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Do motor-vehicle users in the US pay their way?

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Abstract

Governments in the US spend over a hundred billion dollars per year to build and maintain roads and provide a variety of services for motor-vehicle users. To pay for these infrastructure and services governments collect revenue from a variety of taxes and fees. The basic objective of this paper is to compare these government expenditures with the corresponding user tax and fee payments in the US. At the outset I argue that the such comparisons tell us something about the equity but not necessarily the economic efficiency of highway financing. I then present four different ways one might tally up government expenditures and user payments, depending on the extent to which one wishes to count "indirect" expenditures (e.g., on prosecuting car thieves) and non-targeted general-tax payments (e.g., severance taxes on oil). I make a comprehensive analysis of all possible expenditures and payments, and then compare them according to three of the four ways of counting expenditures and payments. The analysis indicates that in the US current tax and fee payments to the government by motor-vehicle users fall short of government expenditures related to motor-vehicle use by approximately 20–70 cents per gallon of all motor fuel. (Note that in this accounting we include only government expenditures; we do not include any "external" costs of motor-vehicle use.) The extent to which one counts indirect government expenditures related to motor-vehicle use is a key factor in the comparison.
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1. Introduction

1.1. Background

Federal, state, and local governments in the US spend over a hundred billion dollars per year to build and maintain roads and provide a variety of services, such as highway patrol, for motor-vehicle users (Delucchi, 2005a). To pay for these infrastructure and service expenditures governments collect revenue from a variety of

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taxes and fees, ranging from road tolls to motor-fuel taxes to general-fund tax receipts. Some of these taxes and fees, such as road tolls, are targeted specifically to the use of public motor-vehicle infrastructure and service (MVIS); some, like sales tax receipts, are purely general taxes unrelated to motor-vehicle use; and some, like fuel-excise taxes, may be said to be "in-between" a price on the use of MVIS and a general tax on all commodities.

For two reasons, many people care a great deal about the amount and kind of government-levied taxes and fees used to pay for government-provided MVIS in the US. First, the taxes and fees affect how and how much motor vehicles and other transportation modes are used, and hence are of interest to persons who want to encourage or discourage motor-vehicle use, or maximize the economic efficiency of transportation choices, or accomplish other social objectives.[1] Second, the taxes and fees affect how and how much people *pay* for MVIS, and hence are of interest to people who care about the fairness, or equity, of government patterns of taxation and expenditure. It is this concern with equity that motivates comparisons of user payments for MVIS with government expenditures for MVIS – a comparison which lies at the center of this paper.

1.2. Overview of the paper

The objective of this paper is to establish a reasonable framework for estimating motor-vehicle-user payments towards government-provided MVIS, and then to estimate those payments and compare them with government expenditures in the US. First, I argue that the purpose of estimating tax and fee payments by motor-vehicle users is to determine whether users pay governments a "fair" amount. I thus emphasize at the outset that, properly understood, the debate is primarily about *equity*, not about *economic efficiency*. I show that a comparison of current tax and fee payments – however defined – with current motor-vehicle-related costs (however defined) tells us little about optimal pricing, optimal revenues, optimal expenditures, or optimal use of public or private transportation resources.

Next, I classify the various taxes and fees that one might count as user payments, according to the breadth (or "targetedness") and disposition of the taxes and fees. I classify government expenditures on MVIS according to the "directness" of the relationship between motor-vehicle use and the expenditure in question. (Note that in this analysis, motor-vehicle use refers to the use of all on-road vehicles, from light-duty passenger automobiles to heavy-duty commercial trucks.)

I then present four different ways one might tally up user payments and government expenditures, the differences owing ultimately to the extent to which one counts what we will call "non-targeted" taxes and fees (taxes and fees that are *not* targeted specifically and exclusively at the use of motor vehicles or motor fuel, such as severance taxes on the production of crude oil) and "indirect" expenditures (those that are *not* directly and immediately related to motor-vehicle use, such as public costs for prosecuting car thieves). These four different ways of counting user payments and government expenditures are referred to hereafter as the "WOCs" (for "ways of counting").

After discussing the conceptual framework and the four WOCs, I present estimates of tax and fee payments and government expenditures for MVIS, for all levels of government in the United States in the year 2002 (the latest year for which complete data are available.) I then add up payment and expenditure items according to three of the four WOCs. (The fourth WOC requires a formal macroeconomic model, which I do not present here.) The detailed data and methods used to estimate payments and expenditures are not presented in this paper but are fully documented in Delucchi (2005a,b).

[1] Of course, interest in fuel taxes and road-user charges in general is quite broad. Analysts have examined the optimal (second-best) gasoline tax (e.g., Parry and Small, 2005), the incidence of federal and state motor-fuel taxes (Chouinard and Perloff, 2004; Krupnick et al., 1993), the political feasibility of raising fuel taxes (Hammar et al., 2004), the history and disposition of gasoline taxes (Puentes and Prince, 2003), alternatives to the gasoline tax (Transportation Research Board, 2005), the implications of financing transportation projects from general fees rather than user charges (Goldman and Wachs, 2003), public preferences for allocating revenues from road-user charges in Britain (Farrell and Saleh, 2005), and the theory and practice of road-user charging schemes in the UK (Saleh, 2005).

Finally, I emphasize that I compare motor-vehicle-user payments only with actual monetary outlays by government; I do not include on the "cost" side of the ledger any non-monetary or external costs of motor-vehicle use, such as damages from climate change or the macroeconomic costs of oil disruptions.[2]

1.3. Previous studies

1.3.1. US national studies

Not surprisingly, there is a good deal of argument about whether motor-vehicle users in the US pay fully for government-provided MVIS. Lee (1994), MacKenzie et al. (1992), and others have argued that in the US, payments by motor-vehicle users fall well short of outlays by the public for roads and related services. But Beshers (1994) and Lockyer and Hill (1992) claim that in the US road-user tax and fee payments at least equal government expenditures related to motor-vehicle use, and Dougher (1995) argues that road-user payments exceed related government outlays by 50%. Morris and DeCicco (1996, 1997) revise Dougher's (1995) accounting, deducting general taxes from the revenue side and adding some motor-vehicle-related services to the expenditure side, and find that revenues from users fall short of government expenditures by 22%. Similarly, the most recent highway-cost allocation study by the Federal Highway Administration (FHWA) et al. (1997) indicates that "highway user fees" are about 20% below highway-related expenditures, for all levels of government and all vehicle classes in the US in 2000.[3]

1.3.2. Studies of US regions and of other countries

As one would expect, there are genuine differences in payments versus expenditures from region to region in the US and from country to country, independent of differences in accounting frameworks. Cameron's (1994) accounting for Southern California in 1991 suggests that tax and fee receipts related to motor-vehicle use easily exceed public-sector expenditures (when bus and rail receipts and expenditures are excluded from both sides of the ledger), but Komanoff and Sikowitz's (1995) accounting for New Jersey indicates that there receipts are only 77% off expenditures. Hanson's (1992) accounting for Wisconsin in the early 1980s indicates that state and federal user fees are only about half of roadway expenditures by all levels of government, and Ryan and Thomas Stinson's (2002) accounting for the seven-county Twin Cities metropolitan area of Minnesota in 1996 shows that user taxes and fees (which exclude general property taxes, general state aid, and special assessments) provide about 60% of all revenue used for highways.

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[2] Several European studies have compared user payments with the social costs of road use. Link (2005) summarizes the results of the EU-funded UNITE study, which compares user payments of tolls, vehicle taxes, and fuel taxes, with the costs of infrastructure (capital plus operating), air pollution, noise, global warming, and accidents, in several European countries (see Section 1.3.2 of this paper). The RECORDIT project estimates the private and external costs of intermodal freight transport in Europe (www.recordit.org).

Proost et al. (2002) use the TRENEN models to compare current transport prices with efficient (marginal-social-cost) transport prices for cars and buses, in peak and off-peak periods, in several European cities. (In Proost et al., current transport prices are equal to equal to resource costs [fuel, maintenance, vehicles, etc.] plus time costs and taxes, and marginal social costs are equal to marginal resource costs [fuel, vehicles, infrastructure, parking, etc.] plus time costs and marginal external costs [accidents, air pollution, and congestion].) Proost et al. (2002) find that the marginal social cost of auto travel in the peak period in European cities greatly exceeds the user price, primarily because of the large cost of congestion. (The marginal social cost also exceeds the user price in the off-peak period, in most cases, but by less than in the peak period.) By contrast, the estimated cost of bus travel is relatively close to the estimated user price, in both the peak and the off-peak periods.

Nash et al. (2001) compare infrastructure plus external costs (congestion, accidents, air pollution, global warming, and noise) with user tax and fee payments, for several case studies of inter-urban transport and one case study of intra-urban transport. They find that payments easily exceed costs for all modes in all of the case studies except the case of intra-urban car transport.

Finally, Glaister and Graham (2005) estimate the impacts on travel of three different transport pricing schemes in the UK: current fuel taxes plus externality charges, zero fuel taxes plus externality charges, and zero fuel tax plus externality charges and a mark-up to maintain government revenue. They find that the externality charges are less than current fuel taxes, and hence that the economically efficient option (zero fuel tax plus externality charges) reduces transport prices and increases travel.

Note that most European studies, including UNITE, RECORDIT, TRENEN, and Nash et al. (2001) rely on the "ExternE" project (www.externe.info) for methods of estimating air-pollution damages.

[3] The FHWA cost allocation study estimated the ratio of user payments to allocated costs for different vehicle classes in the year 2000, as follows: automobiles, 0.7, pickups and vans, 0.9, buses, 0.4, combination trucks over 80,000 lbs, 0.7, all trucks, 0.8, all vehicles, 0.8.

Newbery estimates that in Britain the ratio of road-use taxes to road costs (excluding accidents) was 1.4 in 1986 (Newbery, 1988) and 1.9 in 1996/1997 (Newbery, 1998), mainly because of much higher fuel taxes in Britain than in the US. Booz Allen Hamilton (2005) estimate a user-payment/road-cost ratio of 0.70 for New Zealand in 2001 when interest charges on capital are treated symmetrically on the payment and expenditures side, as in this paper. And most authoritatively, Link (2005) reports the results of the European-Union-funded project UNITE (UNIfication of accounts and marginal costs for Transport Efficiency), which provided standardized information on the total social costs and revenues of transport for all transport modes and all EU countries plus Switzerland. The UNITE project counted tolls, vehicle taxes, and fuel taxes (excluding the standard rate "value added tax", which is the same as the general sales tax in the US) as user payments, and the capital and "running" costs of infrastructure as government expenditures. UNITE also estimated a total "core" cost, equal to government expenditures plus the external costs or air pollution, noise, global warming, and accidents.[4] With this framework, UNITE estimated the follow ratios of user payments to government expenditures and total core costs (Link, 2005):

	Payments: expenditures	Payments: total core costs
Australia	1.13	0.68
Belgium	3.97	1.16
Denmark	3.71	1.71
Finland	3.24	1.65
France	1.72	0.97
Germany	1.59	0.70
Greece	1.97	0.71
Hungary	0.31	0.25
Ireland	9.10	1.80
Italy	2.65	1.20
Luxembourg	3.87	1.40
Netherlands[5]	2.33	1.24
Portugal	2.13	1.10
Spain	2.07	0.86
Sweden	2.40	1.27
Switzerland	1.11	0.71
UK	3.48	1.57

These results show that payments exceed government expenditures – usually by a wide margin – in every European country except Hungary, and that payments even exceed total social costs in more than half of the countries.

In the US, the disagreements about user payments versus expenditures result from different opinions about what should count as a "user payment" to the government, on the one hand, and what should count as a government expenditure related to MVIS, on the other. More specifically, the disagreements center around the proper treatment of non-targeted taxes and fees on the payment side and indirect government expenditures related to MVIS on the expenditure side. This paper illuminates this debate by providing an original, detailed, comprehensive accounting of all possible user payments and government expenditure and delineating several ways of adding up and comparing them.

[4] The estimates of external costs in UNITE are discussed in Bickel et al. (2006).

[5] See also Vermeulen et al. (2004), who estimate total social costs and total user payments, by mode and type of vehicle in the Netherlands. (For some cost components, Vermeulen et al. adopt the methods of the UNITE study.) Vermeulen et al. (2004) estimate that for gasoline cars in the Netherlands, user payments slightly exceed total social costs, and are about double infrastructure costs. However, for heavy-goods vehicles, user payments are less than infrastructure-related costs.

1.4. The contribution of this analysis

As indicated in Section 1.3, there have been a number of analyses of motor-vehicle-user payments and government motor-vehicle-related expenditures in the US. The analysis presented here expands and improves upon this previous work in several ways:

(1) We have a clearly delineated conceptual framework. We explain why people are interested in motor-vehicle-related payments versus government expenditures, and how the results of such analyses may be interpreted and applied. We carefully construct four different ways of counting (WOCs) "motor-vehicle user payments" and "government expenditures for MVIS" and make estimates for three of the four WOCs.
(2) We have a comprehensive accounting system: we have identified and quantified all potentially relevant and significant categories of motor-vehicle-user payments and government motor-vehicle-related expenditures. On the payment side we quantify all conceivable targeted and non-targeted taxes and fees, such as severance taxes on oil production, special property taxes on motor vehicles, and general sales taxes on vehicles and fuels (Table 1). On the expenditure side we quantify all conceivable direct and indirect costs

Table 1
Payments by motor-vehicle users for the use of highways and public services related to motor-vehicle use (10^9\$)

Payment item	Low cost	High cost	Q[a]
A. Year 2002, weighted results			
A1. Special taxes and fees targeted to vehicles and fuels and used for MVIS (FHWA method)			
A1.1. FHWA-estimated federal, state, and local tax, license, and toll payments by highway users	79.6	79.6	A3
A1.2. Interest earnings on payments invested to cover highway and other capital	47.4	226.4	A3
Subtotal, WOC #1	**127.0**	**306.0**	
A2. Other taxes, fees specifically related to motor-vehicle use			
A2.1. Taxes and fees dedicated to non-highway purposes, including collection expenses	21.1	21.1	A3
A2.2. Property-tax-like fees specifically related to motor-vehicle use	0.7	0.7	A3/4
A2.5. Air-quality, environmental fees on motor vehicles	0.1	0.1	A3
A2.6. Environmental excise taxes on petroleum	0.0	0.0	A3
A2.7. Gas-guzzler taxes, luxury taxes, other minor taxes	0.4	0.4	A4
A2.8. Traffic fines and parking fines	12.0	8.0	A2
A2.9. Public parking fees and all parking taxes	6.1	7.5	A3
A2.10. Miscellaneous taxes, fees not counted elsewhere	0.5	0.5	D
Subtotal, WOC #2	**167.0**	**344.3**	
B. Selective taxes, fees on a limited range of commodities and activities			
B1. Severance taxes paid on oil and gas (attributed to MV use)	1.3	0.0	A3
B2. Special property taxes	0.2	0.0	A3
B3. Special sales taxes	1.2	0.1	A3
B4. Other selective taxes and fees	1.1	0.0	A3
C1. General taxes on a wide range of commodities and activities			
C1.1. Portion of general sales taxes on motor vehicles, fuels, parts, and services	1.1	2.1	A2
C1.2. Portion of corporate income taxes paid by motor-vehicle related industries	0.3	0.6	A3
C1.3. Portion of personal income taxes paid by employees in motor-vehicle related industries	2.0	4.3	A2
C1.4. Portion of general property taxes paid on motor vehicles and by motor-vehicle related industries	0.6	0.9	A3
C2. Tax expenditures			
C2.1. Tax expenditures: corporate income taxes	0.0	(3.1)	A2/3
C2.2. Tax expenditures: general sales taxes	0.0	(9.8)	A2/3
C2.3. Tax expenditures: property taxes on highways	0.0	(10.8)	A3
TOTAL, WOC #3	**175.6**	**328.5**	

(*continued on next page*)

Table 1 (*continued*)

Payment item	Low cost	High cost	Low wt.	High wt.
B. Year 2002, unweighted results and weights				
A1. Special taxes and fees targeted to vehicles and fuels and used for MVIS				
A1.1. FHWA-estimated federal, state, and local tax, license, and toll payments by highway users	79.6	79.6	1.00	1.00
A1.2. Interest earnings on payments invested to cover highway and other capital	47.4	226.4	1.00	1.00
A2. Other taxes, fees specifically related to motor-vehicle use				
A2.1. Taxes and fees dedicated to non-highway purposes, including collection expenses	21.1	21.1	1.00	1.00
A2.2. Property-tax-like fees specifically related to motor-vehicle use	0.7	0.7	1.00	1.00
A2.5. Air-quality, environmental fees on motor vehicles	0.1	0.1	1.00	1.00
A2.6. Environmental excise taxes on petroleum	0.0	0.0	1.00	1.00
A2.7. Gas-guzzler taxes, luxury taxes, other minor taxes	0.4	0.4	1.00	1.00
A2.8. Traffic fines and parking fines	12.0	8.0	1.00	1.00
A2.9. Public parking fees and all parking taxes	6.1	7.5	1.00	1.00
A2.10. Miscellaneous taxes, fees not counted elsewhere	0.5	0.5	1.00	1.00
B. Selective taxes, fees on limited commodities and activities				
B1. Severance taxes paid on oil and gas (attributed to MV use)	1.6	1.0	1.00	0.051
B2. Special property taxes	0.1	0.1	1.00	0.051
B3. Special sales taxes	0.8	0.8	1.00	0.051
B4. Other selective taxes and fees	0.7	0.4	1.00	0.051
C1. General taxes on a wide range of commodities, activities				
C1.1. Portion of general sales taxes on motor vehicles, fuels, parts, and services	19.6	16.3	0.020	0.051
C1.2. Portion of corporate income taxes paid by motor-vehicle related industries	6.3	6.2	0.020	0.051
C1.3. Portion of personal income taxes paid by employees in motor-vehicle related industries	40.1	38.9	0.020	0.051
C1.4. Portion of general property taxes paid on motor vehicles and by motor-vehicle related industries	12.4	9.0	0.020	0.051
C2. Tax expenditures				
C2.1. Tax expenditures: corporate income taxes	−2.5	−2.5	0.00	1.00
C2.2. Tax expenditures: general sales taxes	−2.0	−1.6	0.00	1.00
C2.3. Tax expenditures: property taxes on highways	−5.9	−5.9	0.00	1.00

See the text for details. "Low cost" means "low social costs net of user payments," and "high cost" means "high social costs net of user payments." Hence, the low-cost case can incorporate numerically higher payments, and vice versa. See Appendix 17-A.3 of Delucchi (2005b) for further discussion of "low" and "high" user payments in this context.

The weighted costs shown in part A are equal to "unweighted" costs multiplied by weights that represent the fraction of each unweighted cost that is counted as a payment under WOC #3. Part B of this table shows the weights and the unweighted costs for the year 2002.

[a] Q = Quality of the baseline year – 1991 estimate (see Table 3). Ratings in brackets refer to the quality of the analysis in the literature reviewed.

such as the motor-vehicle-related costs of fire-protection services and the judicial and legal system (Table 2).

(3) Our estimates are built on original, detailed analyses of primary data, for a base year of 1991. In all payment and expenditure categories we use primary government data as opposed to estimates derived from the work of other analysts. We use primary data for both our direct estimates of expenditures and payments and for our estimates of the motor-vehicle-related share of certain government expenditures. To estimate payments and expenditures for years other than 1991, we use a combination of primary data (for the most important payment and expenditure categories) and extrapolation.

(4) We have a rigorous estimation method that ensures that our estimates of motor-vehicle-user payments are consistent with our estimates of government motor-vehicle-related expenditures. Where possible, we use the same primary data sources for both payments and expenditures; we apply capital amortization principles and interest rates consistently to payments and expenditures; and we develop a careful, comprehensive, internally consistent definition of "low-cost" and "high-cost" cases, in which "low cost" means low expenditures and high payments.

Table 2
Motor-vehicle infrastructure and services provided by the public sector, 2002 (10^9\$)

Cost item	*Low*	*High*	*Q*[a]
A1. Direct expenditures (FHWA method)[b]			
Annualized cost of highways (capital, M&R, administration)	159.9	335.7	A2
Highway law enforcement and safety (estimated by FHWA)	12.6	15.8	A3
Subtotal, WOC #1	**172.5**	**351.4**	
A2. Other direct expenditures[c]			
Collection expenses, LUST, extra M&R	8.3	8.3	A3
Annualized cost of municipal and institutional offstreet parking	17.5	29.0	A2/3
Deduction for embedded private investment in roads[d]	(6.6)	(16.7)	C
Subtotal, WOC #2	**191.7**	**372.1**	
B. Indirect expenditures			
Other police costs (not estimated by FHWA) related to MV use	1.9	9.3	A2
Fire-protection costs related to MV use	1.4	5.5	A2
Emergency-service costs of MV accidents included in police, fire costs above[d]	(1.4)	(1.4)	A2/B
Judicial and legal-system costs related to MV use	8.9	11.6	A2
Legal costs of MV accidents included under judicial and legal-system costs above[d]	(1.2)	(1.2)	A2
Jail, prison, probation, and parole costs related to MV use	7.0	9.4	A2
Regulation and control of air, water and solid-waste pollution related to MV use	7.1	15.4	A2
Energy and technology R&D related to MV use	0.3	0.8	A3
MV-related costs of other government agencies	0.1	0.1	D
Military costs related to the use of Persian-Gulf oil by MVs	0.8	11.2	B, D[e]
Annualized cost of the Strategic Petroleum Reserve	0.0	0.9	A2
Total, WOC #3	**216.5**	**433.6**	

Source: Delucchi (2005a). MV = motor vehicle; M&R = maintenance and repair, LUST = leaking underground storage tanks; R&D = research and development.

[a] Q = Quality of the baseline year-1991 estimate (see Table 3).

[b] With minor exceptions, these are based on FHWA estimates of government expenditures for highways. The A1 estimates shown here *exclude* user tax-and-fee collection expenses, LUST-fund costs, and extra maintenance and repair (M&R) costs, but *include* the embedded private-sector investment in roads, because the FHWA expenditure estimates exclude collection, LUST, and extra M&R costs, but include embedded private costs. In part A2 of this table the excluded collection, LUST, and extra M&R costs are added back in, and the included embedded private costs are deducted.

[c] See note [b].

[d] We deduct private investment in roads because it is not government-provided infrastructure to be paid for by tax and fee payments to government, but rather is a private-sector cost bundled into the price of houses or other private-sector goods and services. We deduct embedded emergency-service and legal costs related to accidents because these should be paid for as *accident* costs, via insurance or other specific accident liability charges, rather than as general government-service usage costs to be paid for by user tax and fees to government.

[e] A review and analysis of the literature with a good deal of supposition.

2. The purpose of estimating user payments and government expenditures

2.1. Conceptual overview

I emphasize at the outset that the purpose of this exercise is to shed light on the *fairness* of patterns of government taxation and expenditure, not to gain insight into the economic efficiency of government taxation or expenditure. To see this more clearly, let us suppose that we estimate that motor-vehicle users pay \$$X$ annually for public MVIS that costs \$$Y$ annually. The pertinent question here is: what, if anything, does the difference \$$X$ minus \$$Y$ or the ratio of \$$X$ to \$$Y$ tell us? For example, if we changed user taxes and fees so that total payments equaled \$$Y$ instead of \$$X$, would we have insured the most economically efficient use of the transportation system, or at least have increased the efficiency of use?

The answer to foregoing questions regarding efficiency is "no, not necessarily". The difference between government revenues and government expenditures related to MVIS has no straightforward relevance in an analysis of social costs or efficient pricing. In the first place, it is not a condition of efficiency that a government

recover from users revenues equal to costs. In the second place, current user taxes and fees, of which the motor-fuel tax is the largest, do not look anything like efficient (i.e., marginal-cost) prices, which means that changing the *magnitude* but not the *structure* of the current taxes and fees (which is all that we do when we demand simply that taxes and fees be increased to cover costs) might decrease economic welfare as soon as increase it. As is widely known, the relevant condition of economic efficiency is marginal-cost pricing, which, when applied to highways and public MVIS would result in a price and tax structure that would look nothing like the present charge structure,[6] and which would *not* generate user revenues sufficient to cover government expenditures (e.g., CBO, 1992; Gillen, 1997; Booz Allen Hamilton, 2005).

2.2. The structure of present motor-vehicle-user taxes and fees

Let us examine first the question of the structure of present user taxes and fees more closely. Few if any of the present highway user taxes and fees were set to be marginal-cost prices.[7] Consider the most prominent of the present user fees, the motor-fuel tax. The excise tax on motor fuel is a charge per gallon consumed. The public service and infrastructure putatively being charged for is highway construction and maintenance. But clearly there is little correspondence between fuel consumption and "consumption" of highway infrastructure and services, and as a result the fuel tax is not a marginal-cost price on highway use (FHWA, 1982; CBO, 1992; Button, 1993). As Button (1993) remarks, "charges levied on road users relate very little to the costs of providing and maintaining the infrastructure provided let alone to wider notions of optimizing its use either from a purely traffic perspective or from a much wider social perspective" (p. 99).

The same could be said about user fees other than the fuel tax; namely, that they certainly are not set at marginal cost. Given, then, that the structure of current taxes and fees is so different from an economically efficient structure, it is not possible to know a priori the effect on economic efficiency of changing the magnitude but not the structure of current taxes and fees.

2.3. The relationship between total costs and total payments

It is generally agreed that with efficient pricing of highways and related services, price-times-quantity revenues need *not* cover costs. For example, an efficient variable-cost charge for wear and tear will cover the cost of highway maintenance and repair, but an optimal congestion toll may or may not cover the optimal long-run capital cost of the highway. Indeed, the congestion toll will cover the capital cost only if: (a) the road is in fact congested (even at its optimal size, it need not be) and (b) the cost-per-unit-capacity of the highway is constant or rising with additional capacity.[8] If these conditions are not met, then there will be a revenue shortfall or surplus. Ideally, any revenue shortfall will be made up by what is known as "inverse elasticity pricing" or lump-sum transfers from individuals to the public sector (see CBO, 1992 for an accessible discussion of these measures). Importantly, from the standpoint of efficiency the individuals who make the lump-sum transfers need not be users. Thus, merely setting payments equal to costs does not in itself necessarily improve economic efficiency.

2.4. Summary

If our objective is to have efficient use of transportation infrastructure and services, then we should set prices on the infrastructure and services equal to marginal social costs. The exercise of adding up the revenues

[6] An efficient highway-user charge would have two components: a variable-cost charge, equal to the cost of wear of the highway per mile of travel, and a congestion charge, equal to the cost of delay imposed on all other travelers as a result of an additional mile of travel by each (Mohring, 1976; Keeler and Small, 1977; Newbery, 1989; Gillen, 1997). However, see Rothengatter (2003) for a critique of the marginal-social-cost-pricing principle in the transport sector.

[7] Some road tolls, probably by coincidence, may be efficient prices. Similarly, some fines and producer charges may be efficient (i.e., equal to marginal cost), but again most likely only by coincidence.

[8] There has been much debate over whether cost-per-unit-capacity for highways increases, decreases, or remains constant with increasing capacity. Anderson and Mohring (1997) cite studies that found constant cost, but Mills and Hamilton (1984) cite studies that found increasing or decreasing costs, and Rothengatter (2003) implies that the cost decreases. If the cost-per-unit-capacity is decreasing, then the marginal-cost price, multiplied by quantity, will not cover total cost.

from the currently in-place (and economically inefficient) taxes and fees on motor-vehicle use and comparing the total with total government expenditures is not by itself directly relevant to the exercise of setting efficient marginal social-cost prices or determining optimal levels of investment.

But even though we cannot say that efficiency requires that revenues from the present tax and fee system equal government expenditures, we may say that *fairness* demands it. Similarly, we also may demand that the government highway and motor-vehicle enterprise operate with a balanced budget. In the following sections, we classify, organize, and add up user payments and fees and compare them with government expenditures in order to determine if motor vehicle users fairly "pay their way".

3. Classification of user taxes and fees and of government expenditure categories

3.1. Overview

As mentioned in Section 1.3, arguments about whether motor-vehicle users "pay their way" are in part arguments about which tax and fee payments ought to be counted against government expenditures. Arguments about which taxes and fees should count depend in part on the breadth or "targetedness" of the tax or fee in question: whether it applies only to motor-vehicle use, or to all commodities and services in the national economy, or to something in between. Therefore, to begin to address this question of whether motor-vehicle users "pay their way," we distinguish several classes of possible user tax and fee payments for MVIS:

- (A1) special taxes and fees levied only on motor vehicles, motor fuels, drivers, and so on, and used by government for motor-vehicle-related purposes;
- (A2) other taxes and fees specifically targeted to motor vehicles and fuels;
- (B) selective taxes and fees levied on a limited number of commodities;
- (C1) general taxes and fees on a wide range of commodities; and
- (C2) general tax expenditures or subsidies.

Table 1 shows our classification of all motor-vehicle-user tax and fee payments considered in this paper.

Similarly, on the expenditure side of the ledger there are arguments about precisely which government expenditures ought to be attributed to motor-vehicle use and hence compared with motor-vehicle user tax-and-fee payments. Some types of expenditures (e.g., for highways) are obviously directly related to motor-vehicle use, but other types (such as judicial-system costs for prosecuting car thieves) are related to motor-vehicle use only indirectly, and hence arguably could not be counted as government expenditures on MVIS. This suggests that it is useful to make a general classification of expenditures according to how directly they are related to motor-vehicle use:

- (A1) direct expenditures on highways, as estimated by FHWA;
- (A2) other expenditures related directly to motor-vehicle use;
- (B) expenditures related only indirectly to motor-vehicle use.

Table 2 shows our classification of all government expenditures considered in this paper.

3.2. Classes A1 and A2: special taxes and fees targeted to vehicles and fuels, and direct expenditures on MVIS by government

3.2.1. Class A user payments

First, we distinguish special taxes and fees that are levied only on motor vehicles, motor fuels, driving, parking, and other motor-vehicle activities and commodities, from all other more general tax and fee revenues. In the class of special taxes and fees, which we will designate class A, are such things as gasoline excise taxes, road tolls, and motor-vehicle registration fees. These special taxes are distinguished from more general taxes such as sales taxes on motor vehicles.

Within class A we may make a further distinction based on the classification of the US. Federal Highway Administration (FWHA). The FHWA is a widely used original source of data on government expenditures and receipts for highway-related purposes in the US (e.g., FWHA, *Highway Statistics*, annual report, www.fhwa.dot.gov/policy/ohpi/hss/index.htm). In its *Highway Statistics* annual report, FHWA identifies a class of taxes and fees that according to its criteria are highway-user payments for the highways (see Section 4.2 for details). Because the FHWA data on expenditures and receipts are widely used in the US., and because the FHWA classification of user payments for the highways is used as the basis of some studies of highway costs versus user payments, it is sensible to define here a separate class of taxes and fees that corresponds to the FHWA class of "highway user payments for the highways". This is a subset of our class A here – class A1. This leaves a variety of taxes and fees that are specifically targeted to motor-vehicle use but that FHWA does not classify as highway user payments for the highways. These compose our class A2. Examples of taxes and fees in this class (A2) are portions of fuel taxes and other user fees allocated specifically for deficit reduction, mass transit, and other non-highway purposes (Table 1).

3.2.2. Class A government expenditures

First, we distinguish direct from indirect government expenditures on MVIS. In the class of direct expenditures, which we call class A, are all expenditures on highway construction, maintenance and repair, operations, and administration, and expenditures on parking. Within class A we then make a further distinction, analogous to the one made within user payments class A, between expenditures classified as highway-related by the FHWA (class A1), and other direct expenditures not classified as highway-related by the FHWA (class A2). We make this distinction because, as noted in Section 3.2.1, FHWA's financial data and its expenditure and payment accounting are widely cited. Table 2 shows the items in class A2, which we consider to be direct expenditures related to motor-vehicle use but which FHWA does not.

3.3. Class B: selective taxes and fees, and indirect expenditures

3.3.1. Class B user payments

Next, we make two classes out of the broad category of taxes and fees that are not targeted specifically to motor-vehicles and motor fuels. The first (class B) are certain taxes on the production or use of motor vehicles and fuels that are part of a selective tax structure that focuses on a limited range of commodities, including but not limited to motor-vehicle and motor-fuel commodities. The breadth of these selective taxes fall in between the wide breadth of the general taxes of class C and the narrow breadth of the special taxes of class A. Selective taxes include severance taxes on energy production and certain property taxes and sales taxes on motor vehicles (Table 1).

3.3.2. Class B government expenditures

Table 2 shows the expenditures that we consider to be only indirectly related to motor-vehicle use. Our distinction between "direct" and "indirect" expenditures is based on our sense of the strength of the relationship between changes in motor-vehicle use and changes in the expenditure in question, and ultimately is somewhat arbitrary. As an example, the most indirect expenditure – the one for which the relationship between motor-vehicle use and the expenditure in question is most tenuous – is military expenditures to protect the use of Persian-Gulf oil for motor vehicles.[9] While it is possible to construct a story in which changes in motor-vehicle use result in changes in military expenditures, there are many steps in the story, and the linkage is ultimately quite indirect (Delucchi and Murphy, 2004). One reasonably might be disinclined to count military expendi-

[9] It is possible that US military expenditures to "protect" Persian Gulf oil cause more problems than they prevent. If this is the case, then there are additional "external" costs of motor-vehicle use that ought to be counted in a full social-cost analysis. However, we are interested here in the military expenditures per se, and questions about the *effects* of military expenditures are not relevant to the issue of the relationship between changes in motor-vehicle use and changes in US military expenditures.

tures as a government cost of motor-vehicle use. By contrast, expenditures on public parking obviously are fairly directly related to the use of motor vehicles.

We note, though, that the ultimate arbitrariness of our classification is not problematic for our analysis, partly because we do comparisons with and without indirect expenditures, and partly because we provide a comprehensive listing of all relevant user payments and government expenditures with which readers can construct their own accounting.

3.4. Classes C1 and C2: general taxes and general-tax subsidies

3.4.1. Class C user payments

General taxes on the production and use of motor vehicles and motor fuel include: corporate and personal income taxes in businesses related to motor-vehicle and motor-fuel production and use; general sales taxes on vehicles, fuels, and related items; and property taxes on vehicles and roads. By definition the general taxes of class C are part of a broad tax structure that covers many and in some instances virtually all commodities. Because these taxes apply to most commodities, and not just to motor vehicles and fuels, they may be considered to be taxes for a wide range of general government services rather than user payments for specific things like government-provided MVIS.

In this class of general taxes we include estimates of government "tax expenditures" related to motor-vehicle use. Tax expenditures (also called "tax subsidies") represent a loss of government tax revenue due to a particular commodity being taxed at less than a prevailing or average rate. Tax subsides can be estimated in several categories: corporate income taxes paid in motor-fuel and motor-vehicle industries; general state and local sales taxes paid on vehicles, fuels, parts, and automotive services; and general state and local property taxes foregone on development displacement by roadways. Corporate income-tax subsidies and general sales-tax subsidies are estimated in Delucchi (2004) and are used in this paper. Property-tax subsidies related to roadways are estimated in Delucchi (2005b).

3.4.1.1. Class C government expenditures. In this analysis, there are no class C government expenditures.

4. Ways of counting taxes and fees government expenditures

4.1. Overview

In this section we establish four different ways of counting (WOCs) for user payments and government expenditures towards MVIS. The four WOCs treat classes of payments (A1, A2, B, C1, and C2) and classes of expenditures (A1, A2, and B) differently, to wit:

WOC	Treatment of user payments	Treatment of government expenditures
(1) Targeted taxes and fees; direct expenditures (FHWA method)	Only taxes and fees that are specifically targeted to highway users *and* are actually used by government for highways are counted as user payments. (This is similar to the method used by the FHWA.) **Comprises: class A1**	Only direct government expenditures on highways (e.g., capital, repair, highway patrol) are counted as government expenditures for MVIS. (This is similar to the method used by FHWA.) **Comprises: class A1**
(2) All targeted taxes and fees; all direct expenditures	Same as WOC #1 plus a few targeted user payments for that FHWA excludes **Comprises: class A1** and **Class A2**	Same as WOC #1 plus some direct expenditures related to motor- vehicle use that FHWA excludes **Comprises: class A1** and **Class A2**

(*continued on next page*)

Table (*continued*)

WOC	Treatment of user payments	Treatment of government expenditures
(3) All targeted and some non-targeted taxes and fees; all direct and indirect expenditures	Same as WOC #2 plus some portions of selective and general taxes and fees not targeted specifically to motor vehicles or motor fuels **Comprises: class A1, Class A2, Class B**, and some of **Class C**	Same as WOC #2 plus government expenditures related indirectly to the production and use of motor vehicles and motor fuels **Comprises: class A1, Class A2,** and **Class B**
(4) Marginal changes in user payments; marginal changes in expenditures	Whatever *net additional* revenues from taxes and fees the government gains as a result of some marginal change in motor-vehicle use is counted as user payments against whatever net additional expenditures the government makes as a result of the change **Not formally estimated here**	

4.2. WOC #1: Targeted taxes and fees and direct expenditures, FHWA method

4.2.1. User payments

WOC #1 adopts the FHWA's relatively restrictive criteria for determining what counts as a user payment for government-provided MVIS. The FHWA, which in the *Highway Statistics* annual report tabulates revenues and expenditures related to highway use, counts a tax or fee as a user payment for highways if it meets two criteria. First, the tax or fee must qualify as a "highway user" charge, and second, it must *not* be specifically allocated for *non*-highway purposes. The FHWA (1991) elaborates on the distinction between highway-user and non-user charges:

> Thus, if the tax is applied to a broad spectrum of commodities (even if a given portion is dedicated to highways), it is considered by FHWA to be a nonuser tax... Conversely, if a tax is exclusively (or substantially) targeted to highway users, it is included [as a highway-user tax]... (p. i)

Others have suggested similar criteria. For example, the CBO (1992) suggests that "if the revenues go to a general fund, the tax should not be considered a user tax" (p. 16–17), an idea which goes back at least 40 years to Zettel (1961).

With its second qualification – that a highway-user charge not be allocated specifically to non-highway purposes – FHWA excludes as a payment for highways all highway-user revenues allocated for deficit reduction, mass transit, and other non-highway purposes. FHWA also does not count the cost of collecting highway-user imposts as a highway-related cost, or the payments that are allocated to cover collection expenses as a payment by highway users for highways. By contrast, under WOC #2, which we discuss next, we ignore earmarking for non-highway purposes and thus count the entire highway-user tax as a user payment for MVIS.

With reference to our classes of user payments, WOC #1 comprises class A1 user payments (Section 3.2.1).

4.2.2. Interest component of user payments

Note that we make one important modification to the FHWA estimates of user payments. The FHWA reports annual user payments without any interest credit. This is appropriate for its accounting method, which reports annual capital outlays as opposed to the annualized cost of the entire capital stock, the difference between these being that the latter includes an interest charge whereas the former does not.

By contrast, we estimate the annualized capital cost of the entire capital stock. With this method, the total capital value of the infrastructure first is amortized over its life at an appropriate interest rate. Given this, user payments are properly viewed as being *invested* in the highway infrastructure, and hence as earning a rate of return equal to the interest rate at which the capital value of the stock is amortized. Therefore, using the

annualized cost and investment method (as opposed to the annual capital outlay method), we must credit the user payment side with an interest component equal to the interest charge embodied in the annualized capital cost (Delucchi, 2005b; Booz Allen Hamilton, 2005).

In sum, we may compare annual expenditures on highways with annual receipts from highway users, or we may compare the annualized value of highway capital stock with the annualized value of the user payments that are treated as being invested in the capital. If annual user payments cover annual capital expenditures (which they have, for many decades (Delucchi, 2005b)), then the annualized portion of user payments towards capital must equal the annualized cost of the capital covered by the payments.[10] Hence, our class A1 of user payments includes an interest component corresponding to the return on the investment of user payments in highway capital (Table 1).

4.2.3. Government expenditures

For consistency with WOC #1 for user payments, WOC #1 for government expenditures also adopts FHWA's relatively restrictive accounting (with one exception, to be noted momentarily). FHWA counts only what it considers to be direct expenditures related to the use of highways: highway construction, highway maintenance and repair, and the highway patrol. With reference to our classes of expenditures, WOC #1 comprises class A1 expenditures (Section 3.2.2).

As mentioned above, there is one difference between our WOC #1 for government expenditures and what the FHWA considers to be expenditures for the highways: we estimate *annualized* capital costs, whereas FHWA reports actual annual capital outlays, the difference between them being that annualized capital costs include an interest cost.

4.3. WOC #2: All targeted taxes and fees and direct expenditures related to motor-vehicle use

4.3.1. User payments

Under WOC #2, we count all direct tax or fee payments that FWHA counts (class A1) plus some payments that FHWA excludes solely because they are earmarked for what FHWA considers to be non-highway purposes. The additional taxes and fees counted under WOC #2 but not WOC #1 include: highway-user tax revenues and tolls tax dedicated to what the FHWA refers to as "non-highway purposes"; some motor-vehicle license fees (such as in-lieu-of-property-tax fees) dedicated to highways; some of what the FHWA considers to be "nonuser imposts dedicated to the highways"; air-quality or emission-control fees paid with vehicle registration; some environmental excise taxes; gas-guzzler taxes, luxury taxes, and other minor charges; parking and traffic fines; and parking taxes (Table 1). With reference to our classes of user payments, WOC #2 of counting comprise class A1 *and* class A2 user payments (Section 3.2.1).

4.3.2. Government expenditures

Under WOC #2 for expenditures, we make a few adjustments to the FHWA-based estimate of expenditures that constitutes WOC #1. First, we exclude certain private-sector contributions to highways, on the grounds that they are not actually government expenditures, whereas FHWA includes them. Second, we include all costs related to collecting and administering highway user taxes and fees, because they are direct costs of highways, whereas FHWA excludes them. Finally, we include costs of municipal and institutional parking, because these are related to motor-vehicle use, whereas FHWA doesn't count them as "highway" costs.

With reference to our classes of expenditures, WOC #2 comprises class A1 and class A2 expenditures (Section 3.2.2).

[10] Newbery (1998) compares annual road-user taxes with the annual interest on the capital value of the roadway. I do not think that this method is right: it omits the depreciation of the actual stock itself on the one hand, and the parallel investment interest that should be imputed to user payments on the other.

4.4. WOC #3: All targeted and some non-targeted taxes and fees, all direct and indirect expenditures related to motor-vehicle use

4.4.1. User payments

Under WOC #3, we count a tax or fee as a user payment towards government MIVS if it is related to the production or use of motor vehicles, motor fuels, etc., and if one cannot argue convincingly that the tax or fee by its nature ought to be considered to be a charge for services or goods unrelated to motor-vehicle use. The "nature" of the tax or fee is determined by its relation to other taxes and fees, the presence or absence of similar taxes and fees on non-motor-vehicle goods and services, and general social conventions.

Because all of the taxes and fees in class A1 and A2 are specifically related to motor vehicle use, and because there is to my mind no convincing reason to treat them as charges for goods or services unrelated to motor-vehicle use, I count them here, under WOC #3, as user payments towards MVIS. However, what is not immediately clear under WOC #3 is whether or not user payments of selective or general taxes (classes B and C), such as the sales tax on motor vehicles, should count as a payment towards expenditures on MVIS, or whether they should be disallowed on the grounds that they ought to be considered to be general payments for other government goods and services.

Consider first tax and fee payments in class B: selective sales and excise taxes on motor-vehicle and related goods and services; selective property taxes on motor-vehicle goods and services; severance taxes on natural resources; and other special taxes on petroleum and motor-vehicle businesses. These taxes and fees are not targeted exclusively to motor vehicles and motor fuels, and are not dedicated to highways, but neither are they as broad-based as the most general taxes and fees. Thus, one reasonably might or might not consider them to be motor-vehicle-user payments. Therefore, I do the analysis both ways: in a "low-cost" (high-payment) case, I lump these payments with the specific targeted taxes of class A, and in a "high-cost" (low-payment) case, I lump them with the non-targeted general taxes of class C.

Next we consider class C1: general sales taxes, property taxes, and so on, that are paid on motor vehicles and fuels but that are part of a broad tax structure that covers many commodities. Because these are part of a general tax structure, it seems more reasonable to view them as supporting a wide range of government services rather than as related even just indirectly to motor-vehicle use. However, one might argue that a small portion of the general taxes paid on vehicles and fuels ends up effectively funding MVIS in particular: namely, the portion of the general tax payment that, after being mixed into the general fund, on average goes back towards funding any government-provided MVIS costs *not* covered by specific user payments (classes A1 and A2 in our accounting system). I estimate this portion and count it as user payment for MVIS. This ends up being a very small amount because only a small portion of government-provided MVIS is not funded by specific user payments, and only a small fraction of general funds go towards government-provided MVIS.

Because general tax payments (and to a lesser extent tax expenditures) related to motor-vehicle use are quite large, the extent to which they are counted as a payment for motor-vehicle use has a major impact on the comparison of payments with expenditures. Indeed, a significant part of the large differences among past studies (Section 1.3) is due to different treatment of general taxes. For this reason, in the following sections we focus more closely on the treatment of general taxes and tax expenditures.

4.4.2. Treatment of general taxes (class C1)

Although general sales, income, and property taxes are related to motor-vehicle use and – to the extent that they are incorporated into prices – are perceived by users to be part of the price of motor-vehicle use, I argue that they nevertheless are more reasonably viewed as meant to support a wide range of government services, most of which are not related to motor-vehicle use. There are two reasons for this. First, general taxes typically are deposited into the general-fund accounts of governments and used for general purposes. (Although some general taxes are earmarked for transportation purposes, in my view and in the view of FHWA this earmarking does not mean that the taxes should be considered payments by motor-vehicle users for motor-vehicle use.) Second, and more importantly, most products – not just those bought for motor-vehicle use – are assessed a sales tax; most corporations – not just those involved in motor-vehicle-related businesses – pay an income tax; most workers – not just those in motor-vehicle and related industries – pay an income tax; and many forms of property – not just those related to motor-vehicle use – are assessed a property tax.

An alternative, less restrictive view is that if a tax looks like a price and acts like a price to motor-vehicle users, then it should count as a payment for motor-vehicle use, regardless of whether or not it is part of a general tax structure. By this criterion, the sales taxes paid on motor-vehicles, gasoline and motor-vehicle parts and services would count as user payments and go towards offsetting public expenditures related to motor-vehicle use. However, I feel that this criterion is too loose, because it does not allow that some taxes might more reasonably be viewed as required payments for government services other than those related to motor-vehicle use.

There is, however, some disagreement on this point. For example, Beshers (1994) asserts that the sales tax "certainly ought to be" counted (p. 10), although he does not develop his argument. Dougher (1995) argues that the sales tax actually is selective, because it is not applied to all sales, and that therefore, sales taxes on motor vehicles and fuels can be counted as user taxes. However, her argument may be challenged on four grounds (see also Morris and DeCicco, 1996). First, if the mere existence of exemptions disqualified a tax as "general", then there would be no general taxes at all. Personal income taxes do not tax all personal income, and corporate income taxes do not tax all corporate income, yet usually we conceive of these as general taxes. Second, in the retail trade sector in 1990, state and local sales tax receipts were 3.6% of sales (Bureau of the Census, 1991). Given that state and local sales tax *rates* averaged 5.9% in 1992 (Dougher, 1995), we may conclude that the bulk of transactions in the retail trade sector are in fact subject to the tax. Third, and perhaps most tellingly, government received far, far more from sales taxes than it did from any unarguably "selective" or "user" tax (Delucchi, 2005b). In fact, in 1991, government sales-tax receipts were 3 times greater than the receipts from the single largest user tax (the gasoline tax), and even larger than receipts of corporate income tax, which would few would call anything other than a general tax. Fourth, receipts from sales taxes on vehicles, fuels, and parts were only 11% of all sales-tax receipts (Delucchi, 2005b) – similar to the percent contribution of these items to the GNP. This suggests that motor vehicles and fuels are being subjected to a broad-based tax. Similar arguments may be mustered against counting general property taxes on motor vehicles (Delucchi, 2005b).

4.4.3. Tax expenditures (class C2)

If one counts as a motor-vehicle user payment the portion of a general motor-vehicle-related tax that, after being mixed in with general funds, ends up funding government MVIS, then one may want to take a broader look at general taxes paid on motor vehicles and fuels and ask whether they are contributing fairly towards *all* of the government goods and services that general taxes are supposed to fund. That is, it might be considered unfair to credit motor-vehicle users with general tax payments towards government MVIS if in general motor-vehicle users are paying less general tax than are consumers of other commodities.

If a particular commodity or activity is subject to general taxes, such as sales taxes, at less than the average rate for all commodities or activities, then the resultant reduction in tax revenues to the government (compared with what the government would get were the particular commodity or activity in question taxed at the average rate) is called a "tax expenditure" or "tax subsidy". It turns out that motor-vehicle users get considerable tax subsidies, mainly in the form of property taxes foregone on development displaced by public roadways (Delucchi, 2004). Should these tax subsidies count as negative user payments? I think it is reasonable to do the accounting either way – to count all of these tax subsidies, or to count none of them, as negative user payments. Hence, in the high-cost (low-payments case), I count tax expenditures (subsidies) against user payments, but in the low-cost (high-payments) case, I ignore them.

4.4.4. Government expenditures

Under WOC #3, we count any government expenditure related directly or indirectly to the use of motor vehicles. We begin by identifying every general government expenditure category that might have a component related to motor-vehicle or motor-fuel use:

- highway construction, maintenance, and administration;
- municipal and institutional offstreet parking;
- highway law enforcement and safety;
- other police protection;

- fire protection;
- courts;
- prison, probation, and parole;
- regulation and control of pollution;
- research and development of motor-vehicles and motor-fuels;
- other government-agency costs;
- military expenditures related to the use of Persian-Gulf oil;
- the Strategic Petroleum Reserve (SPR).

The estimation objective then is to estimate the public-sector costs that would be saved in each of the above expenditure categories in the long run if motor-vehicle use and the motor-vehicle infrastructure were eliminated. I will call this saved resource cost the "motor-vehicle-related" cost, or MVC. In most public-sector expenditure categories, MVC is estimated simply as the total annualized cost in the entire expenditure category, multiplied by the fraction of the total cost that would be saved were motor-vehicle use eliminated (call this fraction ΔACM). It is necessary to estimate ΔACM because, obviously, nobody keeps separate motor-vehicle accounts in the expenditure data for fire protection, police protection, and so on. The estimation of MVC, ΔACM, and other parameters is documented fully in Delucchi (2005a).

With reference to our classes of expenditures, WOC #3 comprises all classes of expenditures (A1, A2, and B).

4.5. WOC #4: "Marginal Changes"

In WOC #4, we define user payments and government expenditures related to MVIS to be the net additional (or "marginal") tax and fee payments to government and the net additional government expenditures that are generated by some additional (marginal) production and use of motor vehicles and fuels, relative to some base-case scenario. Underlying WOC #4 is the notion that marginal changes in public MVIS should be self-financing. Suppose, for example, that some policy or investment results in an increase in miles of roadway, vehicles, vehicle-miles of travel, fuel-use, highway-related services, and so on. We can in principle estimate the additional governmental expenditures for this additional MVIS. But we also can estimate (in principle) the net additional governmental tax and fee revenue that actually results from the macroeconomic changes engendered by the additional production and use of vehicles, fuels, roads, parts, services, and so on. We then might consider it fair if the net additional revenue to government – which is additional with respect to some counterfactual or baseline scenario and net of changes in tax revenue from all sectors – is approximately equal to the additional government expenditures on MVIS.

Elsewhere (Delucchi, 2005b) I offer further qualitative discussion of how one might estimate marginal tax revenues from motor-vehicle production and use, but do not actually develop or apply any formal macroeconomic models to quantify marginal changes in government revenues and expenditures related to motor-vehicle use. Consequently, this paper does not present any estimates of user payments and government expenditures under WOC #4.

5. Results of the analysis

5.1. Payments versus expenditures in the US in 2002

Our estimates of user tax and fee payments towards government-provided MVIS in the US are itemized in Table 1, and our estimates of government expenditures on MVIS are itemized in Table 2. Table 3 explains the ratings that signify the quality of the underlying analyses. Table 4 summarizes the results and compares the total estimated user payments to governments for MVIS with estimates of government expenditures on MVIS.

The itemized user payments are presented in two parts (Table 1A and B). Table 1A shows the amounts actually estimated under WOC #1, WOC #2, and WOC #3. These amounts are equal to an unweighted amount, shown in Table 1B, multiplied by weights that represent the fraction of the unweighted amount that is counted as a user payment (also shown in Table 1B). These weights are pertinent mainly to the treatment of selective and general taxes.

Table 3
Description of our ratings of the quality and complexity of our analysis

Quality of our analysis	Rating
Detailed and largely original analysis, with extensive calculations based mainly on primary data from the US. Census, FHWA, and other sources	A1
Detailed and original analysis based mainly on primary data, but less involved than level A1 analysis	A2
Straightforward analysis based partly or mainly on primary data, with few and relatively simple calculations. Less involved than A2 analysis	A3
Direct use of a few primary data, with no significant analysis, calculations, or adjustments. A simple citation of primary data	A4
Review and analysis of existing estimates of the whole cost or its major components. The difference between B work and A work is that A work is based mainly on primary data, whereas B work is more dependent on the secondary literature	B
Review of a few existing estimates, with little or no analysis. This is essentially a literature review	C
Estimate or simple, illustrative calculation based ultimately on supposition or judgment	D

Table 4
Summary of motor-vehicle-user payments for and government expenditures on MVIS, under three ways of counting, 2002

	WOC #1		WOC #2		WOC #3	
	Low	High	Low	High	Low	High
User payments for MVIS (10^9 \$)	127.0	306.0	167.9	344.3	175.6	328.5
Government expenditures on MVIS (10^9 \$)	172.5	351.4	191.7	372.1	216.5	433.6
Difference between expenditures and payments (10^9 \$)	45.5	45.4	23.9	27.8	40.9	105.1
Ratio of payments to expenditures	0.74	0.87	0.88	0.93	0.81	0.76
Additional fuel tax that makes payments equal expenditures (\$/gallon)	0.27	0.27	0.14	0.16	0.24	0.62

Sources: User payments from Table 1. Government expenditures from Table 2. Additional fuel tax is equal to difference between expenditures and payments divided by total motor-fuel taxed (gasoline + diesel fuel) in 2002 (www.fhwa.dot.gov/policy/ohpi/hss/index.htm).

Direct or specifically targeted payments, as estimated under WOC #1, account for the bulk of all potential motor-vehicle user payments (Tables 1A and 4). Payments under WOC #3 are about \$20 (high-case) to \$50 (low-cost case) higher than under WOC #1, and payments under WOC #2 are about \$40 billion higher than under WOC #1. (Recall that "low cost" here means a low difference between expenditures and payments, and hence incorporates the numerically low expenditures estimate and the numerically high payments estimates, where the two are independent.) Most of the payments counted under WOC #3 and WOC #2 but not WOC #1 are for collection expenses, traffic and parking fines, parking fees, and (in the case of WOC #3) tax expenditures (Table 1A). Note that unweighted general tax payments are large (section C1 of Table 1B), but that the weights, which represent the portion that we count under WOC #3, are quite small, so that weighted general tax payments end up being small (section C1 of Table 1A). However, since we show the unweighted estimates, readers may apply their own weights and come up with their own accounting.

Similarly, the bulk of all potential government motor-vehicle-related expenditures are direct expenditures for highways as estimated by FHWA (Tables 2 and 4). Other direct expenditures, counted under WOC #2 but not WOC #1 (mainly the cost of public off-street parking), amount to only about \$20 billion (Table 2). However, under WOC #3 of counting we also estimate significant "indirect" government expenditures for police and fire protection, the judicial and prison system, environmental regulation, and military expenditures related to the use of Persian-Gulf oil by motor vehicles (Table 2). All told, the indirect expenditures counted under WOC #3 but not under WOC #1 are about \$40–100 billion in 2002, or 25–30% of the FHWA-based WOC #1 total. As a result, which "indirect" items are included on the expenditure side of the ledger can have a significant impact on the comparison of user payments with government expenditures.

Under the broadest way of counting, WOC #3, payments by motor-vehicle users are about 80% of government expenditures on MVIS in 2002 (Table 4). Under WOC #2 (all direct payments and expenditures), payments are about 90% of expenditures. The shortfall of payments corresponds to about 15 to 60 cents per gallon of motor fuel taxed in 2002 (Table 4).

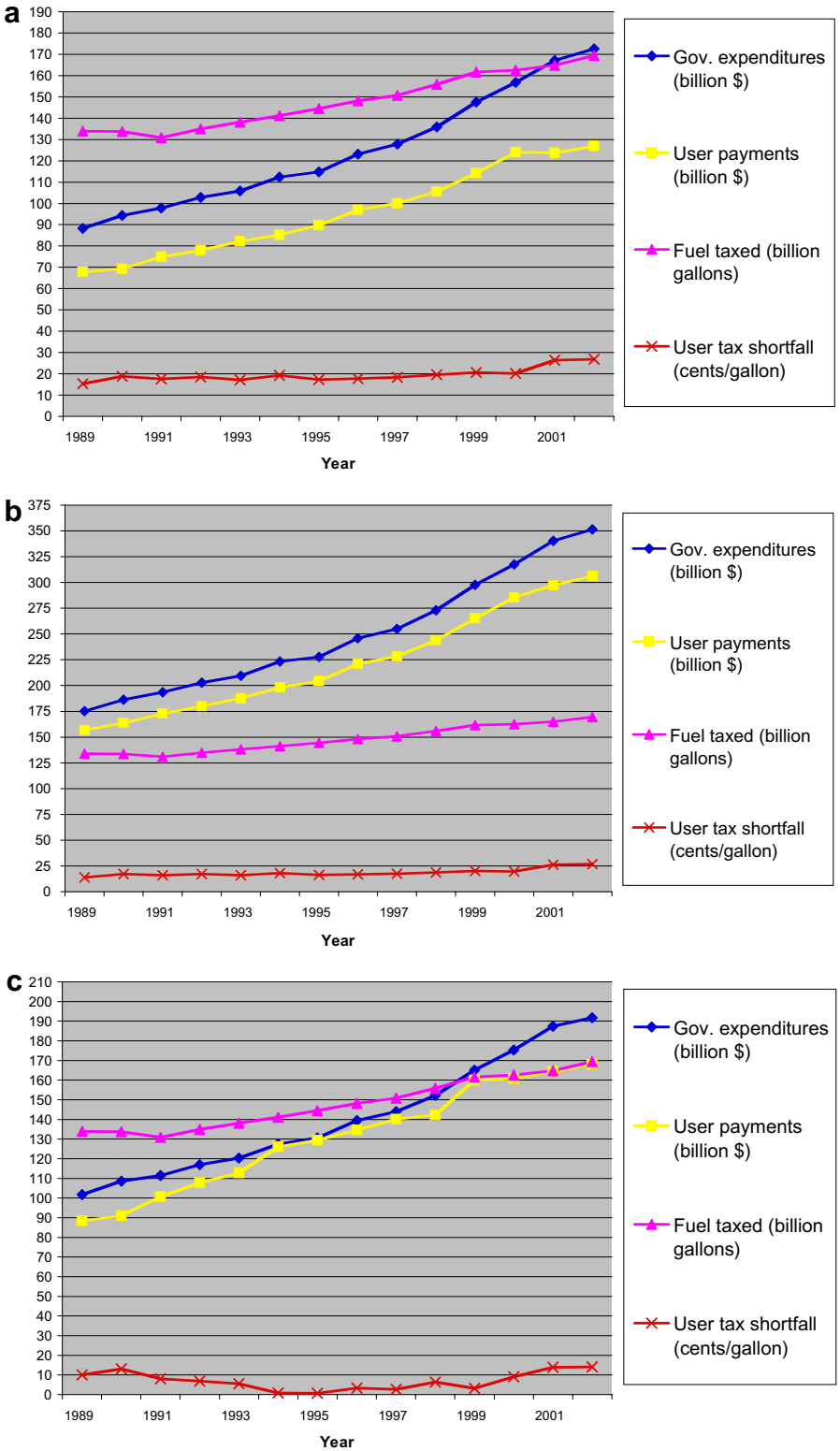

Fig. 1. User payments and government expenditures, 1989–2002: (a) WOC #1, low-cost case; (b) WOC #1, high-cost case; (c) WOC #2, low-cost case; (d) WOC #2, high-cost case; (e) WOC #3, low-cost case; (f) WOC #3, high-cost case.

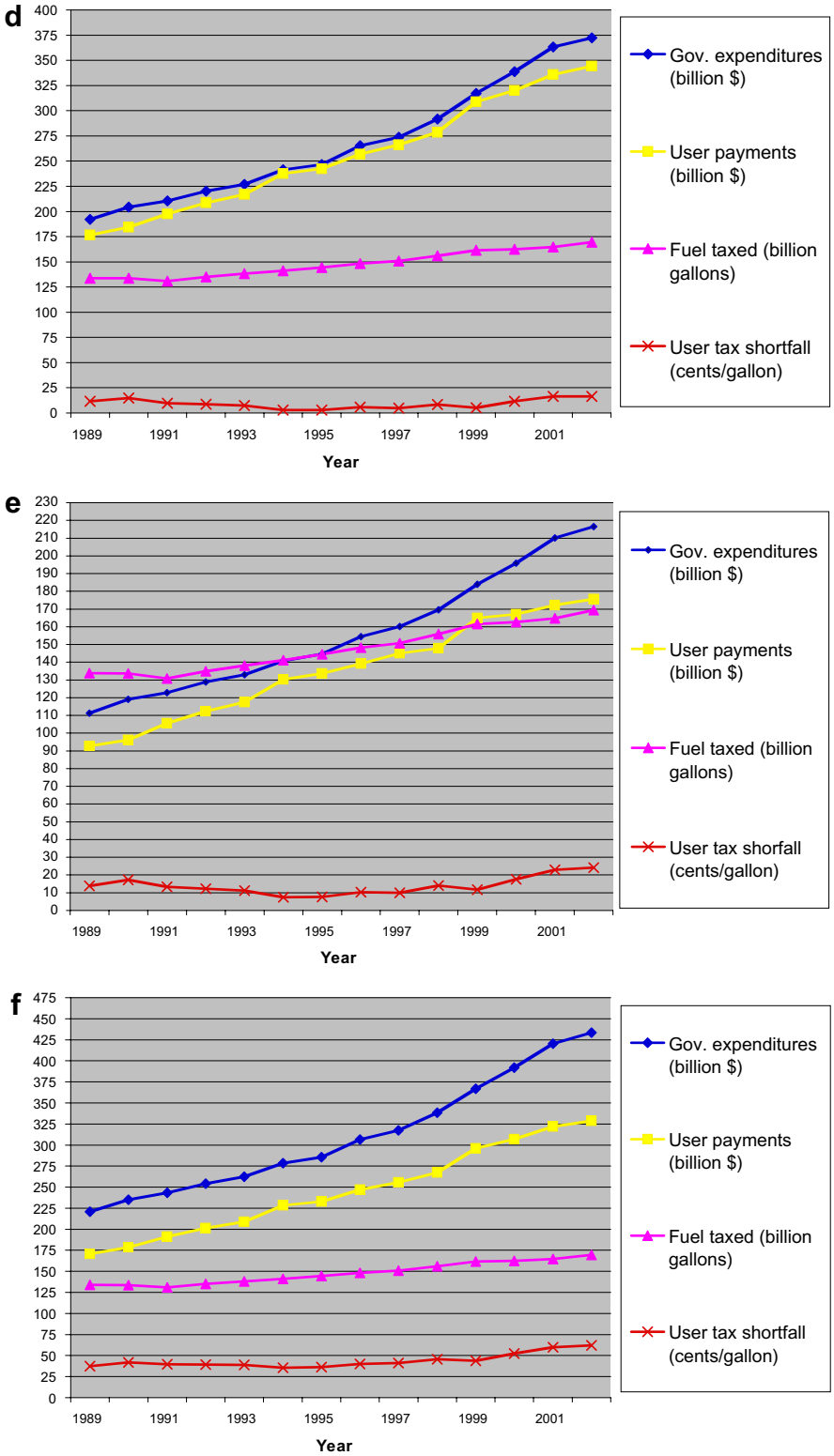

Fig. 1 (*continued*)

5.2. Payments versus expenditures in the US, 1989–2002

Fig. 1 shows low and high user payments and government expenditures and the cents-per-gallon user-payment shortfall for WOC #1, WOC #2, and WOC #3 in the US from 1989 to 2002. As expected, payments and expenditures rise continuously over the period, but at slightly different rates at different times. These differences, combined with the pattern of fuel consumption over time (also shown in Fig. 1), result in the cents-per-gallon user-payment shortfall – equal to the difference between expenditures and payments divided by the amount of gallons of all motor fuel taxed – being constant or slightly declining through the mid-to-late 1990s, then rising through 2002. If the rate of increase in the cents-per-gallon payment shortfall in the post-data period (2003 to present) has been the same as the rate at the end of the data period (about 1998–2002), then the cents-per-gallon user payment shortfall today probably is between 30 and 70 cents per gallon, if one takes the broadest way of counting (WOC #3), but only about 20 cents per gallon if one counts only direct payments and expenditures (WOC #2).

5.3. Summary of results

Recalling, once more, that a comparison of payments with government expenditures is not directly relevant to an economic analysis of efficient pricing or investment, but does matter in discussions of equity and government budget-balancing, I offer the following summary observations. First, current user payments probably are on the order of 80–90% of the associated government expenditures on MVIS. The low end of this range is similar to that estimated by Morris and DeCicco (1997) and FHWA et al. (1997). Second, as suggested by extrapolating Fig. 1 to the present, the fuel tax would have to be increased by about 20–70 cents per gallon to make up the present shortfall between motor-vehicle-user payments and motor-vehicle-related government expenditures.[11] Third, the most important and uncertain components on the "payment" side of the ledger are general taxes, which we have argued should not be counted under any circumstances. The most important and uncertain components on the expenditure side are what we have called indirect expenditures, which we *do* count in WOC #3. Indeed, the bulk of the difference between the cents per gallon shortfall under WOC #2 versus the shortfall under WOC #3 is due to the inclusion of indirect expenditures in WOC #3 but not in WOC #2. Hence, in our accounting, the answer to the question "Do motor-vehicle users in the US pay their way?" depends in large part on whether such things as judicial-system costs and military expenditures related to motor-vehicle use are counted as government expenditures for MVIS.

6. Conclusion

Our analysis indicates that in the US, current (ca. 2005) tax and fee payments to the government by motor-vehicle users may fall short of present government expenditures related to motor-vehicle use by approximately 20–70 cents per gallon of all motor fuel. (By contrast, as summarized in Section 1.3.2, in Europe user payments easily exceed government expenditures (Link, 2005)). As we have emphasized above, while this significant shortfall certainly is pertinent to discussions of the equity of transportation financing, and even to concerns about balancing the budget of the government highway enterprise, it is not necessarily the amount of motor-fuel-tax increase that would ensure the most efficient provision and use of government motor-vehicle-related infrastructure and services. Nevertheless, a 20–70 cent per gallon shortfall is large, especially compared with current state and federal fuel taxes in the US (averaging about 38 cents per gallon total federal + state in 2003 [www.fhwa.dot.gov/policy/ohim/hs03/htm/mf121t.htm]). If the upper end of this

[11] Any increase in the price of motor fuel will reduce the quantity of fuel demanded and therefore reduce the total volume of motor fuel subject to the tax (Transportation Research Board, 2005). To account for this loss of tax revenue due to the higher price, the motor-fuel tax increase would have to be greater than that calculated without consideration of this demand-dampening effect. If the effective price elasticity of demand for motor fuel (the percentage change in demand for fuel per 1% change in the price of fuel) is relatively large (in absolute value), and if the initial cents-per-gallon tax shortfall (before consideration of the demand-dampening effect) is a relatively large fraction of the starting fuel price, then the additional tax required to offset the loss of revenue due the dampening of demand will be large relative to the initial cents-per-gallon user-tax-payment shortfall.

20–70 cent-per-gallon range were added to the price of motor fuel, it likely would have a noticeable effect on fuel consumption and motor-vehicle use. (Moreover, as noted above, an initial increase in the motor-fuel tax likely would reduce the quantity of motor-fuel demanded and thereby necessitate a further tax increase to compensate for the reduced volume of fuel subject to the tax.) Furthermore, our estimate here is only of the difference between user tax and fee payments to government and actual government monetary outlays for motor-vehicle infrastructure and services; it does *not* include the cents-per-gallon-value of any non-monetary environmental or oil-use externalities such as global warming or the macroeconomic costs of oil disruptions. Incorporation of these and other external costs could *further* raise the price of fuel by on the order of a $1 per gallon of motor fuel (Parry and Small, 2005; Delucchi, 2000; Delucchi, 1997). We may conclude, then, that motor-vehicle users in the US – unlike users in most European countries – do not "pay their way".

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