FULL COST PRICING OF HIGHWAYS

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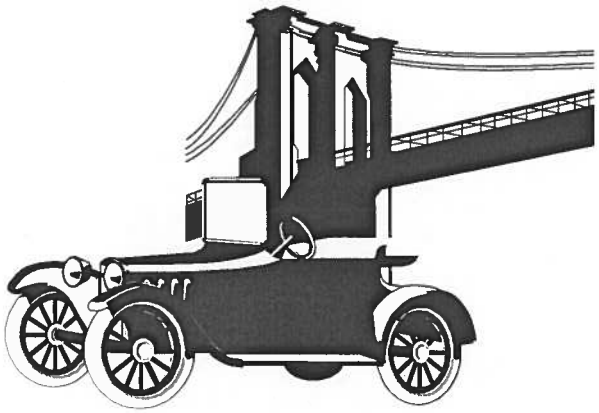

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Full Cost Pricing of Highways: Review and Synthesis[1]

The issue of whether users of public facilities "pay their way" has attracted both political and analytic interest for a long time, but the particular issue of highway costs has received increased attention of late. Environmentalists, especially, have pointed to pollution costs and other externalities as a hidden subsidy to highway users. This seems to have led to a large number of studies that seek to estimate quantitatively the "full" costs of highways and highway usage. This paper attempts to review and summarize this debate.[2]

A flurry of studies has appeared in the last few years directed at aspects of this topic. To varying degrees, the studies are motivated by the idea that because highway users are subsidized, highway travel is overconsumed and transit underconsumed. This claim then becomes the basis for policy recommendations, such as congestion pricing, increased transit subsidies and stronger land use controls. Although these various ideas are interrelated, the logical connection between cost analysis and the recommended policy is often missing, or the implications of the analysis are misinterpreted.

What is Full Cost Pricing?

Full cost pricing (FCP) is a policy strategy based on the idea that the economy would benefit from imposing the discipline on each enterprise that all its costs should be recovered from consumers, i.e., total user revenues should equal total costs for each activity.

One way to investigate full cost pricing for highways would be to estimate the total costs of highways and the total payments by users and subtract them, as in Figure 1. A large share of the costs and payments, however, are between private consumers and private suppliers, such as in the markets for vehicles and fuel. Aside from the difficulty of getting accurate information, tabulating these transactions is unnecessary to the extent it

[1] The present version of this paper has benefited greatly, in my own opinion, from thoughtful comments by Mark Delucchi, Todd Litman, and Ken Small, but they are not otherwise implicated.

[2] Most of the studies that quantify either the full costs or the magnitude of total costs not borne by users contain extensive reviews of and extractions from the literature. These studies come to different conclusions, however, about both the micro and macro items in their accounting frameworks, as well as employing different methods, assumptions, and data to estimate the same items.

can be assumed that private firms are recovering their costs from consumers.[3] Working backwards, then, from the need to estimate only the costs that are not recovered from users (primarily government costs and externalities), only selected portions of full costs and revenues need to be catalogued and measured.

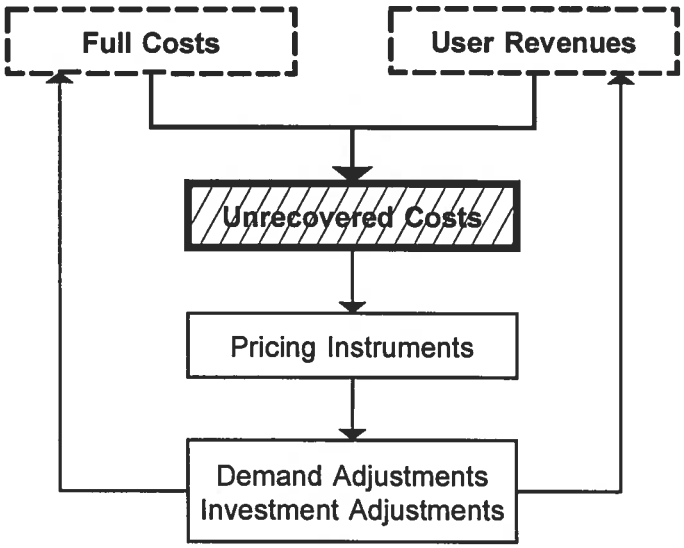

FIGURE 1. Primary components of full cost pricing.

Given a magnitude of revenues that must be raised from users, the next step is to determine what pricing instruments are applicable and what the rates should be. Depending upon the nature of the cost (e.g., fixed or variable), different pricing instruments are more suitable than others. Some form of inverse elasticity pricing might be designed, in which marginal cost and multi-part prices are adjusted so as to meet the total revenue requirement with the least economic distortion. Congestion pricing is an example of a pricing instrument that would be relevant in this step of the analysis.

If user fees are changed from those that applied when the full costs and total user revenues were estimated, then both costs and revenues will change, of course, when prices change. For example, if prices are raised by the government agencies supplying roads, total user revenues will increase but total vehicle travel will be reduced. In the long run, some roads will be no longer justified as a result of less traffic, and disinvestment will occur in these facilities. The level of unrecovered costs will become closer to zero as a

[3] Tabulation and measurement of full costs, including such things as vehicles and fuel paid directly by the user to private firms, would result in something analogous to the portion of total domestic product (GDP, or GNP) contributed by the highway sector, or it might be some alternative form of social accounting that includes basic resource consumption, externalities, and in-kind consumption. That task has been attempted by Miller and Moffet (1993); their estimate of the magnitude of total costs is about $1.1-1.6 trillion per year, of which $380-660 is unrecovered from users.

result of the pricing changes, but could be either positive or negative, leading to further adjustments in prices. Thus the overall topic can be organized into three sequential questions:

(1) Is it desirable that highway consumers pay the full costs of highway provision and use? (normative objective, theoretical issue)

(2) If FCP is desirable, to what extent do revenues earned from users fall short of covering the full costs of the enterprise, including "hidden" or external costs? (empirical/accounting question)

(3) If FCP is not satisfied in practice, what is the most efficient way to raise more revenue from users? (pricing/revenue problem)

An important point of the above discussion is that there are many topics related to estimating full costs that are nonetheless distinct, yet are often confused by being intertwined; for example, the measurement of full costs leaves open the question of what the specific prices should be, or whether they are efficient. Also, as shown by the diagram, not only are the quantitative results imprecise even if there were no unresolved conceptual issues, the "true" full cost is heavily affected by public policies and consumer responses to them; the target itself is continuously moving. This paper seeks to address the first two of the above questions by reviewing the applicable theory and empirical evidence.

Full Cost Pricing versus Marginal Cost Pricing

An explanation of the rationale for imposing FCP draws from basic theory of pricing, which is also subsequently useful for designing instruments for obtaining the revenues. Our aim at the moment, however, is to further explain what is meant by full cost pricing.

The principles of pricing, on the one hand, and full cost recovery, on the other, start from different "givens," but are largely consistent with each other. Pricing focuses on the short run, seeking the optimal utilization of existing fixed facilities. Full cost recovery is oriented toward the long run, which is concerned with investment (and disinvestment) in the capital stock. Both pricing and cost recovery are efficiency concerns, as opposed to equity concerns.

The Pure Theory of Pricing and Investment

The theory of marginal cost pricing (MCP) is that users should be charged their marginal cost in the short run (SR), i.e.,

SR efficiency criterion: $p = MC$

In competitive markets, firms will charge as much as they can but will be forced to charge marginal cost by pressure from competition.

The long run is said to "take care of itself," but it will only do so if total revenues (TR) are required to equal total costs (TC) in the long run (LR), i.e.,

LR equilibrium constraint: TR = TC

If the enterprise cannot recover both its variable and its fixed costs in the prices it charges, then it will shrink (disinvest) until it can raise prices enough to stay in business. If firms are making long run profits, they will expand, or others will enter the market, increasing overall investment. Thus long run efficiency requires that firms invest or disinvest according to which sectors show the greatest profit. In equilibrium, all investment earns the normal rate of return, and all enterprises are self-supporting.

Strict Marginal Cost Pricing

One variant of this theory says that the SR criterion should be primary, leaving the LR equilibrium criterion flexible for cases of market failure such as scale economies. From society's standpoint, then, the LR criterion becomes invest whenever benefits exceed costs, i.e.,

LR investment criterion: Invest if $\Delta B > \Delta C$

This substitutes the benefit-cost criterion, implemented by the public sector, for the cost-revenue forecasts that occur in the normal market process, as the mechanism for investment evaluation.

Under constant returns to scale, marginal cost pricing (MCP) will exactly recover full costs, so the results of FCP and MCP would be the same. Under decreasing average cost (increasing returns to scale), however, marginal cost pricing will recover insufficient revenues to sustain optimal long run investment. Revenues to make up the difference between short run revenues and long run costs must then be extracted from the economy in the form of taxes, i.e., the activity is subsidized. Thus there are instances where FCP and MCP lead to conflicting prescriptions.

Long Run Cost Recovery

In a practical setting, goods such as highway services are sold with a price structure rather than a single price. Some of the components (e.g., congestion pricing) are true marginal cost prices, whereas others (e.g., vehicle registration) affect intermediate-term decisions that do not have significant variable cost consequences in and of themselves. Thus it is feasible to maintain variable cost prices close to marginal cost while using multi-part instruments to recover full costs, without necessarily resorting to taxes. If such market failures as scale economies are not too large, FCP can be imposed as a constraint without doing much damage to MCP.

For government outputs taking the form of public goods, there are no substitutes for taxpayer financing. In the case of highways, however, where benefits are captured by users who can express their valuations by willingness-to-pay, benefit-cost analysis is only a surrogate for what would be a normal market investment choice. If highway users were charged the full costs of their travel, and highway providers invested solely on the basis

of user revenues, then the amount, kind, and location of highway investment would be guided toward efficiency over the long run.

By itself, FCP does not imply either a pricing strategy or an institutional structure; in particular, it does not mean pricing at either long run average cost or long run marginal cost. Nor does it imply an investment criterion. It is quite possible to price at (or close to) marginal cost, invest where benefits exceed costs, and require that users pay the full costs. Imposing the FCP constraint on government enterprises is based on the belief that this will both rationalize investment and also force approximately efficient pricing. All of this leads away from microeconomic theory, however, into questions about institutions.

Institutional Considerations

If the MCP strategy is followed and the full cost recovery constraint is not imposed, then it must be assumed that pricing and investment decisions are made rationally whether by public or private agencies. With private markets, both the total revenue requirement and the pricing structure are consequences of market institutions, for which there are incentives that can be plausibly argued. For governments, however, the incentives that seem to be at work or can be imagined do not tend toward a rational result for the whole. In other words, the unseen hand of the market, however imperfect, tends to extract revenues from those willing to pay and invests where there are economic benefits, whereas the incentives that motivate governments do not have these properties.

Once the government becomes an important economic activity, the simple theory must be left behind and institutional considerations come into play. For services provided by government, neither full cost recovery nor efficient pricing are automatic, i.e., they are not institutionally enforced. On the contrary, governments tend to export costs to other agents (so the expenditures don't appear in the government budget) and to price on political rather than economic grounds. Thus, for a government enterprise, it is necessary to ask the questions explicitly: are highways paying for themselves from "earned" revenues ($TR = TC$), is the pricing efficient ($p = MC$), and is investment directed at worthwhile capital projects ($\Delta B > \Delta C$)?.

The differences between FCP and MCP, then, are primarily a matter of emphasis (which criteria are most important to enforce in the real world) and beliefs about behavior (rational versus inefficient government). If one believes that exhorting public enterprises to apply the principles of marginal cost pricing will lead them toward rational investment, then emphasis should be placed on short-run pricing. If one believes that user financing will encourage cost control, sound investment decisions, efficient pricing, and socially preferable consumption behavior, then impose long-run cost recovery. These are essentially institutional strategies, not distinguishable at the pure level of microeconomic theory. Pursuing both strategies at the same time—encouraging explicit pricing while also calling for full cost recovery—can, however, lead to complementary results.

A Strategy for Designing an Accounting Framework

The intent in designing an accounting framework is to be both exhaustive and non-overlapping. The exhaustive part is the more difficult, and it is necessary to think carefully about what characteristics distinguish costs items that should be included from those that are not appropriately labeled "costs" of highways. Hence some definitions and concepts.

Definition of Cost

"Cost" is an abstract concept, not an empirical fact. The concept -- briefly, the value of foregone benefits -- is not only difficult for most people to apply, it seems unrelated to the normal meaning of cost. Yet when the term "cost" is used in conjunction with policy issues such as environmental quality, traffic congestion, and subsidy, it is apparent that the term is being used in a generalized conceptual way and not simply as meaning the dollars spent on something. In truth, the concept of cost is both subtle and flexible, but can also be misused.

The economist's notion of cost is the value of resources (used for a given output) in their next best alternative use. If, for example, less gasoline were used in highway travel, what would consumers be willing to pay for the fuel for some other purpose, or if it were converted instead to heating oil? If less time were used in travel, how valuable would the time be for whatever purpose travelers chose to use it? If clean air were less consumed in absorbing vehicle pollutants, how much would society benefit from using the air to disperse non-highway pollutants or from breathing cleaner air? This concept of cost depends entirely on benefits foregone; there is no separate measure of cost that is distinct from valuation of benefits.

If markets function properly, it is an easy step to use market prices to reflect costs, because such prices correctly reflect the values consumers place on applying resources to alternative outputs. Under ideal conditions, expenditures are valid measures of cost, entirely consistent with the above definition. There are, however, many transactions and resource consumption decisions for which there is no market at work ("externalities"), or the market is sufficiently imperfect (market failure or government failure) that revealed prices do not accurately reflect benefits foregone.

What "Costs" Should Be Included?

Some major cost categories are listed in Table 1, for the purpose of demarcating the types of cost that are of interest from those that are not. Government expenditures, current or historical, incurred in construction or operation of highways, are obviously relevant, as are direct externalities from highway construction or motor vehicle usage that are imposed on non-users. Costs of vehicle operation borne directly by users, in-kind or pecuniary, including externalities among users, are not relevant because they net out with respect to total costs versus total revenues.[4]

[4] The concept of externality—a "third party" cost, in that the affected party was not a participant in the transaction giving rise to the impact—is elusive in its application and sometimes overextended. "Pecuniary" externalities—those having price but not resource consequences—should not be included in cost estimates.

TABLE 1. Relevant and non-relevant cost categories

	Monetized	Non-monetized
Relevant to FCP	Government Costs: expenditures opportunity costs	Externalities Impacting Non-users: pollution loss of wetlands
Not Relevant	User Costs: vehicle operation time	Externalities Impacting Other Users: congestion pollution

If such amorphous effects as externalities and social overhead are permitted within the scope of costs, how can "true" costs be rigorously separated from those that are spurious or vaporous? Labor and materials used in road maintenance and construction are obviously included in costs, but there are many thorny questions as the scope expands. Vehicles produce emissions of organic compounds and particulate matter, for example, that become air pollution. Most analysts recognize this pollution as an externality whose cost ought to be included in the price users pay, even though the valuation of the cost is necessarily uncertain and indirect. Some analysts, however, would include land use sprawl, the strategic petroleum reserve, military excursions in the Middle East, oil spill damages to the environment, degraded pedestrian amenities, loss of property value from traffic noise and fumes, increased costs of transit service, high-consumption lifestyles, and many other perhaps tenuously-related impacts.

Separating the valid ones from the faulty is not simple, and there is no knife-edge test. Each item must be evaluated on its own merits. One approach is to enumerate the universe of acceptable cost items, and then discuss the reasons for not including other items.

Certain costs are often described as "hidden," but the term seems to embody no technical content, so it is avoided here. Public expenditures that may be attributable to highways but not labeled as such, as well as in-kind impacts such as pollution, and indirect effects such as sprawl, have all, at one time or another, been called hidden. Also, no concern is expressed at this stage as to whether the costs are "quantifiable" or not; the only issue is whether a particular cost item should be included, and how it should be bounded.

Economic Neutrality

To make the full cost argument, it is necessary to apply the concept of economic neutrality: is the particular cost at issue something that a generic private economic activity has to pay? If so, then call it a cost.

Economic neutrality means that, for any given good, there is no a prior tilt toward or away from that good with respect to its substitutes and complements. This is one way, for example, to define "balance" in transportation: each mode is priced at its full cost, and investment made in response to consumer demand. Because all consumption decisions (and the production decisions that serve consumption) constitute resource alloca-

tion decisions within constrained budgets, all goods and services are ultimately competing among each other, and are thus substitutes.

Application of this neutrality concept is most relevant in establishing a basis for calculating social overhead costs. An example of such a cost is taxes on real estate, which go to support general local government. To the extent that such "overhead" services are financed by a broad-based tax on land and property values, highways should contribute the same as railroads, supermarkets, and other economic activities.

Achieving neutrality in practice is difficult because, in part, what is neutral from one perspective is not from another, so that even without pre-existing distortions in highway pricing, investment, and regulatory policies, and distortions in related transportation and non-transportation sectors, compromises may be necessary. "Distortion" simply means a difference in production and consumption between actual results and the results that would be achieved by perfectly neutral markets. The distortion can be caused by market failure (monopoly power, unpriced externalities) or government action (subsidy, regulation), and may or may not be preferred by the body politic. The question addressed here is what a neutral standard would amount to, regarding highways; once that is provided, further consideration can be devoted to choosing whether neutrality is desirable, and how it might be implemented.

Public and Private Costs

Highway services—including the vehicle, driver, road, wetlands paved over, etc.—are provided by a combination of public and private agents. "Private" costs are incurred for goods supplied through economic markets; the default or null assumption is that the prices paid by users for these good represent their true social costs. Thus the price of gasoline includes the capital and operating costs of the refinery, the transportation of crude and product, the search for and extraction of oil, and the long run scarcity of the petroleum resource. Similarly, the price of insurance includes the costs of accident repair, fatalities, administration of the insurance system, lost time, debilitating injuries, and medical bills, to the extent that these are paid by the insurance companies.

For "public" costs, there is no basis for assuming that revenues equal expenditures or that expenditures equal social cost. It is possible to argue, for example, that kickbacks from corrupt contractors and politically-inflated labor rates are transfers, not costs. Whatever choice is made, however, all costs have to be traced explicitly from one end to the other, or at least into the private sector. Because highway funds flow up and down and among governments, looking at just one level or one jurisdiction is frequently misleading or inconclusive; costs for all levels of government must be included.

Private sector costs may deviate from the assumption of price equals social cost. Each such deviation must be identified with respect to the nature of the market or government failure that causes the deviation, and appropriate empirical methods devised that can be used to estimate the magnitude of the unpriced cost. Air pollution is in part the consequence of consuming fuel, but the cost of the pollution is not included in the price of fuel. To go beyond public sector costs and private prices, then, requires a market failure rationale, of which negative externalities is one category.

A Set of Accounts

Applying these general criteria, a tailored accounting framework emerges for tabulating full highway costs. The objective is to determine the differences between what users pay, as a group, and the full costs to society. Purely private sector transactions, such a buying a car, are implicitly netted out and ignored, except to the extent externalities arise in the process. All public sector costs are explicitly enumerated. The perspective is long run costs, on the assumption that the highway system (if not necessarily all its elements) is to be retained for highway purposes for the foreseeable future. The framework and estimates are shown in Table 2, along with key parameters used in constructing the estimates.

Highway Land

Land in ROW has some value, determined mainly by its location, which can be recovered by selling it and converting its use to something other than highway travel. The value of land used in highway right-of-way is estimated by applying a prototypical land acquisition cost per highway mile to each of nine functional classes.[5] Land is implicitly valued at its purchase price, converted to 1992 dollars. Because the unit land cost rates are historical data updated with FHWA's composite construction cost index, the dollar amounts reflect current projects. This procedure may give a slight downward bias, in that the value of land increases after roads are constructed.

The opportunity cost of land is its market value times the discount rate, i.e., the (real) interest foregone by not selling the land now, rather than next year. This is a pure opportunity cost, in that no expense for it appears in any books. Because land has an infinite life, there is no depreciation. Other uses in the highway ROW, such as sidewalks, pedestrian crossings, and bicycles, may be allocated a share of costs, depending upon location.[6]

Highway Improvements

Much thought is required in dealing with capital costs of improvements. Engineering design, construction of the road (perhaps most of the grading) are sunk costs that cannot be recovered. Yet to "expense" capital costs as if they were consumed in the same year as the expenditure is unrealistic, and regarding previous investments as sunk costs seems myopic. What standard of cost responsibility should be applied to investment in capacity?

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[5] The functional classes are five highway types (Interstate, other major arterial, minor arterial, major collector, minor collector, and local) in two locations (urban and rural), omitting urban minor collector as a category.

[6] Voorhees (1992) estimates the annual cost of land at $97 billion. Hanson (1992) recognizes an opportunity cost of land, but apparently believes that only excess road capacity should be counted. He then values the land at foregone property tax revenues, perhaps on the rationale that highway use exempts the land from property taxes, but this is a transfer payment (we use property taxes as a measure of the local share of social overhead costs). Litman (1992) concludes that only 60-75% of ROW is required for highway use.

TABLE 2. Estimates of Highway Costs Not Recovered from Users ($1991)

COST GROUP	COST ITEM	$Millions/Yr	PARAMETERS			
Highway Capital	Land (interest)	74,705				
	Construction:					
	Capital Expenditures	42,461	77,711	36,154		(HS)
	Interest	26,255	101,270			
	Land acquisition and clearance					
	Relocation of prior uses and residents					
	Neighborhood disruption					
	Removal of wetlands, acquifer recharge					
	Uncontrolled construction noise, dust and runoff					
	Heat island effect					
Highway Maintenance	Pavement, ROW, and structures maintenance	20,420				HS
Administration	Administration and Research	6,876				HS
	Traffic police	7,756				HS
Parking	Commuting	52,877	80,903	$2.61	250	Emp
	Shopping, recreation, services	14,890	24.956	$2.39	250	SF
	Environmental degradation					
Vehicle Ownership	Disposal of scrapped or abandoned vehicles	706	188,371,935	15%	$25	Reg
Vehicle Operation	Pollution from tires	3,000	3,000	$1.00		Tires
	Pollution from used oil and lubricants	480	240	$0.50		Gal
	Pollution from toxic materials	1	138	$10		
Fuel and Oil	Strategic Petroleum Reserve	4,365	568	$15	$210	50%
	Tax subsidies to production	9,000				
Accidental Loss	Governent compensation for natural disaster					
	Public medical costs	8,535	$8,200	$6,700	5%	
	Uncompensated losses	5,850	$1,000,000	39,000	15%	Life
Pollution	Air	43,444	2,172,214	$0.02		VMT
	Water	10,861		$0.005		
	Noise and vibration	6,443	1,288,593	$0.005		
	Noise barriers	5,117	11,603	0.88		
Social Overhead	Local fuel sales tax exemptions	4,302	110,311,540	$0.04		Gas
	Federal gasohol exemption	1,219	8,644,368	$0.141		Ethyl
	Federal corporate income tax	3,389		1%		
	State government sales taxes	13,218		4%		Sales
	Local government property taxes	15,962		1.5%		RVal
TOTAL COSTS	$ million	382,134				
	cents/VMT	17.6				
CURRENT USER REVENUES		52,096	48,787	2,206	1,103	
	cents/VMT	2.4				
SURPLUS (LOSS)		(330,037)				
	cents/VMT	(15.2)				

(1)Forget Sunk Costs. One strategy would be to ignore all non-recoverable capital costs, start with a clean slate, and require all future investments to be paid for over the life of the investment, as they wear out or become obsolete. Initially, unit costs (cents/VMT) would be low, but gradually they would climb as cumulative investments were being charged for. Once the system reached equilibrium -- where all capacity currently in use was the result of a "new" project, and capacity was not changing significantly -- revenues above short run costs would be sufficient to replace capital as it depreciated. But why is now the magic moment? Why not start charging ten years ago, or whenever existing improvements were new? Ignoring sunk costs is a

short-run perspective that is incompatible with the long-term existence of the highway system.

(2)Pay-As-You-Go. Current highway finance practice finances most improvements out of current revenues, eliminating the need for borrowing. If highway users—who are also highway investors—don't have to pay interest on capital improvements, why should they be charged for it? The reason is that money deposited in a highway trust fund earns interest at whatever rate the US Treasury is paying, and that interest is foregone when the money is spent. There is no way to pretend that capital investments have no opportunity cost to the funds committed to them. Equally important, the amount spent in one year bears little relationship to the value of the capital consumed in that year.[7] If the system is wearing down faster than it is rebuilt, for example, current users are living off of previous users/taxpayers who built up the capital stock.

(3)Rate of Return. If the original investment was worthwhile, it should be earning -- over its lifetime -- a rate of return at least equal to the market rate for low-risk investments. If the asset continues to be used as a highway, then implicitly it is worth what it cost, including interest on the outstanding balance. To fail to charge users enough to cover the interest, then, is a subsidy to users, in the form of a zero-interest loan. An upper bound on the opportunity cost, using this method, would be the (depreciated) replacement cost of the facility, times the current interest rate. A neutral approach, then, would be to measure the replacement costs of the existing system, annualize that cost, and recover that amount each year. Replacement cost would be stated in dollars of the current year, hence revenues would keep pace with inflation.[8]

(4)Writeoff. If the prior investment is declared to be without present value, then writing it off implies shutting it down. If operating costs are low or zero, then keeping it open until the capital is fully depreciated (meaning it is no longer usable) may be sensible, but most roads require some maintenance. The cost of the road, then, is still the cost of the maintenance plus the opportunity cost of the land, until time comes for capital replacement; users should then bear the full costs of the capital investment plus interest.

From whichever perspective one starts, then, a single approach emerges: a capital asset that continues to function as a highway has an opportunity cost that can be best approx-

[7] MacKenzie, et al. (1992) use annual expenditures as the measure of capital consumption, and they include interest and debt retirement as well as capital, maintenance, and administration. They do not include any other interest cost item, so their annual cost covers only a small part of the full opportunity cost, and at tax exempt borrowing rates.

[8] Miller and Moffet (1993) present a replacement cost calculation similar in nature to the one used here (with a discount rate of 3%), but employ a different method built up from capacity expansion and pavement damage for their primary estimates. They also omit land in existing highways, but include an agricultural land loss item in their list of unquantified social costs. Apogee uses constructed prototypical long run replacement cost values, including land, as is standard for comparative cost studies and as is done here.

imated as its annualized replacement cost, without regard for when the expenditures were made.[9] To earn a less-than-normal rate of return implies that the long run costs are not justified, and the road ought to be phased out of use.

Thus highway improvements are valued at replacement cost, in the same way land is valued, and amortized over the life of the investment.[10] Several alternatives are offered in the table. First, construction can be replaced by resurfacing only, every 10-25 years depending upon the average volume of traffic in the functional class. Second, capital replacement can be regarded as equal to pavement reconstruction every 20-50 years. Each of these can be converted to an annual capital cost, including interest on the remaining balance, by using a capital recovery factor (CRF). The CRF spreads the debt service over the life of the asset in constant payments in each time period. The difference between these two approaches can be seen in Figure 2. Land cost is the same for both. Expenditures -- which can be compared to actual public expenditures -- are about

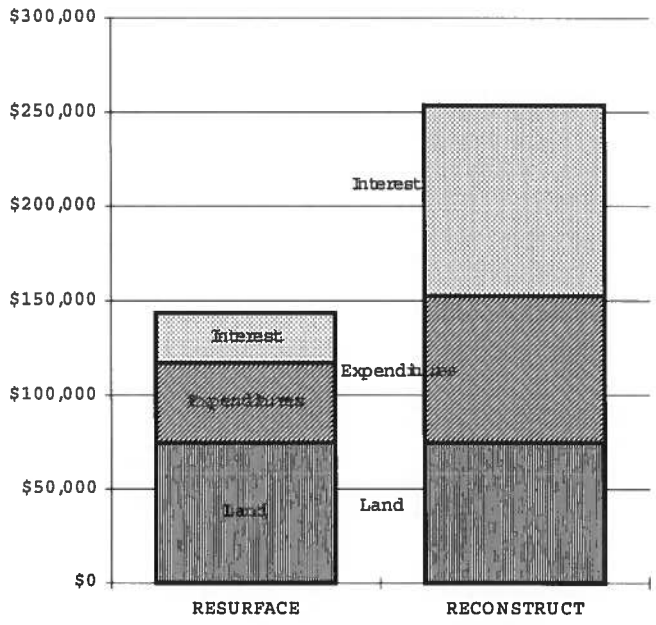

FIGURE 2. Components of annual cost for two estimating methods.

[9] Because economic analysis in the public sector adopts the convention of constant dollars and real (net of inflation) discount or "interest" rates, the value of the prior investment should be stated in constant base year dollars, not historical cost. If, alternatively, historical cost were used for valuing assets, with a rate of return that included expected inflation (as is done in private sector project evaluation), the resulting revenue requirements would be similar.

[10] Bridges and other structures are assumed to be included in both the prototype cost rates as well as the actual expenditure data, but there is no explicit breakout of bridge costs.

twice as high for reconstruction as resurfacing. Interest costs, however, are almost four times as high, because reconstructed pavement lasts twice as long as resurfacing; a larger share of the total cost is in carrying costs rather than frequent expenditures.

Actual capital expenditures by all levels of government combined are shown for comparison in the second column under parameters, and are lower than even the annual resurfacing cost. Yet, as shown in Figure 3, the level of capital spending on highways at the present time is higher than it has ever been, in real terms. The interpretation of this apparent anomaly is that the highway network has been extended and upgraded to the point that existing expenditures are insufficient to sustain it in its current condition; either expenditures must increase or the extent of the network must be reduced.

Land acquisition and relocation are assumed to be included in the estimated costs. The remaining capital costs are "fixed" externalities (i.e., fixed with respect to highway usage) for which no dollar estimate has been made.

Highway Maintenance and Administration

Maintenance includes minor surface treatments, repairs, and other recurring and preventive activities. Reported expenditures are taken as the measure of cost, although, as with highway construction, actual maintenance may be less than enough to preserve the capital stock.

Services provided by national, state, and local governments that are clearly labeled "traffic" or "streets and highways" are included in the national statistics.[11] This includes state police, national and state DOTs, local traffic police, and public research. Other service costs include police efforts to deal with highway-related crime, such as stolen vehicles, court costs for litigation, fire and other emergency response not included elsewhere; these costs are assumed to be covered in the estimation of social overhead.[12]

[11] Federal Highway Administration, Highway Statistics, 1991.

[12] For the municipal service costs, MacKenzie, et al. (1992) use an estimate of $68 billion (about 3 cents/VMT) by Stanley Hart (1985), based on his study of Pasadena, CA, but they do not include a social overhead cost. Litman (1991) accepts 1 and.3 cents (urban and non-urban), from Moffet (1991).

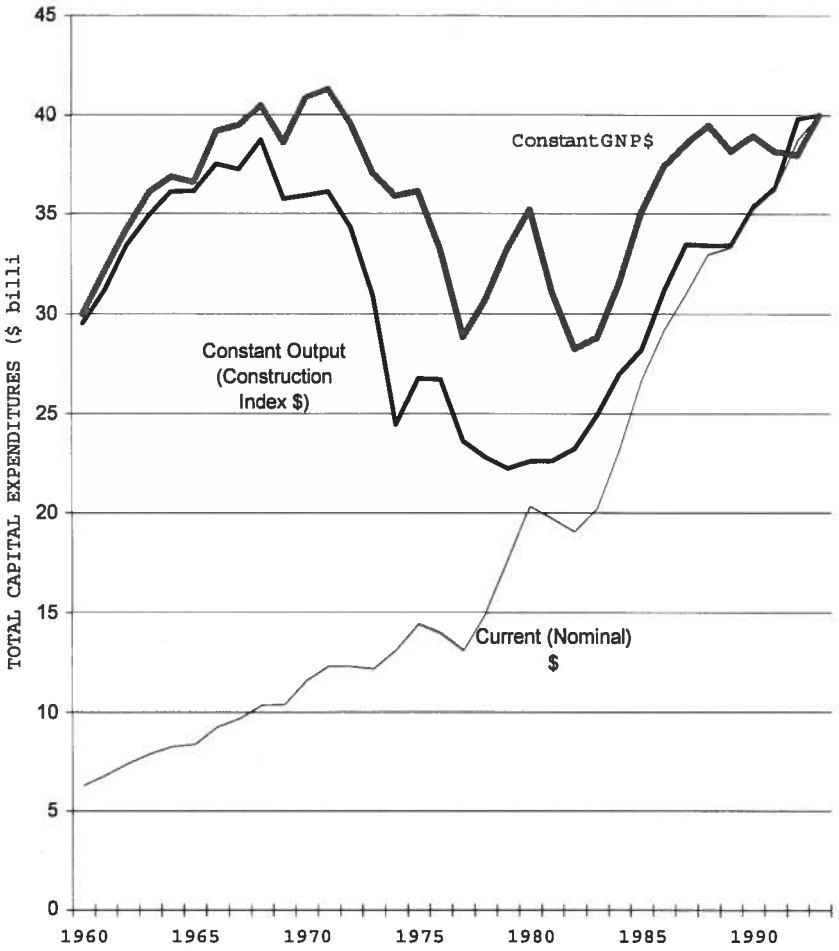

FIGURE 3. Total highway capital expenditures, 1960-1992.

Parking

On-street parking is assumed to be included in the cost of streets. Dedicated parking is provided by both public and private sectors, in garages and surface parking. Suburban and rural residential parking is mostly incorporated into ownership and rental costs, so it can be regarded as a user-paid cost.

Most employment parking is subsidized, almost all retail and services parking is free to the user, and most publicly-provided parking is underpriced.[13] For parking costs borne by private firms, it might be claimed that any cross-subsidies between highway users and other modes must be efficient, or else they wouldn't occur. The counterargument is

[13] Underpricing of urban publicly-provided parking is evidenced, according to Shoup, by queues for public garages and "cruising" for parking.

that in-kind income (parking space) is favored by the tax code, and retail parking is oversupplied due to zoning requirements, and without these distorting factors parking owners would find it worthwhile to charge users.[14]

The estimated net cost for commuting parking uses a breakdown of employment by location (CBD, city, suburb, and other) and size of metropolitan area (over 3 million, 1-3 million, less than 1 million), percent free parking (100% suburban and rural to 65% for major CBD), and price/cost of parking per day. These parameters average out to $2.61 per day cost, or about $654 per year or $6,755 per space capitalized.[15] Non-work parking is estimated by applying parking generation rates to gross leasable square footage of shopping centers, and scaling that up to all retail parking using dollar volume of sales.[16]

Vehicle Ownership

Externalities in the production of vehicles such as air, land, and water pollution from steel, aluminum, paint, plastics manufacturing are not included either conceptually or empirically. Vehicles disposed in junkyards are unsightly, at best, and sometimes a sources of air and groundwater pollution, so these costs are included. Many vehicles are abandoned and must be removed by public authorities. Assuming a scrappage rate of 15% of the fleet per year, and an average of $25 per vehicle needed to accomplish proper disposal or recycling (beyond what owners already pay), the national total is about $700 million per year.[17]

Vehicle Operation

Externalities from vehicle operation not covered elsewhere include junked tires and used oil. An estimated 3 billion scrap tires inhabit the US, and an arbitrary $1 per tire is assigned for cleanup.[18] A considerable volume of used oil, containing metal particles

[14] Pickrell (1993) and Willson (1993) believe the tax code and zoning effects are sufficient to cause the user subsidies observed; Delucchi believes that not charging for retail parking is an efficient market result, and hence such parking costs should not be added to highway costs.

[15] Pickrell (1993) comes up with a range of $26-53 billion based on a spatial disaggregation. His "high" parking prices range from $1 per day in non-SMSA areas to $12 per day in the CBD of cities over 3 million, while his percent free ranges from 100% in suburbs to 65% in large CBDs, and his auto share ranges from 85% in low-density suburbs to 49% in major CBDs. Pickrell estimates about 80 million drivers receive free parking. MacKenzie et al. (1992) use 86 million autos receiving free parking, at an average cost of $1,000 per year, but omit non-work parking.

[16] All data except parking generation rates are published in the Statistical Abstract of the United States 1992. Gross leasable area in shopping centers is reported as 4.6 billion SF by the National Research Bureau, and actual occupied peak parking spaces as 3-5 per 1000 SFGLA in ITE (1985). Shopping center sales are given as $717 billion, versus $1.8 trillion for the industry as a whole. This yields 35 million spaces, of which 10 million are taken by employees (half of retail employment, from the US Census County Business Patterns. Using the average cost of work parking, excluding CBD locations, gives an annual cost of $597 per space.

[17] Vehicle fleet size is measured as registered vehicles including trucks but not motorcycles, as reported in Highway Statistics 1991. Many vehicles are registered more than once in a given year, and the magnitude of double-counting is roughly on the order of 15%. Delucchi thinks the $25 per vehicle is too high.

[18] McPhee (1993) provides the tire estimate. Many of these tires are already in salvage yards. Alternatively, he says 2.5 million are disposed of per year, which, at a cost of $5 per tire, costs $1.25 billion. Recycling of tires is gradually improving, but the salvage value is still a negative number, i.e., the consumer has to pay to have them disposed of.

and other pollutants, is dumped onto the ground or down the drain.[19] The valuations for these items is soft.

Fuel and Oil

The US government maintains an underground petroleum storage facility, at a cost that includes interest on the net accumulated stock (568 million barrels at $15) plus annual operating costs.[20] About half of all oil use is for highway purposes. No attempt is made here to separate out the military costs of petroleum security from general social overhead costs; some share of defense costs are included within the latter category in the table. Tax subsidies to domestic oil production could be included under tax expenditures or here, or excluded as going to a different market than highways.[21] The strongest rationale for inclusion is the fact the distortion is government-induced and primarily in favor of highway interests.

Oil spills receive lots of attention, and small spills add greatly to the volume, but these costs are excluded as being externalities in a related market (see below under "Externalities in Related Markets"), namely, the transportation of petroleum products.

Accidents

Federal flood insurance and disaster relief probably provides some compensation for "Acts of God" that damage highways and motor vehicles. Some victims of auto accidents are treated at public expense, and some share of personal injury and property damage consequences goes uncompensated and hence underreported (this cost is partially offset if other victims are overcompensated). The estimate is based on statistics for uncompensated time lost and a 5% share of medical costs.[22]

The value of human life is estimated at something over $1 million,[23] and motor vehicle insurance seldom covers or pays this much, so compensation to beneficiaries, if made, is

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[19] According to the Automotive Information Council, as reported in the Boston Globe of December 23, 1991, 240 million gallons of waste oil from cars is dumped illegally into sewers or on the ground. Other popular press numbers range from 175 to 385 million gallons. Proposed legislation in Massachusetts would attach a 50-cent deposit to each quart of oil sold, refundable when turned in to an authorized facility, and this amount is taken to be the cost of adequate disposal or recycling.

[20] The 568 million barrels is taken from Scott Pendleton, "Oil Stockpile Stuck in Controversy" in The Christian Science Monitor (Thursday, April 12, 1992), and operating costs from US Congress, "Budget for Fiscal Year 1994." MacKenzie, et al. (1992) show $.3 billion for the SPR, apparently counting only the annual operating costs and not the inventory carrying cost. Under petroleum security, they also include military expenditures of $25 billion. OTA (1991) reviews the technical substitutes for imported oil.

[21] The $9 billion number is from Hines (1988), as cited by Hanson (1992).

[22] MacKenzie, et al. (1992) cite a study by the Urban Institute (1991) claiming $358 billion total social cost of highway accidents in 1988, of which $228 billion is pain and suffering. They assume lost wages and productivity for bicycles and pedestrians is uncompensated ($4.3 billion), plus government payments of $8.8 billion, to which they add medical expenses borne by governments, hospitals, and others ($1.9 billion), unspecified medical ($.8 billion), workplace costs for injured bicyclists and pedestrians ($.4 billion), and pain and suffering of pedestrians and cyclists ($39 billion).

[23] Society's value of life is reflected in lifetime earnings, whereas the individual's willingness-to-pay is revealed by efforts taken to avoid risk. Small and Kazimi (1994) review value of life estimates and settle on an average of $4.9 million.

carried out through life insurance. Highway users buy their own life insurance, but pedestrians and bicyclists (about 15% of fatalities) are not users.[24]

Pollution

Many pollutants arise from the travel of motor vehicles, including air pollution, water pollution, vibration, and noise. Some stem from tailpipe emissions, some from interaction of vehicles and pavement, some from leakage, some from motors and transmissions. Some pollutants go through complex chemical transformations depending upon environmental conditions. Some appear as both air and water pollution.[25]

For emissions of smog precursors, diffusion and atmospheric chemistry are complex, and impacts vary widely from place to place and day to day. Nor can urban pollution be simply distinguished from rural, because plumes accumulate as they migrate from one region to another. Recent estimates of damages from air pollution placed the average cost at about 2 cents per VMT, nationally.[26] Allowing for inflation, offsetting improvements in auto emissions, and expansion of the list of pollutants, using this same rate for all vehicle mileage serves as an initial approximation.

Water and noise pollution are less well documented.[27] Noise costs are derived from property value studies, and apply to urban VMT. In principle, the cost of noise barriers can be added to the value of uncontrolled noise, if the latter is based on the level of noise remaining after the former is implemented.

Social Overhead

Economic neutrality implies that each economic activity should contribute a fair share toward the operation of government and the provision of other collective goods (including income transfers). The share can be crudely regarded as the personal and corporate income tax for the federal government, the sales tax for state governments, and the property tax for local governments.

A pragmatic distinction is made between private and public expenditures in the accounting strategy employed here: purely private transactions are omitted unless an externality or other distortion is evident, while all public expenditures must be tabulated. For the former, the relevant omissions are tax expenditures: exemptions from paying taxes that

[24] Hanson (1992) seems to count all personal injury costs not paid for by auto insurance. He does not, however, include fatalities.

[25] Delucchi claims that re-entrained road dust (particulate matter, or PM) is the largest single pollution consequence of motor vehicle use. Small and Kazimi (1994) show PM as the major cause of damage, but attribute the source primarily to emissions.

[26] Ken Small has been reporting on this topic for several decades; his most recent results are presented in Small and Kazimi (1994).

[27] Litman (1992) reviews a fairly exhaustive list of sources of quantitative estimates. Noise costs are estimated by Jon Nelson (1978) updated by Hokanson (1982). MacKenzie, et al. (1992) provides several estimates of components of environmental pollution. They cite three studies on health costs, and settle on $10 billion, a fairly conservative number. They place more emphasis on greenhouse gas emissions from highway users (almost exclusively CO2), citing a fuel tax of $27 billion as sufficient to attain a short term standard but not adequate in the longer term. They use Hokanson's estimate of $9 billion for noise costs.

otherwise are paid in private transactions. For the latter, the tax base itself must be estimated (from the table), and suitable tax rates applied.

Referring to tax exemptions as "expenditures" derives from the idea that the result would be the same if all taxpayers paid the tax, and revenues were then paid out to the favored subset.[28] The largest of these is the exemption of retail gasoline sales from state and municipal general sales taxes, a loss estimated to be an average of 3.9 cents per gallon sold. At the federal level, a notable tax expenditure is the exemption of ethyl alcohol (gasohol) from fuel excise taxes; the estimated magnitude is based on the volume of alcohol blends sold and the total federal excise tax on gasoline.

General government is financed by broad taxes at each level, and individuals and private enterprises normally pay these taxes. At the federal level, corporate income taxes (estimated here as 1% of gross receipts) would apply to the highway enterprise, in addition to personal income taxes that already apply to individuals. At the state level, sales taxes can be applied to sales of highway services to users, in addition to vehicle and fuel sales, on the assumption that the tabulated costs would be included in the price of highway services, which would then be taxed (note that vehicle and fuel sales are omitted from the sum). At the local level, property taxes are applied to highways at an average effective rate of 1.5% of actual value, times the estimated depreciated replacement cost of the highway system.

These estimates should take into account two considerations: first, the rates should be adjusted downward to maintain revenue neutrality, and second, services provided exclusively to particular individuals or sectors should be excluded from the overhead bill. Other activities should not pay for highways, and highways should not have to pay for transit, farm subsidies, or economic development, consistent with the concept of economic neutrality.[29]

Net Costs Not Borne By Users

The estimate of costs is intended to cover all social costs that are not internal to private markets, so the categories included as highway costs are government expenditures, public opportunity costs, externalities associated with production or consumption of highway services, and public sector general overhead costs. This total "bill" comes to about $374 billion annually, with the many assumptions and guesstimates described above.

User revenues include fuel and other excise taxes, registration and use fees, weight fees and taxes, traffic fines, drivers license fees, tolls, special assessments for road improvements, severance taxes and other miscellaneous taxes specifically earmarked for highways, and perhaps some parking fines. Government parking revenues are excluded, as are bond receipts. Some user taxes are expended on non-highway purposes, and therefore constitute contributions to social overhead. The main example is the portion of the

[28] Ridgeway (1991) refers to tax expenditures as "reduced tax revenue."

[29] Governments may choose to overtax some activities so as to undertax or subsidize others, but the political process can choose to distort other prices and investments as well. The neutral position is no subsidies, other than monetary and in-kind income transfers.

federal gas tax used for transit and deficit reduction.[30] These are added to the user revenues deposited in highway trust funds.

Thus the net costs not borne by users is about $330 billion per year, or an average of about 15 cents per vehicle mile if the total cost is spread uniformly across all VMT. This unit cost calculation is simply to gain a sense of scale; no suggestion is implied that vehicles be charged an additional uniform fifteen cents for each mile of travel. The various principles and instruments that might be used to close the gap between total costs and user revenues are pricing considerations.[31]

While the "cost" framework has been greatly extended compared to traditional public sector accounting practices, the numbers are not all that surprising in retrospect. The capital cost estimates dominate any other group of items, reflecting the vary large accumulated investment in the highway network and the opportunity cost that implies. Parking is prominent mainly because so little of its cost is paid directly (or indirectly) by users. Pollution externalities are large enough that they deserve serious attention, but not so large that strenuous restrictions on highway travel are warranted. Finally, the social overhead costs are substantial, but not out of line with the general taxes that could be expected from an enterprise of this size.

Excluded Cost Items

Although the scope of costs outlined in Table 2 is broadly inclusive, some cost items have been intentionally omitted. All of the ones described below have been proposed by analysts as costs that should be attributed to highways, and their exclusion may or may not be justified upon further reflection.

Congestion and Pavement Damage

The above estimates omit all cost items pertaining to travel time, delay, pavement damage, and user costs from pavement damage, and they ignore which vehicles impose which costs. This is because such costs are not relevant to the total. Pavement repair is included, based on a periodic resurfacing or reconstruction cost, and this replacement cycle, ideally, would be tied to the rate at which users wore out the pavement. Similarly, vehicle repair costs due to rough pavement are based on an average rate, which, ideally, should be tied to the quality of the pavement (among other factors). Obviously, it would

[30] Because these revenues are never deposited in the highway trust fund, they never appear as user revenues in the tabulation of FHWA's Highway Statistics.

[31] In the past, a category called "non-user costs" or "non-user benefits" was used to rationalize the expenditure of general government revenues for highway purposes, mainly at the local level. The nature of these costs/benefits were described as "property access benefits" and "emergency services" as well as delivery of products, all of which may exist, but have little relevance to the question of whether highway costs should be paid by highway users.

be double-counting to include both pavement restoration and pavement damage from trucks, or both vehicle repair costs as well as user costs from pavement damage.

Analogously, congestion costs consist of travel time, running costs, and perhaps accidents. If all running costs have been included, then whether they stem from congestion or some other cause is beside the point for estimating total costs. Travel delay could be included, but, like vehicle repair costs, it is fully paid by the user; in the accounting between the highway user and the rest of society, the amount of time and money the user spends or wastes is internal to the user side, therefore netted out.[32]

For total costs, then, internal relationships -- e.g., trucks cause pavement damage that imposes costs on cars -- are of no concern. Whether the system is efficiently utilized is also of no concern. When the question becomes "who should pay the costs?" these structural relationships become important. They affect (1) the "equitable" shares of cost borne by different user groups, (2) the microbehavioral aspects of usage in response to prices (e.g., fewer ESAL miles, fewer congested VMT), and (3) whether the system operates more or less efficiently as a result.

Externalities in Related Markets

An example of a non-included externality is the pollution generated by the steel, mining, petroleum, and automobile manufacturing sectors that produce highway products. To the extent that these industries produce externalities, the price of their outputs to the consumer or intermediate buyer may be too low; hence, a second-best argument can be made that the final consumers (auto buyers) should be charged extra to compensate for the undercharging for the externalities. This will dampen demand for the output of the polluting industries and offset the distortions caused by the externalities.[33]

Other than the imbalance in the magnitudes and the negligible improvement in efficiency from such a policy, charging one sector for the sins of another is not economically neutral. It could be equally argued that the steel industry should be charged a surcharge to compensate for the tendency of some steel products to wind up in cars that pollute. In addition, the indirect mechanisms for achieving second-best efficiency are so generally ineffective as to be not worth the effort and complication. The way to correct auto pollution is emissions pricing or regulation on autos, and the way to correct steel pollution is by pricing or regulation on steel manufacturing. Two wrongs rarely make a right.[34]

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[32] MacKenzie, et al. (1992) include congestion costs as a separate additional item of $100 billion, covering time ("productivity"), extra fuel consumption, and additional accidents (insurance premiums), but they don't add it to the unrecovered costs. Miller and Moffet (1993) combine congestion with parking, pollution, and capital costs into their category of "Government and Social" costs. Komanoff (1994) includes a share of congestion as "borne by public."

[33] Many studies include some number of indirect externalities, but Pollution Probe (1991) offers the most extensive list of such impacts. Beshers (1994) takes the opposite side, suggesting that most of the externalities should be corrected in markets other than that for highway services.

[34] Those who would like to throw the door wide to external costs should be aware that they may be confronted with external benefits arguments, e.g., Beshers (1994), Mallinckrodt (1992), and Cox and Love (1994).

Externalities in related markets are possibly relevant to benefit-cost analysis, on the rationale that investment in the activity of direct interest reduces demand in the related market, indirectly reducing the externality. From a full cost perspective, the objective of the accounting system is to include everything exactly once (a mutually exclusive and exhaustive partition). Pollution from vehicle operation is closely tied to the operation of the highway and hence its output; the highway operator is responsible for optimizing the externality by pricing or controls on highway users. Users then optimize within whatever framework (e.g., emissions pricing) is established by the highway owner. If externalities from vehicle operation are treated as a related market, i.e., not the responsibility of the highway owner, then users would have to transact with owners of the air, a technically infeasible market to construct. Thus, even in an efficient world with purely private roads and numerous collective entities seeking acceptable resolutions of the right amount of pollution of the common pool resource of air in various airsheds, it is hard to imagine that the road owners could be left out of the transaction. The issue is moot, however, since the pollution is undeniably a component of the cost of highway operation.

Indirect (or less direct) externalities, however, are only assignable to highway users by a stretch. Emissions from oil refineries, and oil and product tankers are externalities, but not from the market for highway travel. If refinery owners face higher costs to pollute, they will respond by installing control equipment, by raising output prices to cover these costs, shrinking output, and employing fewer people and capital equipment. Only they, and not highway users, can make these tradeoffs; highway users have nothing to contribute other than their price elasticity. Making refinery owners liable for refinery pollution is comparable to making highway owners responsible for vehicle pollution: it internalizes the externality, whereas charging highway users for refinery pollution does not. The additional price highway users would face if refinery pollution were efficiently internalized would be a substantially less than the cost of the uncontrolled pollution.

Alternatively, if we take refinery pollution and make it the responsibility of all petroleum consuming activities, we could equally well take vehicle pollution and make it the responsibility of vehicle manufacturers. Permitting these possibilities opens up huge ambiguities: which externalities are allocated to consuming or otherwise related activities, and which are the responsibility of the consumers and producers in the immediate market? The only reasonable strategy is to assign externalities to the direct market, and omit the indirect externalities.

Foreign Wars

The recent excursion in the Persian Gulf seems undeniably linked to a perceived national interest in protecting access to Middle East oil supplies, however effective the method may be. It might be argued that even though the oil is used for many purposes, only our mobility is seriously at stake and hence most or all of the cost should be borne by highway users.

Alternatively, all defense expenditures could be regarded as overhead expenses to be shared among all activities and sectors. If only the marginal costs of operation "Desert Storm" are assigned to oil security, and 50%, say, to highways, then the burden is fairly small in the long run. If more defense readiness and overhead costs are included, then

the share attributable to highways goes down. If it is all social overhead, and highways constitute 10% of GDP, then that represents the base share (of a much larger total) allocated to highways. Thus there is a range of discretion, but not so large as it might initially appear.

Sprawl

Low highway prices are claimed to cause land uses to spread out, relative to what would occur otherwise. Hence, dispersed activity is a consequence of the policy to undercharge highway users.[35] One can argue the desirability or undesirability of this policy, but at this level it is a matter of taste. More travel is consumed, more households have access to lower cost housing by traveling further from employment locations, and employment locations are more dispersed and in lower cost-and-height buildings. These are all tradeoffs which, absent of market failure, are optimized collectively by individual consumers and producers. To the degree that residential land use development takes place in remote locations because highway travel is cheap, that is a market outcome of low-priced travel.

Thus the "costs" of sprawl are balanced by consumer benefits that are probably impossible to measure comprehensively (private space, housing, open space, crime, sense of community, aesthetics). The cost question turns on whether there is market failure that makes the "sprawl" equilibrium less efficient than the "compact" one. Things like pollution and environmental degradation are relevant externalities, but those from transportation have already been included in the cost accounts. The land development process also may undervalue environmental resources, but the amount that can be attributed to highways is probably small, while zoning and related controls, as currently exercised, may inefficiently suppress development (and spread it out). In other respects, land use markets do not seem especially prone to market failure.

Transportation Diversity

Terms like auto dependence, mobility, and the transportation disadvantaged emerge in various assertions that a pro-highway emphasis reduces social welfare. The main substantive element to this concern is referred to by economists as option demand, meaning the benefits from having choices available even though they are not used. As with sprawl, the number of options offered is a market response to a particular policy, but not identifiable as a net cost.

The other aspect to mobility is the fear that equity -- the disparity across the range of incomes -- is worsened by undercutting those modes (namely, transit) that are best able to serve the needs of the poor, elderly, and physically handicapped.[36] Again, it may be true that highway subsidies favor the non-poor, but transforming this into a cost to be applied to highway users -- such as fees sufficient to neutralize equity impacts relative to a specified norm -- requires constructing a contract or policy that is well outside the normal definition of cost.

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[35] Miller and Moffet (1993) include sprawl as a social cost item, but do not quantify it; Apogee (1994) lists "induced land use patterns" as a societal cost, but also do not quantify it.

[36] Miller and Moffet (1993) include equity as a cost, but do not quantify it.

Transit Costs

Low-priced highways reduce demand for transit, making unit costs higher to the extent that large capital facilities (e.g., subways) are underutilized. Because of spread-out land uses, transit is more costly for the same level of service. Because of congestion, transit buses suffer delay and can make fewer round trips.

Not surprisingly, the conditions that would be ideal for transit are not those that are ideal for highways. Nonetheless, assigning the difference between what would be ideal (or at least better for transit) and what exists, as a cost to highways, is not a satisfactory application of the concept of cost. Both highways and transit systems can be overbuilt or underbuilt, but errors in one mode cannot realistically be blamed on the other. If highways are underpriced, then there ought to be less transit service than if highways are fully priced. Again, two sets of general equilibrium conditions are being compared, and, while the differences can readily be noted, there is no way to value one more highly than the other, except by collective political taste.

What Full Cost Pricing is Not

Reasons for being interested in full cost pricing have been given above, but these may not motivate some who respond to different logics. A few examples of tangential approaches and concerns may help to illuminate the differences.

Countervailing Subsidies

If the FCP standard is to be applied, the only conclusion that can be drawn from this analysis is that at least some user charges should be raised enough to eliminate the shortfall. The existence of a shortfall does not imply that other modes should be subsidized to compensate for underpricing of highways, or that any particular type of user charge should be raised (e.g., congestion tolls), or that any particular group of users (e.g., trucks) should pay more, or that other modes (e.g., transit) are more "efficient," whether or not they are subsidized more or less than highways.

Nor do we intend to argue, as some do, that the failure of highways to recover full costs is justification for excusing competing modes or increasing their subsidies. Each activity can be approached (ideally) on its own merits, and the decision made whether or what degree to move it into or out of taxpayer financing. For present purposes, the question is what would total user payments need to be to move highways into the fully user supported type of activity, analogous to a private sector business.

Comparative Cost

This is not a comparative cost study showing full costs of prototypical trips by alternative routes and modes. A thread that began with Meyer, Kain and Wohl (1965) and was advanced by the UC Berkeley comparative cost study (e.g., Keeler and Small, 1975) is the comparison of the per-passenger-trip cost for prototypical urban trips from given origins to given destinations. Costs are full social costs, not particularly those borne by users. Usually these comparative cost studies are done for specific urban areas. For

example, a suburb-to-central city peak commute trip might be carried by single-occupant auto, carpool, walk plus bus, or car plus rail transit. The costs of these alternative mode combinations can be compared, per trip or per passenger mile, and perhaps time costs monetized and included.[37]

Full cost pricing, in contrast, is only concerned with a single mode, without regard for how it may be used in combination with other modes or its own occupancy levels. Possibilities for compensating distortions are ignored.

Cost-Revenue Studies

If the term "subsidy" is defined to mean the difference between the total costs of highway services and the total amount paid by users, then the unrecovered cost estimate above can be called a subsidy. Here, costs are defined to include expenditures, opportunity costs of capital assets, externalities, and social overhead. User payments may be made in money or in kind (e.g., time), but must be tied directly to highway usage (e.g., licensing, fines, and special assessments) rather than indirectly (e.g., property taxes).

A narrower type of cost-revenue study is the expenditure-revenue study, in which government user revenue (fees and user taxes) are compared to government expenditures, perhaps on an annual basis[38] Third party costs are not counted. Normally such studies stick to direct governmental costs and direct user revenues conditional on highway use, but some may also count indirect revenues in the form of taxes on highway-related enterprises[39].

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[37] Both Apogee (1994) and Miller and Moffet (1993) are mixtures of several different types of studies, but primarily comparative cost studies. The former uses Boston and Portland, ME, as case study settings for prototypical trips combining several modes; the latter study makes generic comparisons for single modes. The "least cost" transportation idea is a comparative cost application.

[38] Both Hart (1985) and Lee (1972) conducted what were essentially cost-revenue studies from the perspective of a particular urban jurisdiction, and Hanson (1992) did much the same.

[39] Mallinckrodt (1992) is an example.

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