. The overall size of the issue lends itself to segmented approaches.

The meager state of knowledge reflects a prevailing lack of interest, until quite recently, in applying market principles to the pricing of highway use. After all, if market principles were not being applied, a segmented approach focusing on specific, important problems (e.g., reduction of accident occurrence and severity of injuries) made sense.

The net result is that very few systematic economic treatments of the overall social costs of highway use exist, and treatment of the specific aspects is uneven. The work of Hanson (*2*) and Ketcham (*6*) is a starting point for assembling an aggregate picture, at the urban or the national level, of the social costs of highway use. The Hanson work explicitly excludes a number of social cost items that need to be developed. Coincidental with the publication of that work, FHWA published a major study by Miller et al. (*5*) on the cost of highway crashes that provides considerable information to fill in some of the exclusions in the Hanson work.

The Ketcham work provides an estimate, for selected localities and at the national level, of the total costs of transportation ($1,658 billion in 1990, which is equal to about one-third of the U.S. gross national product) and for social costs ($860 billion). However, definitional questions as to what is an externality or social cost versus a private cost are left unanswered and need to be addressed. Other aggregate studies have been done at the municipal level, including the work of Hart (*7*) and Kinney (*8*).

Recommendations for future research include development of a national aggregate social cost estimate and establishment of a set of highway social cost accounts on the basis of environmental accounting. Such work appears to be under way under the auspices of the Economic Analysis Division of the U.S. Department of Transportation's Volpe National Transportation Systems Center. Such a set of accounts would provide time series data measuring developments in externalities, publicly funded infrastructure costs, and some private societal costs not routinely reported.

Categorical Costs—Externalities

Traffic Accidents The health costs attributable to highway accidents have been the subject of recent work at the Urban Institute (*5*). This work is thorough and extensive. An issue not treated in the Urban Institute report but critical to this review is which of the costs considered should be labeled social costs and which are exclusively private costs. An important cost, which in many instances can be considered a social cost, is the impact on nonprotected users (i.e., pedestrians and bicyclists). This subject is treated in some depth in the European literature (*9*).

Roadway Opportunity Cost The literature review found few studies presenting systematic economic estimates of roadway opportunity costs. The issue is identified by Giuliano in an October 1989 report to FHWA, *Literature Synthesis: Transportation and Urban Form* (DTFH61-89-P-00531). Because this is a complex issue relating to past decisions and requiring specification of alternative land use patterns and their value, this does not seem to be a promising area for research.

Energy (Portion Not Included in Private Cost) The issue of nonprivate energy costs is largely one of the tax treatment of the oil industry. The tax benefits are reasonably well known and do not make up a large cost item (*2*). The indirect environmental impacts and hence social costs of oil and natural gas production are much larger, with both routine and episodic events (e.g., the *Exxon Valdez* spill in Prince William Sound). As a matter of convention in the literature reviewed, studies estimating indirect effects were not included.

Loss of Aesthetics Loss of aesthetics results from the influence of highways on urban and rural landscapes and from visibility losses attributable to motor vehicle emissions. There are qualitative discussions of aesthetic loss, but this review did not find systematic attempts to place an economic value on aesthetic losses. The loss of visibility has been evaluated in research, notably by Crandall et al. (*10*) and Freeman (*11*). Current work dealing with visibility losses (not associated with transportation sources) in the Grand Canyon has arrived at some very high estimates of damages using contingent valuation. Such approaches are controversial.

Odor The literature provided no economic estimates of the social cost of odor from highway sources beyond qualitative treatment.

Noise The primary references in the literature approach valuation and noise impacts by associating the loss of property values with noise levels, using hedonic property price methodologies. The difficulty presented by this literature is that it focuses only on specific highway segments and conditions. There were no reported attempts in the literature to derive urbanwide values other than that of Ketcham (*6*).

Water Pollution Water pollution associated with highway construction and use is frequently addressed in the literature. There is little in the way of economic evaluation of the impacts, however, beyond the work of Murray and Ernst (*12*).

Air Pollution and Climate Change The social costs of air pollution are possibly among the three largest categories of social costs of highway use. The two other leading categories are traffic accidents and congestion costs. The importance of the subject is reflected in the Clean Air Act of 1990. There is, however, considerable uncertainty about the cost of air pollution in the literature.

The review found a few recent studies attempting to update transportation-related social cost estimates for air pollution since the 1970s and early 1980s. Some recent estimates are provided by MacKenzie and Walsh (*13*), which use a $10 billion per year estimate. The authors consider this estimate to be conservative, citing the work of Sperling and DeLuchi (*14*), which cites a range of $10 billion to $200 billion, and the American Lung Association (*15*), which estimates costs due to pollution at $40 billion to $50 billion from all sources on the basis of health care costs and work time lost. Ketcham (*6*) reports $30 billion for health care costs alone due to transportation air pollution.

Some recent studies have examined the benefits of air pollution control in the California South Coast Air Quality Management District (*16–18*). The estimated benefits from pollution reduction with the district plan ranged from $2.4 billion to $20 billion per year by 2010 for all sources, including transportation. In evaluating those studies for the district, Krupnick and Knopp (*19*) arrived at a wide range of estimates of up to $4 billion. In the same study, the authors found a range of benefits nationwide of $250 million to $1 billion for volatile organic compound emissions control only, to reduce ground-level ozone. This national study was based on an Office of Technology assessment study (*20*), which excluded transportation control plans, and considered acute health effects only.

Difficulties in using these studies to estimate transportation damages include the following:

- Some do not distinguish between transportation-related damages and other damages;
- Some consider the benefits of emissions reduction, not the total cost of damage from all emissions present; and
- Some do not estimate damages from all emissions, particularly the study by Krupnick and Knopp.

If global climate change is included under air pollution social costs, air pollution social costs could be much greater. The climate change literature [e.g., Abrahamson (*21*)] indicates considerable scientific uncertainty as to the changes in climate and sea level that may occur. It is well established that atmospheric carbon dioxide concentrations are increasing and that the ozone layer is being depleted, with holes appearing over the poles. It is less certain what the climatic consequences will be, but there is considerable literature suggesting that significant changes are possible. Some of the studies indicate massive economic disruption and damage. Transportation is one of the major contributors to global carbon and chlorofluorocarbons emissions, important precursors to climate change.

Congestion Costs are large and rapidly growing in many large urban areas. Ketcham (*6*) uses various sources including the 1982 FHWA cost allocation study to provide a national estimate of congestion costs for 1990 of $168 billion. Hanks and Lomax (*22*) and DeCorla-Souza and Kane (*23*) assess costs for specific cities and specific highway facilities in urban core areas and urban fringes.

Acid Rain Acid rain is a growing concern in the northeastern United States and eastern Canada and more recently in parts of the western United States. Although sulfur species are the most important precursors, nitrogen oxides are the next largest, and their emissions are strongly associated with motor vehicles. As total sulfur emissions decline nationally, the role of nitrogen oxides may become more significant. As damage estimates are developed, attention should be given to the transportation contributions.

Publicly Funded Infrastructure Costs

Publicly funded infrastructure costs represent large transfers from society in general to highway users. The benefits of the transfer increase with increasing private use of highways. Recent forecasts by FHWA (*24*) indicate that highway user fees will account for 61 percent of the $80 billion in highway receipts for calendar year 1992. Of this total, $19 billion (23 percent) is estimated to come from property taxes, general fund appropriations, and other taxes and fees, representing a significant transfer.

An increasingly popular theme in the literature is that if market principles are to be applied to transportation, these infrastructure costs should be borne by highway users along with the social costs. Whereas there is a significant body of information on these costs at the federal level [see, for example, the discussion of DeCorla-Souza and Kane (*23*)], the work of Hanson (*2*) suggests that the costs could well be higher than reported in the FHWA data. Data collection procedures and definitions should be reviewed to identify means of collecting data on costs that are currently being missed or underreported. These data should be collected as part of the highway social cost accounts.

RESEARCH NEEDED TO QUANTIFY SOCIAL COSTS

Overview

An underlying rationale for research in the area of social costs of highway use is movement toward establishing economically efficient user fees. This goal implies a research program that would assist in the design and establishment of such user fees. Such fees are an important feature of multimodal transportation strategies that substantively support nonmotorized modes. Efficient user fees are also an essential element in transportation demand management (TDM).

On the basis of the review of existing literature, five areas of research would serve such a research program:

1. Studies on aggregate social costs at urban and national levels, with supporting research in water pollution; the social costs of crashes, including unprotected users; and differences in per capita travel within urban areas;
2. Development and implementation of a set of social cost accounts linked to conventional transportation data and accounting systems;
3. Support for publicly and privately funded TDM actions and infrastructure projects where highway pricing or other traffic demand aspects are important parts of the project (this research support program would also evaluate social costs of specific highway segments or other transportation infrastructure where these costs are unusual in type or magnitude);
4. Review of successful nonmotorized mode development in industrialized and developing nation settings; and
5. Evaluation of the application of integrated least-cost planning (developed and now extensively used in the electric and gas utility industries) to transportation planning.

In addition, it is recommended that a center for research on least-cost transportation planning be established. Such a center would both undertake and fund research in areas including highway social costs, highway user charges, and TDM. The center would emphasize the appropriate role of nonmotorized modes in least-cost, multimodal transportation planning. The center could be a new, stand-alone entity or could be established by assigning an additional discrete focus to one of the centers in the University Transportation Centers Program.

The recommended research agenda recognizes certain critical underlying conditions. It is evident from the literature that the social costs of highway use are uncertain, but very large. Some further estimation is useful to fill in important gaps. Whereas sufficient scientific information exists to establish average minimum user charges for urban areas or for states, perceived political realities do not permit higher user charges. Such user charges include tolls, fuel taxes, excise taxes, or other charges, possibly utilizing intelligent vehicle/highway systems that would account for all existing direct costs in most instances. This ignores the even larger social costs, which would raise highway tolls or other user fees by an even greater amount.

Whereas minimum average costs can be determined at this time, marginal cost pricing is the ultimate goal in establishing efficient highway tolls. More information will be required to determine marginal costs and establish user charges at specific times and places. Where congestion costs are dominant, this information can be collected and partial marginal cost fees established on the basis of lost time. More work would be required to include marginal energy use and emissions costs.

Within this context, it is prudent to focus some research on urban areas where innovative highway charges and nonmotorized modes could be implemented in the near future. Areas include nonattainment areas under the Clean Air Act and tolls for new highways, tunnels, and bridges under public or private ownership being built to meet congestion relief needs. This market-oriented research focuses on issues of consumer acceptance of TDM and the social and economic effects of various TDM measures. This in turn lays the groundwork for future program and project designs.

This research agenda also recognizes that the development of social accounts will, over time, provide a basis for monitoring the evolution of social costs and environmental impacts associated with transportation without necessarily expressing those costs in monetary units. Such an accounting system is useful for considering environmental and other social implications of the transportation system and lays part of the framework for estimating social costs as they become better defined, measured, and understood. As actions are taken to reduce urban emissions, such accounts will provide a baseline against which progress can be measured.

Specific Recommendations on Research Needs and Approaches

Urban and National Level Social Costs

Some aggregate estimates of urban and national level social costs have been made since the 1982 Federal Highway Cost Allocation Study. These studies include the estimates of DeCorla-Souza and Kane (*23*), Hanson (*2*), Hart (*7*), Kinney (*8*), Ketcham (*6*), and most recently MacKenzie and Walsh (*13*). In the light of the social costs not included in these studies, some of which have been recently treated [the cost of highway crashes (*25*)], it is recommended that an updated range of national estimates be developed. Such an effort should be augmented by work delineating the social cost portion of the social costs of crashes and by work in water pollution. The work would establish a new bench mark range of estimates of the social costs. The current estimates of costs appear to be in the range of $60 billion to $860 billion per year as indicated in Table 1. Excluding some costs that arguably should be deleted from the high estimate and including costs explicitly excluded from the lower estimates, the plausible range might be narrowed to $200 billion to $400 billion per year.

TABLE 1 Estimates of the Social Costs of Highway Use

Source:	$ Billion/Year
American Public Transit Association (automobile only) (Developments Vol. 1, No. 2, Spring Summer 1990)	300
Hanson (2) (excludes highway crash, congestion and greenhouse costs) (uses conservative estimates for all cost categories)	64
Hart as cited in (13)	60
Ketcham (6) (most inclusive estimate) (includes costs which are self insured and greenhouse effects)	860
MacKenzie, Down and Chen (13)	300

In conjunction with the estimate of national social costs, a set of urban and rural area costs should be developed to better understand the diversity of costs across the United States and within urban areas. Urban area estimates should take into account the highly variable travel patterns in different parts of urban areas. One reason for measuring the difference in per capita travel in different locations is to estimate the costs that residential (and possible industrial and commercial) locations impose on society. Locations that demonstrate higher per capita travel levels might be subject to user or impact fees according to the "capacity" that development in those locations demands. Capacity-related fees of this type are common in utilities.

A 1983 study for FHWA (*26*), for example, revealed that residents living in exurban rural areas of Dane County, Wisconsin, traveled twice as much as urban (Madison urban service area) residents. Residents in outlying cities and villages traveled more than urban residents but less than their rural neighbors. Similar findings are reported by Newman et al. (*27*) for Perth and New York City. These findings may imply some revisions in the national personal transportation survey to better understand the role of residential location in influencing travel patterns and social costs.

If new survey work is to be undertaken, an initial pilot survey and analysis of a small cross section of cities will require perhaps 2 years. This research should concentrate on the level and location of travel and estimates of the burden on public infrastructure and social costs. This type of information would be useful for the design of tolls and toll collection systems.

Development and Implementation of Highway Social Costs Accounts

Increasing attention has been given by the environmental science community to the issue of environmental accounts. Environmental accounts include more than social accounts. The rationale is that there is a need for consistent information on environmental burdens (i.e., emissions, effluents, and resource use) and effects (e.g., health effects, materials damage, and ecosystems impact). Environmental accounts in conjunction with routinely collected transportation system information would provide a more complete picture of the direct consequences of transportation systems investments and use. From an economic perspective, the measured and perceived benefits of choices of transportation system investment, management, and use could be better weighed against the private and social costs.

Many environmental indicators could be included in a transportation environmental accounting data base. As a matter of consistency, environmental accounts should be collected and published by existing, responsible units within the U.S. Department of Transportation and FHWA. The design of the environmental accounts, however, should be the subject of a research effort that would recommend the contents of such accounts, including specific measures, units, and means for collecting the data.

Initial guidelines for such an accounting framework should rely on existing secondary data sources as much as possible and emphasize aspects in Figure 1 that are known to have large social costs, such as urban air pollution, congestion, and highway crashes.

TDM Research Initiative

There has been a nationwide increase in TDM projects. Projects include measures in five broad categories:

1. Managing flows on specific segments with such measures as computerized signalization and high-occupancy vehicle (HOV) lanes;
2. Altering time of travel with such measures as staggered shifts and flexible hours;
3. Altering modes of travel by vanpooling, transit of various kinds, bicycling, and walking;
4. Altering parking incentives by imposing or increasing fees, providing equal compensation for transportation support for all employees (e.g., an employee using transit or walking would receive compensation equal to the cost of providing parking for those driving), or preferential locations for HOV parking; and
5. Marginal cost road pricing for new or existing roads, bridges, areas, and so forth.

What is often missing in these TDM projects, which are frequently experimental in nature, is a research design by which more useful knowledge can be gained. Information, such as responses to specific measures, would be useful in improving the management of the projects as well as in establishing a base of knowledge from which other TDM projects and communities could benefit.

It is recommended that a TDM research initiative be established, which would include a research fund to which project implementers can apply for carrying out the research design, data collection, and analysis aspects of TDM projects. It is also recommended that a center for least-cost transportation planning be established. The purpose of the center would be to conduct research on TDM and other transportation planning functions, to administer the TDM research fund, and to gather information on least-cost transportation research, planning, and management, including the use of tolls and other user fees.

Analysis of the Application of Utility Least-Cost Planning to Transportation Planning

The electric and gas utility industries have gone through major changes during the last decade in the planning and management of their investments and operations. Many of the changes have come about because of the adoption of integrated least-cost planning (also known as integrated resource planning or simply least-cost planning). An important feature of least-cost planning has been the elevation of demand-side measures to equal status with traditional supply-side measures. If the marginal cost of a demand-side measure (including social costs, where they have been measured) is less than the marginal cost of new supply, the demand-side measure is preferred. Another important feature of least-cost planning is the emphasis given to the social implications of investment choices, including such issues as employment and air pollution.

Many elements of utility least-cost planning are directly applicable to transportation planning in general and to the issue of social costs in particular. A review of the applicability of utility least-cost planning to transportation planning is recommended. An important benefit of the application of least-cost planning to transportation is the potential for placing the issues of highway social costs and highway tolls in a broader economic and planning framework. Such a framework would have an urbanwide or regional focus (similar to a utility service area) rather than a static, segment-by-segment focus.

A review of the applicability of utility least-cost planning to the field of transportation planning would specifically address such questions as the institutional differences in ownership and regulatory authority, the greater difficulty in measuring and metering use of highways, and the large federal funding role. Energy utilities, whether privately or publicly owned, derive their revenue from their service territory, and in the case of investor-owned utilities are subject to state regulation. Despite these differences, an analysis of the application of utility least-cost planning to transportation is timely.

CONCLUSION

The social costs of highway use and transfers are plausibly in the range of $200 billion to $400 billion per year. The exclusion of these costs from highway user fees creates an important incentive to private motor vehicle use. Efforts to include these costs in economically efficient user fees will serve to reduce the demand for private motorized travel and encourage alternative modes, including nonmotorized modes. The magnitude of the impact on travel behavior in the long run cannot be estimated with current models. However, the enormous size of the social costs and transfers suggests that major behavioral changes could result from efficient user fees.

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