NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP Report 416

Alternative Approaches to the Taxation of Heavy Vehicles

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This report contains recommendations that are applicable to federal and state governments for evaluating alternatives to the taxation of heavy vehicles. An evaluation procedure and general assessments and recommendations on future activities are presented. The report provides guidance and resource material for use by federal and state agencies. The results will be of interest to those who deal with the identification of revenue sources for highway purposes and to the motor carrier industry. The research report is supplemented by an *Applications Manual*, available on the Internet.

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Report 416

Alternative Approaches to the Taxation of Heavy Vehicles

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

Note: The Transportation Research Board, the National Research Council, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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NOTICE

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The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation Officials, or the Federal Highway Administration, U.S. Department of Transportation.

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FOREWORD

By Staff
Transportation Research Board

This report contains recommendations that are applicable to federal and state governments for evaluating alternatives to the taxation of heavy vehicles. An evaluation procedure and general assessments and recommendations on future activities are presented. The report provides guidance and resource material for use by federal and state agencies. The results will be of interest to those who deal with the identification of revenue sources for highway purposes and to the motor carrier industry. The research report is supplemented by an *Applications Manual*, available on the Internet (see below).

Motor-carrier user fees, typically applied as fuel taxes and registration charges, are an important component of surface transportation financing. Heavy vehicles used by motor carriers have characteristics that differ substantially from automobiles and other light vehicles. While their numbers on the highways are far fewer than light vehicles, heavy vehicles play an important role in determining the costs of constructing and maintaining durable, safe highways. Economic factors influencing motor-carrier operations also differ substantially from those affecting usage of lighter vehicles. For these reasons, appropriate alternatives to the motor-fuel tax for heavy vehicles may be very different from those considered best for other segments of the highway user market.

In a previous NCHRP study, documented in *NCHRP Report 377*, "Alternatives to Motor Fuel Taxes for Financing Surface Transportation Improvements," a flexible and comprehensive method was developed for identifying and evaluating alternatives to the motor-vehicle fuel tax. Although some of the alternatives evaluated in that research were applicable to motor-carrier taxation, many of the issues surrounding heavy vehicles needed further amplification.

Under NCHRP Project 20-24(7)A, "Alternative Approaches to the Taxation of Heavy Vehicles," Cambridge Systematics, Inc., with Sydec, Inc. and R. D. Mingo and Associates, developed a procedure for evaluating taxation systems for heavy vehicles and used the procedure to compare alternatives to the traditional motor-carrier taxation systems used by states to finance surface transportation system improvements. The results of this research will provide guidance and resource material to federal and state agencies for evaluating proposed schemes nationally and locally. To further the implementation of the research results, the agencies produced an *Applications Manual*, which is available on the Internet through the NCHRP World Wide Web site <www2.nas.edu/trbcrp> under the project write-up for NCHRP Project 20-24(7)A.

Readers should direct their initial attention to the "Summary," which has been identified with shaded page edges. The full research report follows for those interested in the details of the research effort and all of the findings.

CONTENTS

AUTHOR ACKNOWLEDGMENTS

The research effort reported herein was performed under NCHRP Project 20–24(7)A by Cambridge Systematics, Inc., with Sydec, Inc., and R.D. Mingo and Associates as subcontractors and Dr. Porter Wheeler as a consultant.

Dr. Herbert Weinblatt of Cambridge Systematics, Inc., (CS) managed the project and was the principal author of Chapters 1, 4, 6, 7, and 8. Dr. Joseph Stowers of Sydec, Inc., served as co-principal investigator and was the principal author of Chapter 2 and major contributor to Chapters 4 through 8. Dr. Porter Wheeler was the principal author of Chapter 3, and Roemer Alfelor of CS was a major contributor to that chapter. Roger Mingo of R.D. Mingo and Associates was a major contributor to Chapters 6 and 7, and William Hyman of CS was the principal author of Chapter 5.

Other contributors to this project included Ted Tilles of CS (a major contributor to Chapter 4); Holly Wolff (Chapter 2); Patrick Balducci of CS (Chapter 5); and Eric Martinusen of R.D. Mingo and Associates (Chapter 2 and 3). The research also benefited from several insightful comments by the NCHRP Project Panel and by the NCHRP Senior Program Officer, Crawford F. Jencks.

ALTERNATIVE APPROACHES TO THE TAXATION OF HEAVY VEHICLES

SUMMARY

The objectives of this project were to develop procedures for evaluating taxation systems for heavy vehicles and to use the procedures to compare alternatives to the traditional motor-carrier taxation systems used by the states to finance surface transportation system improvements. These alternatives require evaluation within a range of possible future scenarios for such matters as intramodal and intermodal competitiveness, energy policy and fuel use, and air quality regulations. The study focused on the specific characteristics of heavy commercial vehicles as they influence the relative merits of alternative financing mechanisms.

The project team reviewed existing state highway tax systems and analyzed how these systems affect heavy vehicles. A survey was conducted of state agencies responsible for administering these taxes, and previous studies of the equity of state and federal systems were reviewed. An analysis was conducted of the ways in which taxes paid per mile vary with registered weight, private versus for-hire operation, interstate versus intrastate operation, and other vehicle characteristics. An analysis was also performed of the effects that variations in tax systems in different states have on the competitiveness of carriers based in these states.

The heavy vehicle tax systems in ten foreign countries were reviewed to identify taxes and administrative procedures that might be of interest in this country. Also, a review was conducted of technologies that have potential for decreasing administrative and compliance costs or reducing evasion of heavy vehicle taxes.

Finally, six criteria were developed for evaluating heavy vehicle tax systems, and these criteria were used to produce qualitative evaluations of four generic tax systems. An *Applications Manual*, presenting quantitative procedures for applying these criteria to actual tax systems, has been prepared as a separate document, which is available on the NCHRP World Wide Web site at http://www2.nas.edu/trbcrp under the NCHRP Project 20–24(7)A write-up.

HEAVY VEHICLE TAXATION SYSTEMS

Comparison of States' Tax Structures

Table 1 presents a state-by-state comparison of the relative importance of most sources of state revenue collected in 1994 from trucks (excluding pickups and vans).

TABLE 1 Proportions of state truck user revenues from each tax category (1994)

State	First Structure Taxes				Second Structure Taxes	Third Structure Taxes				
			Ad Valorem Taxes							
	Registration, Weight Fees & Related[1]	Drivers' Licenses & Related[2]	Title Fees[3]	Vehicle Property Taxes[4]	Gasoline, Diesel, & Special Fuels[5]	Weight-Distance & Mileage Taxes	Tolls[6]	Gross Receipts Taxes[7]	Fines, Penalties, & Misc.Fees[8]	Total
Alabama	19.3%	0.3%	s	p	73.9%	0.0%	0.0%	0.0%	6.5%	100%
Alaska	37.7%	6.3%	0.0%	p	31.3%	0.0%	20.4%	0.0%	4.2%	100%
Arizona	11.4%	0.2%	s	p	46.3%	33.7%	0.0%	0.0%	8.4%	100%
Arkansas	21.9%	0.5%	s	p	73.7%	0.0%	0.0%	0.0%	3.9%	100%
California	36.2%	0.5%	s	20.3%	37.9%	0.0%	1.9%	1.6%	1.5%	100%
Colorado	30.0%	0.4%	s	p	65.8%	0.0%	0.0%	0.0%	3.8%	100%
Connecticut	28.1%	1.8%	s	p	54.6%	0.0%	0.0%	0.0%	15.4%	100%
Delaware	15.2%	0.6%	10.8%	0.0%	36.0%	0.0%	33.2%	0.0%	4.3%	100%
District of Columbia	22.5%	2.5%	1.9%	0.0%	55.8%	0.0%	0.0%	0.0%	17.2%	100%
Florida	15.9%	0.6%	s	0.0%	60.5%	0.0%	9.9%	0.0%	13.0%	100%
Georgia	35.0%	0.9%	s	p	59.5%	0.0%	2.2%	0.0%	2.5%	100%
Hawaii	60.7%	1.6%	s	0.0%	36.3%	0.0%	0.0%	0.0%	1.4%	100%
Idaho	11.0%	0.1%	s	0.0%	53.9%	29.3%	0.0%	0.0%	5.6%	100%
Illinois	35.1%	0.1%	s	0.0%	48.3%	0.0%	10.7%	0.1%	5.8%	100%
Indiana	32.0%	0.1%	s	p	61.2%	0.0%	4.4%	0.0%	2.3%	100%
Iowa	33.7%	0.2%	s	0.0%	63.7%	0.0%	0.0%	0.0%	2.5%	100%
Kansas	32.7%	0.5%	s	p	52.3%	0.0%	7.8%	0.0%	6.7%	100%
Kentucky	7.3%	1.6%	16.4%	p	35.3%	26.6%	1.0%	0.0%	11.8%	100%
Louisiana	14.6%	0.2%	s	0.0%	71.4%	0.0%	4.5%	2.1%	7.2%	100%
Maine	29.0%	0.9%	s	p	47.9%	0.0%	12.3%	0.0%	9.8%	100%
Maryland	15.4%	0.2%	14.7%	0.0%	56.8%	0.0%	10.5%	0.0%	2.5%	100%
Massachusetts	26.0%	1.1%	s	p	52.2%	0.0%	12.6%	0.0%	8.0%	100%
Michigan	38.1%	0.5%	s	0.0%	55.3%	0.0%	1.2%	0.0%	4.9%	100%
Minnesota	27.4%	1.1%	s	0.0%	62.6%	0.0%	0.0%	0.0%	8.9%	100%
Mississippi	21.0%	1.0%	s	p	66.7%	0.0%	0.0%	0.0%	11.2%	100%
Missouri	38.0%	0.5%	s	p	54.3%	0.0%	0.0%	0.0%	7.1%	100%
Montana	6.4%	0.6%	0.0%	p	56.0%	0.0%	0.0%	0.0%	37.0%	100%
Nebraska	20.9%	0.1%	s	p	76.1%	0.0%	0.0%	0.0%	2.9%	100%
Nevada	33.5%	0.2%	s	p	58.8%	0.0%	0.0%	0.0%	7.5%	100%
New Hampshire	18.3%	1.2%	0.0%	0.0%	36.6%	0.0%	14.4%	0.0%	29.4%	100%
New Jersey	17.5%	1.3%	s	0.0%	30.9%	0.0%	28.2%	0.0%	22.1%	100%

Also shown at the bottom of the table are national averages for these revenues and national averages for revenues from these sources collected from all highway users. Excluded from this table are revenues from general sales taxes and general property taxes applied to vehicles and fuel. On a national basis, revenue from the excluded sources represents about 25 percent of all revenue from highway users.

In all states except three (Alaska, Hawaii and Oregon), per-gallon fuel taxes are the largest source of revenue from trucks. Nationally, fuel taxes account for 53.0 percent of the Table 1 revenue from trucks (and 52.0 percent of the revenue from all vehicles). However, for individual states, this share ranges from 7.5 percent in Oregon to 76.1 percent in North Carolina.

The second most important revenue source is registration fees. Nationally, these fees account for 23.5 percent of the Table 1 revenue from trucks (and 17.7 percent of the revenue from all vehicles), with the percentage of truck revenue for individual states ranging from 5.5 percent in New Mexico to 60.7 percent in Hawaii. Fines and miscellaneous fees, tolls, weight-distance taxes, vehicle property taxes, and title fees account for substantially smaller percentages of national revenue from trucks (between 2.8 percent and 6.6 percent), but each of these sources is relatively important in a few states.

TABLE 1 *(continued)*

State	First Structure Taxes				Second Structure Taxes	Third Structure Taxes				
			Ad Valorem Taxes							
	Registration, Weight Fees & Related[1]	Drivers' Licenses & Related[2]	Title Fees[3]	Vehicle Property Taxes[4]	Gasoline, Diesel, & Special Fuels[5]	Weight-Distance & Mileage Taxes	Tolls[6]	Gross Receipts Taxes[7]	Fines, Penalties, & Misc.Fees[8]	Total
New Mexico	5.5%	0.2%	7.7%	0.0%	40.0%	39.8%	0.0%	0.0%	6.7%	100%
New York	10.5%	0.8%	s	0.0%	35.8%	28.1%	18.9%	0.0%	5.9%	100%
North Carolina	19.6%	0.2%	s	p	76.1%	0.0%	0.1%	0.0%	4.0%	100%
North Dakota	27.5%	0.4%	s	p	61.9%	0.0%	0.0%	0.0%	10.3%	100%
Ohio	29.6%	0.5%	s	0.0%	56.7%	0.0%	3.9%	0.0%	9.4%	100%
Oklahoma	18.5%	0.6%	s	p	56.3%	0.0%	16.4%	0.0%	8.2%	100%
Oregon	10.6%	0.2%	0.0%	0.0%	7.5%	72.2%	0.0%	0.0%	9.5%	100%
Pennsylvania	18.6%	0.2%	s	0.0%	61.7%	0.0%	13.0%	0.0%	6.5%	100%
Rhode Island	10.7%	0.9%	s	p	40.9%	0.0%	2.8%	6.1%	38.6%	100%
South Carolina	27.9%	0.5%	s	p	64.2%	0.0%	0.0%	0.0%	7.4%	100%
South Dakota	35.5%	0.6%	s	0.0%	61.9%	0.0%	0.0%	0.0%	2.0%	100%
Tennessee	31.1%	0.4%	s	p	62.9%	0.0%	0.0%	0.0%	5.6%	100%
Texas	17.2%	0.8%	19.5%	p	58.9%	0.0%	1.4%	0.0%	2.2%	100%
Utah	19.3%	0.4%	s	p	70.7%	0.0%	0.1%	0.0%	9.6%	100%
Vermont	23.0%	0.2%	14.4%	0.0%	59.2%	0.0%	0.0%	0.0%	3.2%	100%
Virginia	14.5%	0.2%	8.2%	p	59.2%	0.0%	5.8%	0.0%	12.1%	100%
Washington	19.7%	0.2%	s	18.1%	49.9%	0.0%	5.5%	0.0%	6.6%	100%
West Virginia	19.6%	0.3%	10.8%	p	57.2%	0.0%	8.2%	0.7%	3.2%	100%
Wisconsin	37.0%	0.2%	s	0.0%	59.4%	0.0%	0.0%	0.0%	3.4%	100%
Wyoming	21.1%	0.5%	s	p	64.8%	0.0%	0.0%	0.0%	13.5%	100%
Average - Trucks	23.5%	0.5%	2.8%	2.9%	53.0%	5.0%	5.4%	0.3%	6.6%	100%
Average - All Users	17.7%	1.6%	5.3%	7.2%	52.0%	1.3%	7.2%	0.1%	7.6%	100%

Notes: [1] May include some ad valorem-based registration fees and miscellaneous fees related to registration.

[2] Includes commercial drivers' licenses.

[3] Includes some taxes that are collected on the same basis as general sales taxes, but which are identified as vehicle title fees. States with an 's' in this column levy a general sales tax which is applicable to motor vehicles but not considered to be a highway user tax. See Table 9 for general sales taxes applicable to motor vehicle sales.

[4] States with a 'p' in this column have a personal property tax that applies to motor vehicles in addition to other types of personal property. This tax is not considered to be a highway user tax.

[5] Includes gross receipts after refunds, distributor and dealer licenses, etc., and regional surcharges. See Table 9 for sales taxes applicable to fuel sales.

Survey of the States

A survey of all state agencies responsible for heavy vehicle taxation was conducted with the assistance of the American Association of State Highway and Transportation Officials (AASHTO). Some of the findings of this survey are as follows:

- Twenty-one of 36 responding states have conducted recent studies of one or more heavy vehicle taxation issues. Fifteen of these states have evaluated evasion, the most frequently addressed issue.
- There is general agreement that the International Registration Plan (IRP) and the International Fuel Tax Agreement (IFTA) reduce carrier compliance costs; contribute to the equity, economic efficiency, and stability of revenue; and have positive economic impacts. Most respondents also believe that these agreements have reduced both administrative costs and the potential for tax evasion; however, several respondents thought the agreements had negative impacts in these areas. Several suggestions were made for expanding the agreements, improving their

administration, or modifying provisions that adversely affect revenue collected by some states.

- Thirty-two of the 36 respondents identified one or more measures that their states have taken to reduce evasion. Fifteen states have improved their auditing procedures or reporting requirements, 11 mentioned involvement in the Federal/State Motor Fuel Tax Compliance Project, and ten states changed the point of collection for fuel taxes.

Equity of Heavy Vehicle Tax Systems

The equity of highway tax systems usually is evaluated by comparing the extent to which different vehicle classes pay user charges that are proportional to the class' estimated responsibility for public agency costs. For this purpose, equity ratios are obtained for each class by dividing user charges paid by the class by the estimated cost responsibility of the class. For each class, the equity ratio then is the revenue received from that class divided by the cost responsibility of the class. Equity ratios are less than one for classes that underpay their cost responsibility and greater than one for classes that overpay.

Table 2 shows the equity ratios developed in the *1997 Federal Highway Cost Allocation Study*. Separate sets of ratios are shown for Federal costs and user charges, costs and user charges for all states (as a group), costs and user charges for all local governments, and costs and user charges for all three levels of government combined. The table indicates that revenue received from all trucks as a class approximately equals their responsibility for all state-level costs but falls short of their responsibility for Federal and local costs. When distinctions are made by registered weight, the table indicates that vehicles with low registered weights generally overpay while vehicles with high registered weights generally underpay. The low equity ratios shown for local governments indicate that highway users pay only about one-tenth of local governments' expenditures on streets and roads. Considering all levels of government, highway users

TABLE 2 Ratios of revenues to allocated costs by vehicle class for all levels of government

Vehicle Class/Registered Weight	Federal	State	Local	All Levels
Autos	0.9	1.0	0.1	0.7
Pickups/Vans	1.2	1.2	0.1	0.9
Buses	0.1	0.8	0.0	0.4
All Passenger Vehicles	1.0	1.0	0.1	0.8
Single-Unit Trucks				
≤ 25,000 lb	1.4	2.2	0.1	1.5
25,001 - 50,000 lb	0.6	1.0	0.0	0.6
> 50,000 lb	0.5	0.5	0.0	0.4
Total Single Unit	0.8	1.2	0.1	0.8
Combination Trucks				
≤50,000 lb	1.4	1.7	0.1	1.3
50,001 - 70,000 lb	1.0	1.3	0.1	0.9
70,001 - 75,000 lb	0.9	1.1	0.1	0.8
75,001 - 80,000 lb	0.9	0.9	0.1	0.8
>80,000 lb	0.6	1.0	0.0	0.7
All Combinations	0.9	1.0	0.1	0.8
All Trucks	0.9	1.0	0.1	0.8
All Vehicles	0.9	1.0	0.1	0.8

Source: FHWA, *1997 Federal Highway Cost Allocation Study,* August 1997, Table ES-5.

underpay their cost responsibility by about 20 percent, primarily because of their low payments to local governments.

Table 3 summarizes the results of the most recent highway cost allocation studies known to have been conducted since 1982. The table shows which states have had (unadjusted) heavy vehicle equity ratios in ranges of less than 0.60, between 0.60 and 0.80, between 0.80 and 1.00, and more than 1.00. The definitions of "heavy vehicles" and the methods used vary significantly among the studies; however, most of the studies used methods that are similar to the Federal studies.

Table 3 shows that 16 state studies have found that heavy vehicles are underpaying and seven have found that they are overpaying. The reasons for the differences in the results are often complex and sometimes cannot be adequately derived from the available reports. Several of the states with low equity ratios are states which have low overall tax rates for heavy vehicles. Of the seven states where heavy vehicles were overpaying, four have weight-distance taxes (Arizona, Kentucky, Idaho, and Oregon).

TAX BURDEN AND EFFECTS ON COMPETITIVENESS

Table 4 shows estimates of total annual and per-mile state taxes paid by four prototypical vehicles operating in each state. The four vehicles are registered at gross vehicle weights (GVWs) of 30,000, 50,000, 60,000 and 80,000 lb, and they are assumed to have annual mileages that are typical for vehicles registered at these weights. The taxes included in the table are registration fees, fuel taxes, weight-distance taxes, property taxes, and sales taxes, but they exclude tolls and several minor taxes.

Cost responsibility per mile rises with GVW, and so it would be desirable for taxes per mile also to rise with GVW. Table 4 indicates that annual taxes paid do rise with GVW; however, annual mileage also rises with vehicle-miles traveled (VMT). Hence in most states, taxes paid per mile fall with GVW for GVWs above 50,000 lb; and there are only three states (Arizona, Idaho and Oregon) in which taxes per mile are higher for 80,000-lb vehicles than for 60,000-lb vehicles.

Registered GVW is only one of the variables affecting tax burden and equity. Vehicles registered at a given weight generally have higher annual mileages (1) if they are operated by a for-hire carrier than if they are operated by a private carrier and (2) if they operate in several states than if they operate entirely (or almost entirely) in a single state. Hence, taxes paid per mile generally are higher for private carriers than for for-hire carriers, and they generally are higher for intrastate carriers than for interstate carriers.

TABLE 3 Summary of results of recent state highway cost allocation studies regarding equity of tax structure for heavy vehicles

Revenue-to-Cost-Responsibility Ratio	State and Year of Study
<0.60	Maryland (1982), Colorado (1988), Georgia (1991), Texas (1995)
0.60 - 0.80	Connecticut (1982), Missouri (1984), Indiana (1988), Minnesota (1990), Nevada (1994)
0.80 - 1.00	Wisconsin (1982), North Carolina (1983), Kansas (1985), California (1987), Pennsylvania (1990), Vermont (1990), Virginia (1992)
>1.00	Maine (1989), Delaware (1992), Arizona (1992), Kentucky (1992), Montana (1992), Idaho (1994), Oregon (1995)

TABLE 4 State taxes paid by four prototypical vehicles

	Registered GVW							
	30,000 lb		50,000 lb		60,000 lb		80,000 lb	
	Annual	Per-Mile	Annual	Per-Mile	Annual	Per-Mile	Annual	Per-Mile
Alabama	$988	7.4¢	$1629	9.0¢	$2226		$3902	5.5¢
Alaska	356	2.7	519	2.9	797	2.8	1500	2.1
Arizona	1533	11.5	2457	13.5	3821	13.6	9751	13.8
Arkansas	843	6.3	1459	8.0	2203	7.9	4229	6.0
California	1595	12.0	2514	13.8	2909	10.4	5588	7.9
Colorado	2409	18.1	3149	17.3	3794	13.5	5727	8.1
Connecticut	937	7.0	1757	9.7	2427	8.7	4352	6.2
Delaware	1081	8.1	1754	9.7	2451	8.7	4549	6.5
District of Columbia	914	6.9	1374	7.6	1837	6.5	3832	5.4
Florida	901	6.8	1603	8.8	2293	8.2	4459	6.3
Georgia	431	3.2	758	4.2	1125	4.0	2175	3.1
Hawaii	1219	9.2	1872	10.3	2398	8.5	4179	5.9
Idaho	782	5.9	1239	6.8	1902	6.8	6367	9.0
Illinois	1312	9.9	2221	12.2	3110	11.1	5468	7.8
Indiana	1336	10.0	2165	11.9	3039	10.8	5747	8.2
Iowa	1071	8.0	1935	10.6	2703	9.6	4955	7.0
Kansas	1233	9.3	1965	10.8	3245	11.6	5839	8.3
Kentucky	1537	11.5	2441	13.4	4296	15.3	7368	10.5
Louisiana	748	5.6	1164	6.4	1895	6.8	3638	5.2
Maine	1211	9.1	1878	10.3	2601	9.3	4488	6.4
Maryland	840	6.3	1705	9.4	2429	8.7	4784	6.8
Massachusetts	1250	9.4	1958	10.8	2718	9.7	4732	6.7
Michigan	982	7.4	1615	8.9	2144	7.6	3659	5.2
Minnesota	952	7.1	1634	9.0	2430	8.7	4786	6.8
Mississippi	1019	7.7	1738	9.6	2428	8.7	4712	6.7
Missouri	781	5.9	1257	6.9	2393	8.5	4532	6.4
Montana	1259	9.5	2030	11.2	2915	10.4	5516	7.8
Nebraska	1317	9.9	2081	11.4	2918	10.4	5012	7.1
Nevada	1448	10.9	2279	12.5	3185	11.4	5716	8.1
New Hampshire	812	6.1	1285	7.1	1834	6.5	3935	5.6
New Jersey	830	6.2	1321	7.3	1882	6.7	3166	4.5
New Mexico	534	4.0	987	5.4	1651	5.9	4697	6.7
New York	1101	8.3	1844	10.1	3070	10.9	7412	10.5
North Carolina	1038	7.8	1644	9.0	2317	8.3	4309	6.1
North Dakota	702	5.3	1256	6.9	1858	6.6	3569	5.1
Ohio	966	7.3	1616	8.9	2342	8.3	4594	6.5
Oklahoma	654	4.9	1060	5.8	1621	5.8	2936	4.2
Oregon	777	5.8	1464	8.1	2597	9.3	10566	15.0
Pennsylvania	1044	7.8	1705	9.4	2502	8.9	5234	7.4
Rhode Island	1434	10.8	2301	12.7	3271	11.7	5730	8.1
South Carolina	840	6.3	1304	7.2	1845	6.6	3488	5.0
South Dakota	936	7.0	1613	8.9	2240	8.0	4084	5.8
Tennessee	1264	9.5	1931	10.6	2611	9.3	4526	6.4
Texas	1316	9.9	2056	11.3	2737	9.8	4637	6.6
Utah	951	7.1	1504	8.3	2069	7.4	3525	5.0
Vermont	1135	8.5	1966	10.8	2827	10.1	5234	7.4
Virginia	1212	9.1	1930	10.6	2821	10.1	5052	7.2
Washington	1314	9.9	2100	11.6	3083	11.0	5797	8.2
West Virginia	1069	8.0	1692	9.3	2688	9.6	4684	6.7
Wisconsin	1056	7.9	1737	9.6	2536	9.0	5265	7.5
Wyoming	626	4.7	1026	5.6	1414	5.0	2254	3.2
Average	1057	7.9	1715	9.4	2479	8.8	4828	6.9

Sources: Table 25 and American Trucking Associations, *Motor Carrier Advisory Service,* Volume III, State Service, Updated to February 1996.

Similarly, for vehicles registered at a given weight, taxes paid per mile generally are higher for single-unit trucks than for combinations.

For operators of vehicles that compete with each other, differences in taxes paid and in the costs of complying with related administrative requirements have some effect on the ability of operators of these vehicles to compete with each other. In particular

- To the extent that taxes imposed on different vehicles are not proportional to their cost responsibility, operators of the undertaxed vehicles enjoy a competitive advantage; and
- Operators of vehicles based in states that have an ad valorem tax on the sale of vehicles or a property tax that is applied only to vehicles based in the state are at a competitive disadvantage relative to operators of vehicles based in other states.

Several other less significant competitive effects are discussed in the report, though most or all of these effects apply only to small numbers of carriers or vehicles or produce cost differences that are no more than a small fraction of 1 cent per vehicle-mile.

INTERNATIONAL EXPERIENCE

To identify new or different ideas relating to heavy vehicle taxation, a review was conducted of tax systems in seven European countries (the United Kingdom, France, Germany, Sweden, Norway, Switzerland, and Austria), and in Japan, Australia, and New Zealand. A more limited review was conducted of the systems in several other European countries. Some of the findings of this review are as follows:

- The harmonization effort undertaken by the European Union (EU) is having a major effect on the heavy vehicle taxes used by the member states. The EU has set conditions under which several taxes can be imposed, including minimum and maximum rates.
- A recent EU proposal would require that motorway permit fees vary with road-damage class and emissions class. Three road-damage classes would be distinguished, based on axle configuration, GVW, and whether or not the vehicle has an air suspension. Motorway permit fees and tolls would not be allowed to exceed the cost of related infrastructure development, but additional surcharges could be imposed for use of congested or environmentally sensitive routes.
- EU states apparently do not have any tax regulations, such as apportionment or fuel tax reporting, that require information about distance traveled by jurisdiction. Sweden and Denmark have discontinued their weight-distance taxes because, as the only taxes that required odometer readings at border crossings, these taxes put their carriers at a competitive disadvantage with carriers from other states.
- New Zealand continues to use an axle-configuration weight-distance tax. Also, several countries in Eastern Europe apply weight-distance taxes to foreign vehicles, and the EU is considering such taxes for possible future implementation.
- Germany is exploring the use of electronic equipment for administering distance-based permit fees for the use of motorways. Such distance-based fees would replace the time-based motorway permit fees now used by several EU states.
- The United Kingdom has a relatively sophisticated system of registration fees that varies with axle configuration as well as with GVW.
- Motorways in France are built primarily by public/private partnerships and paid for by tolls. Tolls are set to discourage motorway use by private automobiles and to encourage use by heavy trucks.

- Western European countries generally collect substantially more revenue from highway users than is needed to build and maintain their road systems.

TECHNOLOGY

A review was conducted of various technologies that have been implemented or may be implemented in the future for improving the administration of heavy vehicle taxes. These technologies include fuel dyeing, automatic vehicle identification (AVI), automatic vehicle location (AVL) systems such as global positioning systems (GPS), vision technology, electronic data interchange (EDI), electronic funds transfer (EFT), and electronic toll collection. Several systems incorporating these technologies have been tested or are being developed, including the recent Automated Mileage and Stateline Crossing Operational Test (AMASCOT), the Commercial Vehicle Information Systems and Networks (CVISN), and the Commercial Vehicle Operations (CVO) component of the Intelligent Transportation System (ITS). This review leads to several rather limited conclusions:

- Experience over the last ten years demonstrates that quick breakthroughs in the application of new technologies and systems cannot be expected to occur very often.
- There is some possibility that electronic systems can be implemented for collecting and transmitting the mileage-by-jurisdiction data required for registration-fee apportionment and fuel-use reporting. Such systems have potential for reducing both evasion and public-sector administrative costs. However, they are likely to be financially attractive only to truck operators that already use GPS. Also, carriers may be reluctant to use these systems for tax-reporting purposes because of concerns about proprietary information and personal privacy (particularly as to whether carriers would be required to allow state auditors to access their computerized information systems) and concerns that implementation of these systems might lead to increased use of weight-distance taxes.
- National leadership is becoming increasingly important to give direction to research, development, testing, and demonstration programs. This leadership will probably be best achieved through cooperative efforts of several organizations including the Transportation Research Board, U.S. DOT, ITS America, and others. One short-term objective requiring national leadership is reaching agreement on ITS standards that will provide for efficient use of competing manufacturers' products for AVI and related communications systems.
- National and state R&D programs should encourage competition among all interested parties in the development of new technologies and improved tax systems, as a consensus develops on future directions. One of the difficult challenges at the national level is to institute a process that will lead to the adoption of national standards at the appropriate time during the development of new technologies in a manner that will achieve a proper balance between two somewhat conflicting objectives: (a) achieving compatibility of systems, such as cited above regarding transponders and related systems and (b) facilitating an open marketplace for multiple suppliers and improved technologies through competitive R&D efforts by adopting standards that do not stifle competition by favoring one or more suppliers over other potential suppliers.
- Research is needed on the development of a national base state system that would integrate all major heavy vehicle taxation systems, including registration, fuel, weight-distance and other types of taxes. Such a system should use avail-

able technology and computer systems to create simplified, common reporting systems, while preserving the prerogatives of the states to establish tax structures and rates.

- Economists are in agreement that marginal cost pricing offers the greatest benefits to the economy of all forms of the highway user tax structure. Much of this benefit would be realized in freight transportation in the form of congestion relief and more efficient heavy vehicle use. Because of this, more emphasis should be placed on research, development, and demonstrations in this area.

EVALUATION OF HEAVY VEHICLE TAXATION SYSTEMS

Procedures for evaluating heavy vehicle taxation systems were developed and are described in a separate *Applications Manual* that is available on the NCHRP World Wide Web at http://www2.nas.edu/trbcrp under the NCHRP Project 20–24(7)A write-up. Those procedures use six criteria for evaluating the systems. These criteria are listed in Table 5 and described briefly below.

Adequacy

The most important tax issue to transportation administrators is whether the tax system will yield enough revenue to cover expenses. For existing taxes, forecasts of yield

TABLE 5 Criteria for evaluating heavy vehicle tax systems

Adequacy	
	Yield
	Stability and certainty
	Responsiveness to changes in needs
	Responsiveness to inflation
	Potential for increases when needed
Administrative Efficiency	
	Administrative costs
	Enforcement costs
	Compliance costs
	Implementation issues
Equity	
	Allocation of public agency costs
	Among motor vehicles of the same class (horizontal equity)
	Among classes of motor vehicles (vertical equity)
	Relative to competing modes
Economic Efficiency	
	Charging based on full marginal costs
	Public agency costs and other external costs
	Spatial and temporal variation
Evasion and Avoidance	
	Illegal evasion
	Legal avoidance
Feasibility	
	Availability of necessary data and technology
	Political acceptability/opposition
	Constitutional prohibitions

are developed by obtaining data on the current or recent yield of these taxes and determining what changes can be expected in the future. If no changes in the tax system are planned, reasonable forecasts can be obtained by extrapolating past trends observed over one or more business cycles. Forecasts of the net yield of proposed new taxes require information on the proposed tax rate and on the revenue base (VMT, vehicles, sales, etc.), estimates of likely evasion and avoidance and of any other significant effects that the tax is likely to have on the revenue base, and estimates of administrative and enforcement costs.

Other issues relating to the adequacy of a tax system are stability and certainty, responsiveness to changes in needs, responsiveness to inflation, and potential for increases when needed. Highway taxes that are responsive to inflation are those that are indexed to an inflation indicator (preferably a general index, such as the Consumer Price Index) and ad valorem taxes on property or sales. Because fuel prices do not always rise with general inflation, sales taxes on fuel and taxes that are indexed to the price of fuel provide less inflation protection than other ad valorem taxes and taxes that are indexed to a more general measure of inflation.

Administrative Efficiency

From a narrow public-sector perspective, administrative efficiency is measured by comparing public-sector administrative costs and enforcement costs with total revenue collected. From a broader perspective, administrative efficiency can be measured by including the costs incurred by the private sector in complying with the administrative requirements of a tax. All three types of administrative cost should be measured as incremental costs resulting from any tax or set of taxes that is being evaluated in the context of all existing taxes and related programs that are assumed to continue in effect.

For existing taxes to be administered using existing procedures, administrative and enforcement costs can usually be estimated by analyzing agency budgets (though these costs are unlikely to appear as separate line items). However, estimation of private-sector compliance costs will require a more detailed analysis of the procedures used by various categories of taxpayers. In the case of new or proposed taxes, the estimation of all three types of costs requires specifying the procedures and technology to be used for administering the taxes and estimating the implementation and annual costs of the proposed system.

Equity

The equity criterion is usually interpreted as measuring the allocation of public agency costs among user groups (particularly vehicle classes) in proportion to their estimated responsibility for these costs. The other external costs of highway use have traditionally been excluded from consideration when evaluating equity, and this report adheres to this somewhat arbitrary convention.

The most common way of evaluating the equity of a highway tax system is by comparing *equity ratios* estimated for each of several vehicle classes. For each class, the equity ratio is obtained by dividing user revenues paid by the vehicle class by the estimated cost responsibility of that class. The ratios indicate which vehicle classes overpay their cost responsibility, which underpay, and the extent of the over- or underpayment.

Economic Efficiency

The goal of economic efficiency implies that vehicles should be charged a fee equal to their marginal cost responsibility both for public agency costs and for other external

costs of vehicle use. If one motor vehicle pays less than its full social cost responsibility while another vehicle or competing mode does not have such a subsidy, the highway system will be overused by the underpaying vehicle, resulting in both an increase in real resource costs and in the implicit public subsidy of the first motor vehicle.

The economic efficiency goal differs from the most generally accepted version of the equity goal in four ways:

- In addition to public agency costs, the efficiency goal includes the other external costs of vehicle use.
- It is based on marginal costs rather than average costs.
- These costs are compared with the sum of *all* user charges (Federal, state, and local) rather than with charges imposed by a single level of government.
- The marginal fee paid for vehicle use should, to the extent practical, match the marginal social costs attributable to that use.

Currently, there is much uncertainty about the level of external costs and no effective means of charging for these costs. Hence, the usefulness of formal analyses of the economic efficiency of alternative systems of highway taxes is limited. Accordingly, evaluations of economic efficiency usually involve only informal analyses of the extent to which alternative tax systems attempt to charge for external costs and of the resulting costs and benefits.

Evasion and Avoidance

Most major heavy vehicle taxes provide vehicle operators with some opportunity for underpaying their tax liabilities. Some of these taxes also provide operators with opportunities for legally avoiding the taxes. Also, some taxes, notably fuel taxes, provide third parties (not motor carriers) with substantial opportunities to profit from tax evasion.

Examples of potential evasion include use of untaxed fuel, registration of vehicles at declared maximum GVWs that are lower than the actual maximum GVWs, underreporting of mileage subject to weight-distance taxes, and misallocation of mileage operated among states so as to reduce total tax liabilities. This last type of evasion has the effect of increasing tax payments to "low tax" states while decreasing payments to "high tax" states by a greater amount. Examples of legal avoidance include purchasing fuel in states that do not impose sales taxes on fuel, registering trailers in states that charge a low, one-time fee, and declaring vehicles to be based in states where they are not subject to property taxes or vehicle sales taxes or where the effect of these taxes is small.

Both illegal evasion and legal avoidance have important implications for tax adequacy and for equity. Evasion and avoidance reduce tax yields and, if the reduction is appreciable, they may result in a need to increase tax rates. Perhaps more important, evasion and avoidance reduce tax equity by interfering with governmental attempts to tax carriers on the basis of their estimated cost responsibility.

Trade-offs also exist between evasion and administrative efficiency. Evasion can be partially controlled with improved auditing and reporting procedures (e.g., through combined auditing of registration-fee apportionment and fuel-use reporting). On the other hand, increases in tax rates to achieve adequate revenue result in increased incentives for evasion, which, if not accompanied by increased enforcement, will increase evasion.

There are two basic approaches to estimating the overall evasion rate for highway taxes: (1) inferring an overall evasion rate from evasion data obtained in the audit and enforcement process and (2) comparing actual tax collections to independent estimates of the amount that should be collected that are derived from data on highway usage. The

first approach usually produces substantial underestimates of overall evasion and, because of upward biases in currently used procedures for estimating truck VMT, the second approach usually produces substantial overestimates of evasion by heavy vehicles.

Feasibility

Feasibility is primarily a concern in the evaluation of new taxes but may also be a concern in the evaluation of increases in the rates at which existing taxes are imposed, particularly if the proposed increases are large. Feasibility addresses the following:

- Constitutionality of a tax that is new or significantly altered;
- Existence of the necessary technology and the availability of the necessary data to administer the tax; and
- Political acceptability of a new tax, of an increase in existing taxes, or of any new technology proposed for administering a new or existing tax.

Evaluations of the feasibility of potential changes to a tax system are significantly influenced by the time available to legislate and implement the changes. When this time period is short, the number of feasible options is small. As the time period lengthens, the number of feasible options grows. Thus the feasibility criterion is applied differently when addressing an urgent need for increasing revenue than when performing a more in-depth study of potential improvements to the tax system.

In any study of the potential changes to a system of taxes, the feasibility criterion plays a useful role in narrowing the options to be considered. Options that are completely infeasible (e.g., because of constitutional restrictions or the unavailability of needed data) should not be studied. However, for in-depth studies, some care should be used to make sure that this criterion is not applied rashly. Options that present feasibility challenges that are not absolute (e.g., implementation problems or political opposition) are not worth studying if they have no attractive features; however, they may be worth at least some consideration if they do have potential advantages. For these options, the feasibility evaluation consists of identifying the effort that would be required to overcome the feasibility obstacles, and the broader evaluation consists of determining whether or not this effort appears to be worthwhile.

QUALITATIVE EVALUATIONS OF GENERIC TAXATION SYSTEMS

Table 6 presents a simplified summary of qualitative evaluations of three generic heavy vehicle taxation systems. The "basic system" consists of a per-gallon fuel tax, an annual registration fee (and possibly some other annual fees), and monthly or quarterly fees for regular overweight operation. The other two systems are obtained by adding to the basic system either a flat-rate or graduated fuel tax surcharge or a weight-distance or axle-configuration weight-distance tax. (An axle-configuration weight-distance tax is a tax on mileage that is imposed at a rate determined by a vehicle's axle configuration and its declared maximum GVW.)

Table 6 shows a rating of each system's *potential* for satisfying each of the six evaluation criteria. The ratings are on a scale of one (poor) to five (excellent). It should be emphasized that the ratings reflect evaluations of the *potential* for each of the prototypical systems to satisfy the various criteria; they do not measure how well actual tax systems meet these criteria.

Table 6 indicates that the ratings differ slightly for the two principal variants of the fuel tax surcharge system and also for the two principal variants of the weight-distance tax system. Each of the five tax system variants does relatively well under some criteria

TABLE 6 Evaluation summary
Scale of 1 to 5 (poor to excellent)

Tax System	Adequacy	Administrative Efficiency	Equity	Economic Efficiency	Evasion and Avoidance	Feasibility
1. Basic System	4 to 5	4	2	1.5	3	5
2. Fuel-Tax Surcharge System						
Flat rate	5	4	3	2	2.5	4
Graduated	5	3	4	2.5	2	1
3. Weight-Distance Tax System						
Weight-distance tax	5	3.5	4	2.5	3	3
Axle-configuration weight-distance tax	5	3	4.5	3	2.5	2.5

and less well under others. However, the advantages of the graduated fuel tax surcharge system do not appear to balance its very low feasibility rating. With this one exception, each of the principal system variants shown in the table appears to have something to offer. The choice rests primarily on the relative importance placed on the various criteria.

A taxation system that combines the basic system with revenue from tolls was also evaluated, though the results of this evaluation do not readily fit the format of Table 6. A system that includes tolls has unique capabilities for reflecting the significant spatial and temporal variations in the full social costs of highway use. As such, it does far better than any of the other systems in meeting the economic efficiency criterion, at least when electronic toll collection is used. Furthermore, if tolls are set to reflect the difference between cost responsibility for use of toll facilities and the fuel taxes and other user charges paid as a result of that use, toll systems can also meet the equity criterion quite well. However, the potential for toll avoidance makes it very difficult to design toll systems that achieve their economic efficiency objective in an administratively efficient manner. Also, there is substantial popular opposition to introducing tolls on facilities that currently are toll-free and to charging motorists for the external costs of emissions, as well as more moderate opposition to charging for the external costs of a user's impact on congestion.

CONCLUSIONS AND SUGGESTED RESEARCH

The procedures presented in the *Applications Manual* for evaluating heavy vehicle tax systems should be helpful in assessing the strengths and weaknesses of various systems of taxes and tax administration. Unfortunately, the better systems all have some weaknesses. Choosing among these systems involves making trade-offs among the criteria that affect both the choice of taxes and the systems used for administering them.

One of the most important trade-offs is between administrative efficiency and evasion. Effective enforcement efforts can reduce tax evasion, but they generally increase costs for both public-sector administration and private-sector compliance. Political pressures to reduce administrative costs usually result in enforcement efforts that fall well short of optimal. In most if not all states, net tax revenue (after subtracting administrative costs) can be increased by increasing enforcement expenditures. Improved enforcement also would contribute to increasing equity, because there are substantial differences in evasion rates among carriers.

A more complex set of trade-offs relates to the equity criterion and the extent to which various classes of carriers pay their fair share of the public agency costs of highways. Although there are several factors that affect the cost responsibility of an individual heavy vehicle, the most significant that are usually addressed by equity analyses are annual miles of travel and weight.

In most states, the most important heavy vehicle tax is the fuel tax. Revenue from this tax tends to be proportional to miles traveled, but it increases more slowly than vehicle weight and much more slowly than weight-related cost responsibility.

Annual fees, such as registration fees, that may increase sharply with weight can be used to obtain additional revenue from heavy vehicles. However, reliance on these fees results in overtaxing vehicles with low annual miles or undertaxing those with high annual miles. High annual fees and variations in annual miles among vehicle and carrier types result in taxes per mile for vehicles of a given weight being higher, on average, for private carriers than for for-hire carriers, higher for intrastate carriers than for interstate carriers, and higher for heavy single-unit trucks than for combinations. Also, the increase in annual fees with declared weight generally is not as sharp as the increase in average annual miles. For this reason, there are only three states in which the average of total taxes per mile is not lower for 80,000-lb vehicles than for 60,000-lb vehicles.

Weight-distance taxes are capable of being matched to the weight and mileage-related components of cost responsibility. However, relative to fuel taxes, weight-distance taxes entail somewhat higher compliance costs (particularly for intrastate carriers) and they may be somewhat more expensive to administer. More important, because weight-distance taxes make it practical to increase taxes paid by high-mileage heavy trucks, these taxes are strongly opposed by most operators of for-hire interstate trucks.

Varying highway taxes by area of operation is a related and difficult issue that arises when considering the economic efficiency criterion. This issue probably should also be considered when considering the equity criterion, because area of operation has significant effects on public agency costs for expanding capacity and acquiring right of way. Of the charging mechanisms considered in this study, tolls in general and electronic toll-collection (ETC) systems in particular, have the greatest potential for reflecting locational factors. ETC systems can also be used to vary toll charges by time of day and by selected vehicle registration information, such as maximum declared weight. However, toll systems appear to be an imperfect mechanism for varying highway charges by area of operation, because limiting tolls in any area to a small set of roads makes avoidance relatively easy, while extending tolls to a larger set of roads increases administrative costs.

There is some possibility that, in the next several years, electronic systems can be implemented for collecting and transmitting the mileage-by-jurisdiction data required for registration-fee apportionment and fuel-use reporting. Such systems have potential for reducing evasion and reducing public-sector administrative costs. However, they are likely to be financially attractive only to truck operators that already use GPS. Also, carriers may be reluctant to use these systems for tax-reporting purposes because of concerns about proprietary information and personal privacy (particularly as to whether carriers would be required to allow state auditors to access their computerized information systems) and concerns that implementation of these systems might lead to increased use of weight-distance taxes.

Arguments are sometimes made against charging user fees to cover full cost responsibility for heavier trucks because of the negative effects this may have on competition within the for-hire motor carrier industry. However, the analysis of state tax structures conducted in this study shows that most of the effects on competitiveness apply only to relatively small numbers of carriers or vehicles and produce cost differences that are no more than a small fraction of 1 cent per vehicle-mile. Current tax structures have relatively little effect on competition among carriers in the large majority of the for-hire market. The effects on competition are generally minor and are limited to several relatively small segments of the motor-carrier market and to a few states.

The previous discussion presumes that each of the six criteria is readily applied to any heavy vehicle taxation system. However, a lack of available information affects the application of some of the criteria.

The most significant limitations affect the economic efficiency criterion, which requires that highway users be charged for the full marginal social costs of their use. Difficulties in developing tax systems that address this criterion are political (significant opposition by highway users to paying for the external costs of their use), analytic (plausible high and low estimates of marginal external costs differ by an order of magnitude or more), and practical (most proposed externality charges present administrative or evasion/avoidance problems, and the charges do not always vary with responsibility for external costs in an appropriate manner). However, it is worth observing that all taxes that relate to vehicle usage (fuel taxes, mileage taxes and tolls) tend to contribute to economic efficiency while annual fees do not. Furthermore, if political opposition can be overcome, current understanding of external costs is sufficient to justify the introduction of emissions and congestion charges at modest levels.

Good estimates of evasion are also difficult to obtain. These difficulties are partly due to the relatively limited understanding of many administrators of the methods and extent of evasion. Though in-depth studies of the extent of evasion are relatively expensive to perform, the information they produce can be useful in improving enforcement procedures and in reducing evasion.

A more readily surmounted limitation affects the equity criterion. This criterion presumes the availability of information on the responsibility of various vehicle classes for state highway costs. However, relatively few states have performed recent cost-responsibility studies that can be used as the basis for such an evaluation of equity.

Finally, there is a limitation that affects the estimation of private-sector compliance costs, a component of administrative costs. The primary source of information on these costs is the private firms that incur these costs; but cost estimates provided by many of these firms may be intentionally exaggerated.

Suggested Research

There are a number of issues relating to the taxation of heavy vehicles that require additional research:

- A study should be conducted of the effectiveness of base-state auditing in uncovering evasion of fees and taxes owed other states. There is some possibility that base-state auditing procedures are not effective for uncovering misallocation of mileage among states.
- An evaluation should be conducted of the advantages and disadvantages of replacing the IRP and IFTA with a single base-state system for handling both registration-fee apportionment and fuel-use reporting, and perhaps for handling weight-distance taxes as well. The possibility of enhancing such a system to allow it to handle registration fees that vary with annual-mileage bracket might also be considered.
- Software and a users' manual should be developed to be used by the states for performing cost-allocation studies and for evaluating tax systems.
- A study should be conducted to determine the conditions under which closely spaced vehicles are misclassified as larger vehicles and to develop procedures for avoiding and correcting the resulting overcounts of large vehicles. The resulting improvements in VMT estimates of large vehicles will be useful in studies of tax evasion by heavy vehicles and in other analyses of heavy truck operations.

- Substantial additional research is required to produce improved estimates of the external costs of vehicle operation. Current high and low estimates of these costs differ by an order of magnitude or more.
- Research is required into the overall effects of marginal cost pricing on economic efficiency as well as the effects on different user classes, the benefits and costs to these classes, and options for mitigating adverse effects on low-income persons.
- ETC systems and other potential systems for charging for marginal costs on a localized basis require further evaluation and refinement.

Other Recommendations

Some additional recommendations are as follows:

- All states should perform in-depth reviews of their tax administration and enforcement programs to identify opportunities for reducing evasion and increasing net revenue. To the extent that such opportunities are identified, the results should be used to generate support for the funding needed to take advantage of these opportunities.
- Auditing carrier records relating to payment of both registration fees and fuel taxes should be performed jointly, even in states in which other functions related to the administration of the two programs are performed by separate offices. Joint auditing avoids duplication of effort and makes it easy to identify any inconsistencies in mileage reports filed for these fees and taxes.
- All states should perform cost responsibility studies periodically in order to produce better evaluations of the equity of their highway tax systems.
- All states should adopt improved procedures for estimating the VMT of heavy trucks and for counting six-tire trucks. The resulting improvements in VMT estimates will improve the quality of estimates of tax evasion by heavy vehicles as well as the quality of various other analyses of heavy truck operations.
- The EU's evolving heavy vehicle taxation system should continue to be monitored, particularly the effectiveness of existing and proposed fees relating to emissions classes and to congested and environmentally sensitive routes. Other aspects of this system that are of potential interest are discounts for air suspensions and Germany's exploration of ETC technology for implementing distance-based motorway permit fees.

CHAPTER 1

INTRODUCTION

The objectives of this project were to develop procedures for evaluating taxation systems for heavy vehicles and to use the procedures to compare alternatives to the traditional motor-carrier taxation systems used by the states to finance surface transportation system improvements. These alternatives require evaluation within a range of possible scenarios for such matters as intramodal and intermodal competitiveness, energy policy and fuel use, and air quality regulations. The study focused on the specific characteristics of heavy commercial vehicles as they influence the relative merits of alternative financing mechanisms.

This report presents the results of the heavy vehicle taxation systems study. The procedures that were developed for evaluating such systems are presented in the *Applications Manual*, which is available at the NCHRP World Wide Web site at http://www2.nas.edu/trbcrp under the NCHRP Project 20–24(7)A write-up.

The second chapter of the report contains a comparison of state heavy vehicle tax structures plus additional information about these tax systems obtained from a survey of tax administrators in all 50 states and from previously published studies. The third chapter presents the results of a review of the heavy vehicle tax systems used in other countries and includes detailed descriptions of the systems used in seven European countries and in three Pacific countries. Chapter 4 presents additional information about the composition of state tax structures and variations by state in the resulting tax burden on operators of different types of trucks.

The fifth chapter presents a review of new technologies that are capable of reducing the administration and compliance costs of existing and proposed heavy vehicle taxes and reducing evasion of these taxes. Chapter 6 presents a set of six criteria for evaluating heavy vehicle taxation systems. The final chapter applies these criteria qualitatively to four generic heavy vehicle taxation systems.

Appendix A contains a detailed tabulation of responses to the survey of state tax administrators, and Appendix B contains a copy of the survey form.

The *Applications Manual* presents quantitative procedures for applying the six evaluation criteria to heavy vehicle taxes and tax systems along with a sample application of these procedures to a typical state tax system.

CHAPTER 2

HEAVY VEHICLE TAXATION SYSTEMS

This chapter provides in-depth information on heavy vehicle taxation. It contains four major sections:

- A comparison of states' tax structures,
- Results of a survey of the states conducted for this study through AASHTO,
- A description of selected activities and study findings from several states, and
- A summary of the equity of heavy vehicle tax structures based on the findings of many highway cost allocation studies.

The comparison of states' tax structures shows the variations that exist in (a) the proportions of total highway user revenue that come from different types of taxes and fees and (b) the proportions of truck user revenues that come from different types of taxes and fees.

These comparisons provide factual data for use by the states and others performing tax studies. They are not intended to evaluate states' tax structures nor to rank the states by any of these measures. Clearly there are many reasons for significant variations in states' tax structures, including differences in the scope of highway and related programs; differences in environment, soil, terrain, and so forth; and differences in tax policy (e.g., varying emphasis on cost responsibility or decisions made to subsidize selected industries). These comparisons should be very useful to the states in evaluating tax options because these specific types of comparisons have not been made before and because states generally give substantial attention to the tax structures of other states in their tax studies.

The survey of the states provided information on various studies and activities of the states relating to heavy vehicle taxation; assessments of recent experiences with IRP, IFTA, and related programs; and input into the criteria and evaluation procedures used in the second phase of this project.

The purposes of the section describing selected activities and study findings from several states are (a) to facilitate sharing of information on study findings and new program initiatives among the states, (b) to improve understanding of emerging issues and policy concerns, and (c) to provide a better basis for the evaluation of tax alternatives in the final phase of the study. The section describes more than 20 activities, studies, and reports in nine states.

The summary of findings from the many highway cost allocation studies provides a preliminary assessment of the relative fairness of Federal and state heavy vehicle tax structures based on past studies and shows the variations that exist among the states and the variations over time at the Federal level.

COMPARISON OF STATES' TAX STRUCTURES

This section presents a comparison of state highway user revenues in terms of the proportions of total revenues that come from various highway user taxes and fees, for vehicles as a whole and from trucks.[1] These revenues include all revenues that are reported in *Highway Statistics: 1994,* Tables MF-1 and MV-2, including all taxes imposed exclusively on motor vehicles and their use. Revenues in these *Highway Statistics* tables do not include general sales taxes and general property taxes, although these are included as part of the analysis in this section and are included as part of the analysis of taxes paid by selected vehicles in Chapter 4 of this report. The tables presented here do include miscellaneous revenues such as tolls, fines, drivers' license fees, and oversize/overweight permit fees, which are not included in the selected vehicle analysis in Chapter 4.

Table 7 presents the proportion of each state's total highway user revenue that is derived from the various types of taxes. For all states as a whole, fuel taxes constitute 52 percent of all state highway user tax revenue, and registration fees are almost 18 percent of total revenues. The two major forms of ad valorem taxes, vehicle property taxes and title fees, combine to about 13 percent of all revenues. However, several states have property taxes and sales taxes that are not included in the *Highway Statistics* tables because the taxes are general taxes rather than taxes that are specifically applied to motor vehicles. In the states that do have title fees, title fee revenue ranges from 3.6 percent to 33.4 percent of total revenues, and property taxes are about 40 percent of

[1] "Highway user revenue" is defined in this report to include all taxes, fees, and tolls collected primarily or exclusively from the sale, ownership, or use of motor vehicles, regardless of how the revenues are used. The overwhelming majority of highway user revenue is earmarked for highway purposes, but in many states some portion of this revenue is used as general revenue or for specific purposes other than highways. However, in many states substantial amounts of revenue from non-user sources are used for highways. Analysis reported on page IV-2 of the *1997 Federal Highway Cost Allocation Study* (FHWA, August 1997) shows that, on balance, the total amount of highway user revenue collected by the states almost exactly equaled total expenditures for highway-related purposes by the states in 1994.

TABLE 7 Proportions of total state highway user revenues from each tax category (1994)

State	First Structure Taxes		Ad Valorem Taxes		Second Structure Taxes	Third Structure Taxes				
	Registration, Weight Fees & Related[1]	Drivers' Licenses & Related[2]	Title Fees[3]	Vehicle Property Taxes[4]	Gasoline, Diesel, & Special Fuels[5]	Weight-Distance & Mileage Taxes[6]	Tolls[7]	Gross Receipts Taxes[8]	Fines, Penalties, & Misc. Fees[9]	Total
Alabama	12.6%	2.2%	s	p	76.0%	0.0%	0.0%	0.0%	9.2%	100%
Alaska	35.4%	3.3%	0.0%	p	32.4%	0.0%	23.2%	0.0%	5.7%	100%
Arizona	11.2%	2.2%	s	p	62.8%	15.3%	0.0%	0.0%	8.4%	100%
Arkansas	13.3%	1.7%	s	p	75.4%	0.0%	0.0%	0.0%	9.6%	100%
California	17.8%	1.4%	s	42.0%	34.7%	0.0%	1.9%	0.3%	1.8%	100%
Colorado	16.7%	1.7%	s	p	73.6%	0.0%	0.0%	0.0%	8.0%	100%
Connecticut	20.2%	3.5%	s	p	63.8%	0.0%	0.0%	0.0%	12.5%	100%
Delaware	8.4%	0.7%	14.3%	0.0%	35.6%	0.0%	36.7%	0.0%	4.3%	100%
District of Columbia	18.4%	2.0%	3.6%	0.0%	39.0%	0.0%	0.0%	0.0%	37.0%	100%
Florida	14.5%	1.7%	s	0.0%	49.4%	0.0%	13.0%	0.0%	21.4%	100%
Georgia	26.9%	2.8%	s	p	61.0%	0.0%	2.4%	0.0%	6.9%	100%
Hawaii	49.6%	1.5%	s	0.0%	46.9%	0.0%	0.0%	0.0%	2.0%	100%
Idaho	14.5%	1.9%	s	0.0%	62.4%	12.3%	0.0%	0.0%	8.9%	100%
Illinois	26.5%	1.0%	s	0.0%	51.7%	0.0%	13.5%	0.0%	7.3%	100%
Indiana	21.4%	0.8%	s	p	67.5%	0.0%	7.2%	0.0%	3.1%	100%
Iowa	38.1%	1.1%	s	0.0%	55.5%	0.0%	0.0%	0.0%	5.3%	100%
Kansas	23.1%	0.9%	s	p	60.9%	0.0%	10.1%	0.0%	4.9%	100%
Kentucky	4.9%	1.1%	33.4%	p	43.7%	7.0%	1.3%	0.0%	8.7%	100%
Louisiana	9.5%	1.9%	s	0.0%	70.8%	0.0%	4.7%	0.8%	12.3%	100%
Maine	15.9%	2.9%	s	p	54.2%	0.0%	15.9%	0.0%	11.0%	100%
Maryland	9.7%	1.5%	30.3%	0.0%	43.3%	0.0%	8.8%	0.0%	6.4%	100%
Massachusetts	13.5%	4.2%	s	p	54.8%	0.0%	15.3%	0.0%	12.2%	100%
Michigan	35.1%	1.2%	s	0.0%	55.0%	0.0%	1.3%	0.0%	7.4%	100%
Minnesota	44.4%	1.7%	s	0.0%	49.0%	0.0%	0.0%	0.0%	4.9%	100%
Mississippi	13.7%	2.2%	s	p	74.2%	0.0%	0.0%	0.0%	9.9%	100%
Missouri	25.1%	1.6%	s	p	66.7%	0.0%	0.0%	0.0%	6.6%	100%
Montana	6.7%	1.6%	0.0%	p	75.6%	0.0%	0.0%	0.0%	16.0%	100%
Nebraska	14.7%	1.0%	s	p	78.5%	0.0%	0.0%	0.0%	5.8%	100%
Nevada	18.5%	2.4%	s	p	68.4%	0.0%	0.0%	0.0%	10.7%	100%

(*continued on next page*)

total revenue for the two states that have vehicle property taxes. Tolls and fines and miscellaneous revenues each constitute about 7.5 percent of total revenues. Drivers' license fees and weight-distance tax revenues are each around 1.5 percent of total revenues nationwide.

The composition of total revenues varies widely among the states. There is a great variance from state to state in terms of how much is collected in first structure, second structure, and third structure taxes. Registration fees are 4.2 percent of total revenues in the lowest state, Virginia, and almost 50 percent in the highest state, Hawaii. However, the great variation in the percentages that are registration fees tends to be counterbalanced by other first structure taxes, particularly title fees, which are often significant revenue sources in states with low registration fees. Fuel taxes are above 28 percent in all states and are almost 79 percent of total revenues in the highest state, Nebraska. Weight-distance taxes constitute 27 percent of all revenues in the highest state, Oregon. In Delaware and New Jersey, toll collections are more than 34 percent of total revenues, while in most states, toll collections are a small percentage of total revenue or do not exist at all. In no states are drivers' license revenues greater than 4.2 percent, and gross receipts taxes are not more than 1.3 percent of all revenues.

Table 8 presents a comparison of state revenues that are collected from trucks (i.e., all revenues from Table 7 less revenues from autos, pickups and vans, and buses).[2] Overall, the distribution of revenues from trucks is significantly different from the distribution for all vehicles. For all states as a whole, registration revenues constitute a somewhat greater proportion of total revenues from trucks (31.7 percent) than they do

[2] The division of revenues among vehicle classes was performed using distributions developed for the *Federal Highway Cost Allocation Study* (FHWA, August 1997).

TABLE 7 *(continued)*

State	First Structure Taxes				Second Structure Taxes	Third Structure Taxes				
			Ad Valorem Taxes							
	Registration, Weight Fees & Related[1]	Drivers' Licenses & Related[2]	Title Fees[3]	Vehicle Property Taxes[4]	Gasoline, Diesel, & Special Fuels[5]	Weight-Distance & Mileage Taxes[6]	Tolls[7]	Gross Receipts Taxes[8]	Fines, Penalties, & Misc. Fees[9]	Total
New Hampshire	16.8%	3.1%	0.0%	0.0%	46.1%	0.0%	20.2%	0.0%	13.9%	100%
New Jersey	15.3%	1.7%	s	0.0%	28.9%	0.0%	34.9%	0.0%	19.2%	100%
New Mexico	11.9%	0.8%	16.0%	0.0%	51.8%	13.4%	0.0%	0.0%	6.1%	100%
New York	11.5%	3.0%	s	0.0%	46.0%	5.0%	28.7%	0.0%	5.7%	100%
North Carolina	14.3%	1.3%	s	p	74.7%	0.0%	0.1%	0.0%	9.6%	100%
North Dakota	28.8%	1.1%	s	p	63.0%	0.1%	0.0%	0.0%	7.0%	100%
Ohio	19.9%	1.0%	s	0.0%	63.7%	3.1%	4.8%	0.0%	7.4%	100%
Oklahoma	32.2%	1.2%	s	p	44.2%	0.0%	12.3%	0.0%	10.1%	100%
Oregon	10.2%	1.5%	0.0%	0.0%	52.4%	27.0%	0.0%	0.0%	8.9%	100%
Pennsylvania	17.1%	2.0%	s	0.0%	58.0%	0.0%	16.3%	0.0%	6.6%	100%
Rhode Island	14.2%	2.8%	s	p	61.0%	0.0%	4.7%	1.3%	15.9%	100%
South Carolina	14.1%	1.4%	s	p	76.9%	0.2%	0.0%	0.0%	7.3%	100%
South Dakota	27.2%	1.2%	s	0.0%	68.1%	0.0%	0.0%	0.0%	3.4%	100%
Tennessee	17.4%	1.8%	s	p	77.1%	0.0%	0.0%	0.0%	3.8%	100%
Texas	16.2%	1.4%	31.4%	p	46.3%	0.0%	1.2%	0.0%	3.5%	100%
Utah	10.1%	2.0%	s	p	76.4%	0.0%	0.1%	0.0%	11.3%	100%
Vermont	16.6%	1.5%	29.1%	0.0%	45.5%	0.0%	0.0%	0.0%	7.3%	100%
Virginia	4.2%	0.9%	16.9%	p	52.8%	0.0%	5.9%	0.0%	19.4%	100%
Washington	13.3%	1.0%	s	37.9%	39.1%	0.0%	4.7%	0.1%	4.0%	100%
West Virginia	11.7%	0.8%	21.2%	p	53.9%	0.0%	8.4%	0.0%	4.1%	100%
Wisconsin	25.0%	2.1%	s	0.0%	68.0%	0.0%	0.0%	0.0%	4.8%	100%
Wyoming	13.3%	1.6%	s	p	55.5%	0.0%	0.0%	0.0%	29.6%	100%
Average	17.7%	1.6%	5.3%	7.2%	52.0%	1.3%	7.2%	0.1%	7.6%	100%

Notes: [1] May include some ad valorem-based registration fees and miscellaneous fees related to registration.

[2] Includes commercial drivers' licenses.

[3] Includes some taxes that are collected on the same basis as general sales taxes, but which are identified as vehicle title fees. States with an 's' in this column levy a general sales tax which is applicable to motor vehicles but not considered to be a highway user tax. See Table 9 for general sales tax rates applicable to motor vehicle sales.

[4] States with a 'p' in this column have a personal property tax that applies to motor vehicles in addition to other types of personal property. This tax is not considered to be a highway user tax.

[5] Includes gross receipts after refunds, distributor and dealer licenses, etc., and regional surcharges. See Table 9 for sales taxes applicable to fuel sales.

[6] Includes small amounts of passenger-mile taxes in a few states.

[7] Includes only tolls from state-administered facilities, and includes ferries.

[8] Includes only special taxes on motor carriers.

[9] Includes fines and penalties, registration service charges, permit (e.g., overweight) fees, miscellaneous receipts.

Source: FHWA, *Highway Statistics 1994, 1995, Tables MF-1, MV-2 and SDF.*

from all vehicles (23.5 percent). Ad valorem taxes (property taxes and title fees) combine to 5.7 percent of total truck revenues compared with 12.5 percent of revenue from all vehicles. Fuel taxes constitute almost the same percentage of total revenue from trucks as from all vehicles (53.0 percent vs. 52.0 percent). Weight-distance taxes constitute 5.0 percent of total revenues from trucks, but do not apply to other vehicles except for small amounts of passenger-mile taxes collected from commercial buses in a few states. Fines, penalties, and miscellaneous fees are 6.6 percent of total truck revenue, while they constitute 7.6 percent of total revenue from all vehicles.

Table 9 shows the general sales tax rates that apply to motor vehicle sales in 38 states and to fuel sales in nine states. The tax rates shown include the rates for local sales taxes at the rate applied in a major city in each state. The general sales taxes are not included in the other tables in this section because no data are available on the revenue raised by these taxes, nor are data available on the volume of sales to which these sales taxes are applied. However, the following three paragraphs show the approximate magnitude of revenues that are collected from these taxes in comparison with the other revenues shown in these tables.

TABLE 8 Proportions of state truck user revenues from each tax category (1994)

State	First Structure Taxes		Ad Valorem Taxes		Second Structure Taxes	Third Structure Taxes				
	Registration, Weight Fees & Related[1]	Drivers' Licenses & Related[2]	Title Fees[3]	Vehicle Property Taxes[4]	Gasoline, Diesel, & Special Fuels[5]	Weight-Distance & Mileage Taxes	Tolls[6]	Gross Receipts Taxes[7]	Fines, Penalties, & Misc. Fees[8]	Total
Alabama	19.3%	0.3%	s	p	73.9%	0.0%	0.0%	0.0%	6.5%	100%
Alaska	37.7%	6.3%	0.0%	p	31.3%	0.0%	20.4%	0.0%	4.2%	100%
Arizona	11.4%	0.2%	s	p	46.3%	33.7%	0.0%	0.0%	8.4%	100%
Arkansas	21.9%	0.5%	s	p	73.7%	0.0%	0.0%	0.0%	3.9%	100%
California	36.2%	0.5%	s	20.3%	37.9%	0.0%	1.9%	1.6%	1.5%	100%
Colorado	30.0%	0.4%	s	p	65.8%	0.0%	0.0%	0.0%	3.8%	100%
Connecticut	28.1%	1.8%	s	p	54.6%	0.0%	0.0%	0.0%	15.4%	100%
Delaware	15.2%	0.6%	10.8%	0.0%	36.0%	0.0%	33.2%	0.0%	4.3%	100%
District of Columbia	22.5%	2.5%	1.9%	0.0%	55.8%	0.0%	0.0%	0.0%	17.2%	100%
Florida	15.9%	0.6%	s	0.0%	60.5%	0.0%	9.9%	0.0%	13.0%	100%
Georgia	35.0%	0.9%	s	p	59.5%	0.0%	2.2%	0.0%	2.5%	100%
Hawaii	60.7%	1.6%	s	0.0%	36.3%	0.0%	0.0%	0.0%	1.4%	100%
Idaho	11.0%	0.1%	s	0.0%	53.9%	29.3%	0.0%	0.0%	5.6%	100%
Illinois	35.1%	0.1%	s	0.0%	48.3%	0.0%	10.7%	0.1%	5.8%	100%
Indiana	32.0%	0.1%	s	p	61.2%	0.0%	4.4%	0.0%	2.3%	100%
Iowa	33.7%	0.2%	s	0.0%	63.7%	0.0%	0.0%	0.0%	2.5%	100%
Kansas	32.7%	0.5%	s	p	52.3%	0.0%	7.8%	0.0%	6.7%	100%
Kentucky	7.3%	1.6%	16.4%	p	35.3%	26.6%	1.0%	0.0%	11.8%	100%
Louisiana	14.6%	0.2%	s	0.0%	71.4%	0.0%	4.5%	2.1%	7.2%	100%
Maine	29.0%	0.9%	s	p	47.9%	0.0%	12.3%	0.0%	9.8%	100%
Maryland	15.4%	0.2%	14.7%	0.0%	56.8%	0.0%	10.5%	0.0%	2.5%	100%
Massachusetts	26.0%	1.1%	s	p	52.2%	0.0%	12.6%	0.0%	8.0%	100%
Michigan	38.1%	0.5%	s	0.0%	55.3%	0.0%	1.2%	0.0%	4.9%	100%
Minnesota	27.4%	1.1%	s	0.0%	62.6%	0.0%	0.0%	0.0%	8.9%	100%
Mississippi	21.0%	1.0%	s	p	66.7%	0.0%	0.0%	0.0%	11.2%	100%
Missouri	38.0%	0.5%	s	p	54.3%	0.0%	0.0%	0.0%	7.1%	100%
Montana	6.4%	0.6%	0.0%	p	56.0%	0.0%	0.0%	0.0%	37.0%	100%
Nebraska	20.9%	0.1%	s	p	76.1%	0.0%	0.0%	0.0%	2.9%	100%
Nevada	33.5%	0.2%	s	p	58.8%	0.0%	0.0%	0.0%	7.5%	100%

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The unweighted average general sales tax rate in the 38 states that apply them to motor vehicles is 5.4 percent. The average unweighted motor vehicle title fee rate is 5.3 percent in the nine states (including Washington, DC) that apply them. Motor vehicle title fees (as shown in Table 7) account for between 15 and 30 percent of total revenues in most of the states that have them. Therefore, it is logical to expect that revenues from general sales taxes on motor vehicles would also constitute roughly 15 to 30 percent of total revenues in the states that apply them. Only four states (Alaska, Montana, New Hampshire, and Oregon) have neither sales taxes nor title fees for motor vehicles. No state has both types of taxes. Thus, 47 states have either sales taxes or title fees applying to motor vehicles. The total national revenue from sales taxes on motor vehicles is about 5.5 times as great as title fee receipts.[3]

In contrast, fuel sales tax revenues and tax rates are rather small compared with fuel gallonage taxes. Gallonage taxes are collected in all states, ranging from 7.5 to 31 cents per gallon; whereas, sales taxes on fuels are collected in only nine states. Using current state-specific fuel tax prices to convert percentages to cents per mile, fuel sales taxes range from about 2.2 cents per gallon to 8.8 cents per gallon, with the weighted average being 5.9 cents per gallon in the states that apply sales tax to fuel. The weighted average gallonage tax rate is about 18.5 cents, or 3.1 times the average sales tax rate. Gallonage taxes constitute 52 percent of total highway user revenues for all states; whereas, fuel sales taxes constitute an average of about 17 percent of total highway user revenues in the states that apply them. The total national revenue from sales taxes on fuel is only about 10.6 percent of the revenue from gallonage taxes.[4]

[3] This estimate is based on the number of registrations in the two groups of states.

[4] This estimate is based on the gallonage of fuel taxed in the fuel sales tax states as a percent of the total national gallonage taxed.

TABLE 8 *(continued)*

State	First Structure Taxes				Second Structure Taxes	Third Structure Taxes				
			Ad Valorem Taxes							
	Registration, Weight Fees & Related[1]	Drivers' Licenses & Related[2]	Title Fees[3]	Vehicle Property Taxes[4]	Gasoline, Diesel, & Special Fuels[5]	Weight-Distance & Mileage Taxes	Tolls[6]	Gross Receipts Taxes[7]	Fines, Penalties, & Misc. Fees[8]	Total
New Hampshire	18.3%	1.2%	0.0%	0.0%	36.6%	0.0%	14.4%	0.0%	29.4%	100%
New Jersey	17.5%	1.3%	s	0.0%	30.9%	0.0%	28.2%	0.0%	22.1%	100%
New Mexico	5.5%	0.2%	7.7%	0.0%	40.0%	39.8%	0.0%	0.0%	6.7%	100%
New York	10.5%	0.8%	s	0.0%	35.8%	28.1%	18.9%	0.0%	5.9%	100%
North Carolina	19.6%	0.2%	s	p	76.1%	0.0%	0.1%	0.0%	4.0%	100%
North Dakota	27.5%	0.4%	s	p	61.9%	0.0%	0.0%	0.0%	10.3%	100%
Ohio	29.6%	0.5%	s	0.0%	56.7%	0.0%	3.9%	0.0%	9.4%	100%
Oklahoma	18.5%	0.6%	s	p	56.3%	0.0%	16.4%	0.0%	8.2%	100%
Oregon	10.6%	0.2%	0.0%	0.0%	7.5%	72.2%	0.0%	0.0%	9.5%	100%
Pennsylvania	18.6%	0.2%	s	0.0%	61.7%	0.0%	13.0%	0.0%	6.5%	100%
Rhode Island	10.7%	0.9%	s	p	40.9%	0.0%	2.8%	6.1%	38.6%	100%
South Carolina	27.9%	0.5%	s	p	64.2%	0.0%	0.0%	0.0%	7.4%	100%
South Dakota	35.5%	0.6%	s	0.0%	61.9%	0.0%	0.0%	0.0%	2.0%	100%
Tennessee	31.1%	0.4%	s	p	62.9%	0.0%	0.0%	0.0%	5.6%	100%
Texas	17.2%	0.8%	19.5%	p	58.9%	0.0%	1.4%	0.0%	2.2%	100%
Utah	19.3%	0.4%	s	p	70.7%	0.0%	0.1%	0.0%	9.6%	100%
Vermont	23.0%	0.2%	14.4%	0.0%	59.2%	0.0%	0.0%	0.0%	3.2%	100%
Virginia	14.5%	0.2%	8.2%	p	59.2%	0.0%	5.8%	0.0%	12.1%	100%
Washington	19.7%	0.2%	s	18.1%	49.9%	0.0%	5.5%	0.0%	6.6%	100%
West Virginia	19.6%	0.3%	10.8%	p	57.2%	0.0%	8.2%	0.7%	3.2%	100%
Wisconsin	37.0%	0.2%	s	0.0%	59.4%	0.0%	0.0%	0.0%	3.4%	100%
Wyoming	21.1%	0.5%	s	p	64.8%	0.0%	0.0%	0.0%	13.5%	100%
Average	23.5%	0.5%	2.8%	2.9%	53.0%	5.0%	5.4%	0.3%	6.6%	100%

Notes: [1] May include some ad valorem-based registration fees and miscellaneous fees related to registration.

[2] Includes commercial drivers' licenses.

[3] Includes some taxes that are collected on the same basis as general sales taxes, but which are identified as vehicle title fees. States with an 's' in this column levy a general sales tax which is applicable to motor vehicles but not considered to be a highway user tax. See Table 9 for general sales taxes applicable to motor vehicle sales.

[4] States with a 'p' in this column have a personal property tax that applies to motor vehicles in addition to other types of personal property. This tax is not considered to be a highway user tax.

[5] Includes gross receipts after refunds, distributor and dealer licenses, etc., and regional surcharges. See Table 9 for sales taxes applicable to fuel sales.

[6] Includes only tolls from state-administered facilities, and includes ferries.

[7] Includes only special taxes on motor carriers.

[8] Includes fines and penalties, registration service charges, permit (e.g., overweight) fees, miscellaneous receipts.

In summary, the total national state sales tax revenue from motor vehicle and fuel sales is about one-third of the total revenues defined as highway user revenues in Table 7. If these sales tax revenues were to be considered highway user revenues, they would constitute about 25 percent of the total.

SURVEY OF THE STATES

A survey was conducted of all state agencies responsible for heavy vehicle taxation. The goals of this survey were to learn about state policies and experience regarding heavy vehicle taxation and to obtain information about recent state studies of these systems. AASHTO sent a questionnaire developed by the study team to the states with a letter explaining the importance of the survey and enlisting the assistance of state officials. All responses were returned to AASHTO and forwarded to the study team for review and tabulation. Responses were received from 36 states.

The survey questionnaire requested information on the following:

- Recent studies or analyses of issues related to heavy vehicle taxation,

TABLE 9 State and local[1] general sales taxes that are applied to motor vehicle and fuel sales (1994)

State	General Sales Tax Rate Applying to	
	Motor Vehicle Sales	Fuel Sales
Alabama	5.5%	0.0%
Alaska	0.0%	0.0%
Arizona	5.5%	0.0%
Arkansas	5.5%	4.5%
California	7.5%	6.0%
Colorado	5.0%	0.0%
Connecticut	6.0%	0.0%
Delaware	0.0%	0.0%
District of Columbia	0.0%	0.0%
Florida	6.8%	0.0%
Georgia	6.0%	4.0%
Hawaii	4.5%	4.0%
Idaho	5.0%	0.0%
Illinois	7.1%	6.25%
Indiana	5.0%	5.0%
Iowa	5.0%	0.0%
Kansas	5.9%	0.0%
Kentucky	0.0%	0.0%
Louisiana	8.0%	0.0%
Maine	6.0%	0.0%
Maryland	0.0%	0.0%
Massachusetts	5.0%	0.0%
Michigan	6.0%	6.0%
Minnesota	6.5%	0.0%
Mississippi	7.0%	0.0%
Missouri	5.2%	0.0%
Montana	0.0%	0.0%
Nebraska	6.0%	0.0%
Nevada	6.8%	0.0%
New Hampshire	0.0%	0.0%
New Jersey	6.0%	0.0%
New Mexico	0.0%	0.0%
New York	7.5%	4.0%
North Carolina	5.0%	0.0%
North Dakota	5.0%	0.0%
Ohio	6.0%	0.0%
Oklahoma	4.5%	0.0%
Oregon	0.0%	0.0%
Pennsylvania	6.0%	0.0%
Rhode Island	7.0%	0.0%
South Carolina	5.0%	0.0%
South Dakota	4.5%	0.0%
Tennessee	8.3%	0.0%
Texas	0.0%	0.0%
Utah	5.9%	0.0%
Vermont	0.0%	0.0%
Virginia	0.0%	2.0%
Washington	7.6%	0.0%
West Virginia	0.0%	0.0%
Wisconsin	5.5%	0.0%
Wyoming	3.0%	0.0%

[1]Local sales taxes are included at the rate charged in a major city in the state.

Sources: a) Rayola S. Dougher, *Estimates of Annual U.S. Road User Payments Versus Annual Road Expenditures,* American Petroleum Institute, Research Study #078, March 1995, Table 9A.

b) FHWA, *Highway Statistics 1994,* 1995, Table MF-121T.

- Impacts of multistate agreements and suggestions for improving these agreements,
- Criteria for evaluating and selecting highway user taxation methods,
- Evaluations of new technology for administering taxation systems,
- Methods adopted to reduce tax evasion, and
- Assessments of the reliability of fuel taxation and taxation alternatives as revenue sources.

The survey responses are summarized below and a complete tabular presentation of all responses is presented in Appendix A. The questionnaire used is reproduced in Appendix B.

Studies of Heavy Vehicle Taxation

The survey asked whether the states have conducted any study or analysis of heavy-vehicle taxation addressing the following:

- Equity and/or economic efficiency,
- Required state resources,
- Required motor-carrier resources,
- Evasion,
- Economic impacts,
- Alternative taxes or alternative collection methods, or
- Any related subjects.

Figure 1 shows the number of responding states that have conducted studies in each of the above areas. The figure shows the number of states that were identified by the 1997 Federal Highway Cost Allocation Study (HCAS)[5] as having recently conducted cost allocation studies. The HCAS identified 31 states that have recently conducted cost allocation studies, including 24 that responded to the survey. The topics in the survey had received somewhat less attention than cost allocation, with the number of positive responses ranging from four (for studies of motor-carrier resource costs) to 15 (for studies of evasion). Twenty-one respondents indicated that they had conducted at least one of the studies on the list; and one, Oregon, indicated that it had conducted all the studies on the list. A complete tabulation of studies performed by the responding states is contained in Appendix A.

Multistate Agreements

Question 2A asked respondents for their impressions of the impacts of multistate agreements, principally IRP and IFTA, based on the following factors:

- Equity of user taxes,
- Economic efficiency of user taxes,
- Stability and predictability of revenue,
- Flexibility to adjust rates,
- Administrative costs,
- Motor-carrier compliance costs,
- Potential for evasion, and
- Economic impacts on motor carriers and other industries.

Several states submitted different evaluations of the IRP and IFTA by the separate state agencies that administer the registration and fuel tax programs. There were a few more negative evaluations of IFTA than IRP, primarily with regard to administrative costs and the potential for evasion. Some of the concerns clearly relate to start-up costs and problems faced by new members.

The evaluations are presented in Appendix A and summarized in Figure 2. For six of the eight criteria, a majority of the respondents believed the impacts to be positive. The two exceptions were (1) the impact on stability and predictability of revenues, which drew 17 positive responses out of 35 and only two negative responses and (2) rate flexibility, which 70 percent of respondents found to be unaffected and less than 10 percent found to be negatively affected. The only criteria for which more than 10 percent of respondents thought the impacts were negative were administrative costs and potential for tax evasion.

Question 2B asked for additional assessments of the impacts of these agreements. Most of the comments elaborated on responses to Question 2A, but some touched on new subjects. Several respondents found the agreements improved communication among the states and between the state and the carriers. Three respondents indicated that the agreements had increased state revenues, while three indicated directly or indirectly that state revenues had been decreased. One state expressed concern that the agreements are becoming increasingly complex and may clash with state laws. Another state expressed concern over complacency—a belief that someone else will do your work.

Question 2C asked for suggestions for improving the process. The most common suggestion related to increasing the degree of automation in exchanging information. In addition three states suggested some form of streamlining of the administrative process, and three more suggested improvements to the IFTA voting procedures. Two states suggested combining IFTA and IRP, and a third suggested combining the IFTA and IRP audits. Other suggestions included improvements in auditing standards and their enforcement, adding safety verification to the IRP registration process, improving the IRP dispute resolution process, allowing staggered IFTA registration, and revisiting the issue of carriers choosing base states that minimize their tax liabilities. (This last issue is of particular concern to those states that have significant taxes that are applied only to vehicles based in state.)

Criteria for Evaluating Taxation Methods

The third question provided a list of criteria for alternative tax systems and asked respondents to rank these criteria in order of importance from 1 (highest) to 12 (lowest). Figure 3 shows the average ranking assigned to each criterion when

[5] FHWA, 1997 *Federal Highway Cost Allocation Study*, Draft Report, April 1997, Appendix G. These studies involve allocation of all highway expenditures to vehicle classes based on each class' share of costs (as determined by axle weights, number of axles, miles of travel, etc.) and a comparison of each class' cost responsibility with highway user taxes paid.

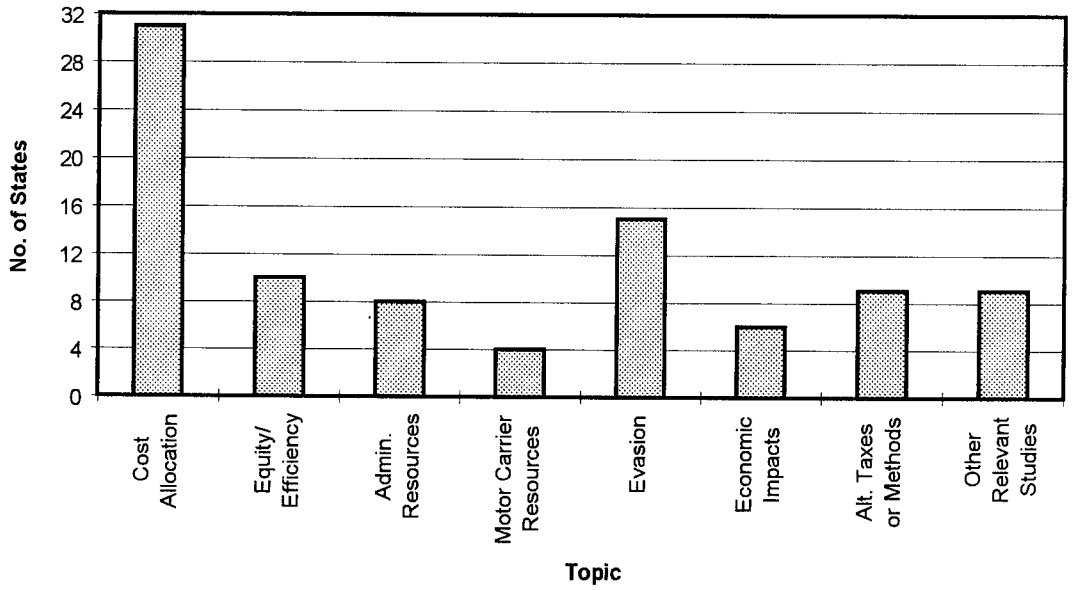

Figure 1. State studies relating to heavy vehicle taxation.

only the numeric scores assigned by respondents are used and these scores are used without adjustment.

Alternative Taxation Methods

Question 4 asked respondents to identify any programs for implementing alternative taxation methods that are being studied or have recently been implemented. Twenty of the 36 respondents identified one or more such programs. These programs include weigh-station by-pass, one-stop shopping, Prepass, Green Light, CVISN (the Commercial Vehicle Information Systems and Networks), ADVANTAGE I-75, the I-95 Corridor Coalition, the New England Consortium, and congestion pricing experiments. Most of these programs are described in Chapter 5. A complete list of responses to Question 4 is contained in Appendix A.

Measures to Reduce Tax Evasion

Question 5 asked about measures the states have taken in the last several years to reduce evasion of highway user taxes. Thirty-two of the 36 respondents identified one or more such measures. Eleven states referred explicitly to participation in the joint Federal/State Motor Fuel Tax Compliance Project or

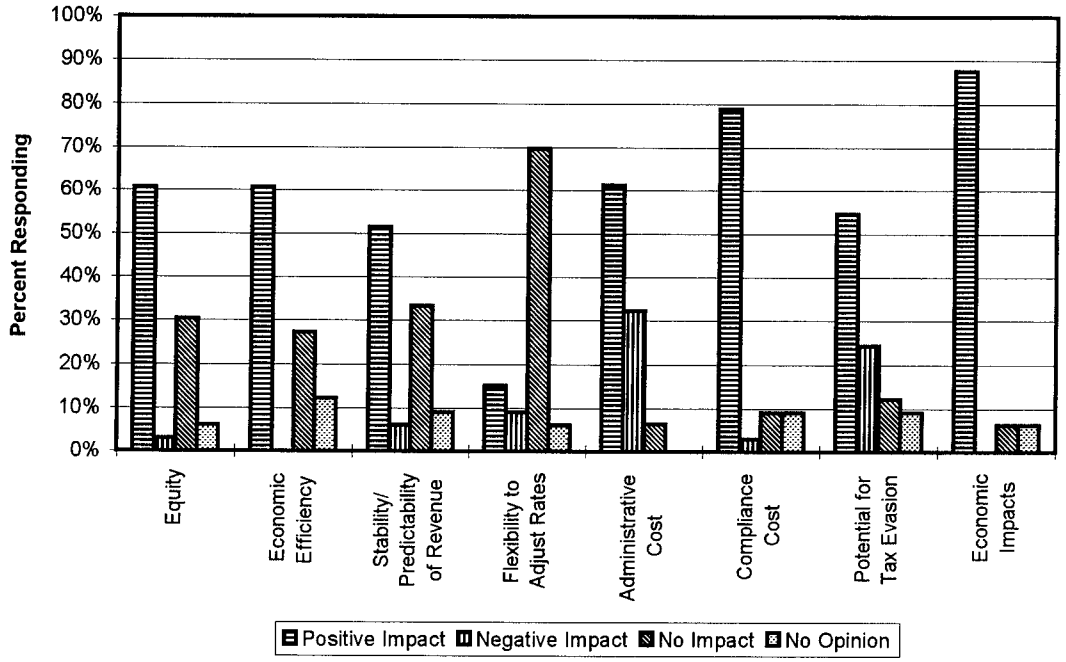

Figure 2. Impacts of multistate agreements.

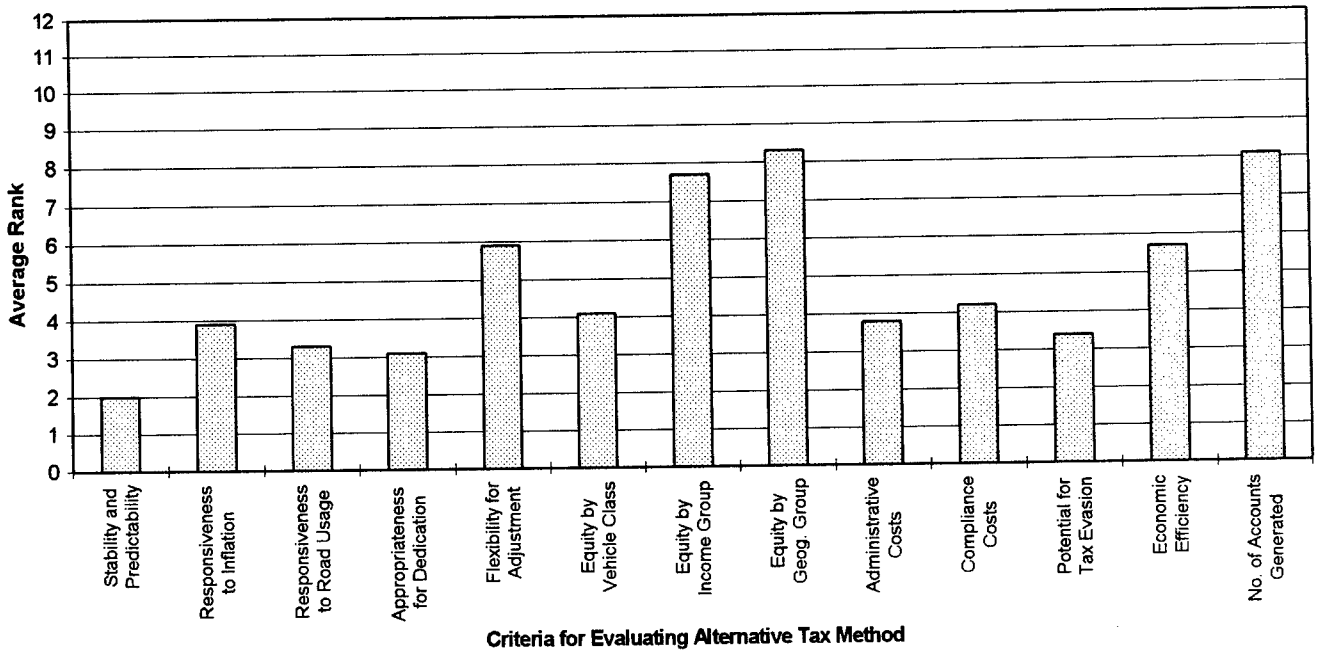

Figure 3. Average rank of evaluation criteria (1—most important, 12—least important).

to the fuel-dyeing component of that project; 10 states changed the point of collection for fuel taxes; 15 improved their auditing procedures or reporting requirements; and 8 states enhanced their enforcement programs in other ways. Other measures identified include reducing tax rates, eliminating third structure taxes, and eliminating exemptions for farmers. Table 10 presents a summary listing of the types of measures taken by each state, and Appendix A contains additional descriptions of the measures taken.

Reliability of Fuel Taxes and Alternative Taxes as Sources of Revenue

The final survey question asked for state assessments of the reliability of fuel taxes or alternative taxes as sources of revenue. Most of the states had not undertaken any such studies and those that had provided relatively mixed comments.

Six states commented about the tendency of revenue from fixed gallonage taxes to lag behind inflation. One of these

TABLE 10 Measures taken to reduce evasion

Federal/State Motor Fuel Tax Project	Changed Point of Tax Collection	Enhanced Auditing/ Reporting	Other Enhanced Enforcement	Other Measures
Colorado	Arizona	Arkansas	California	Arizona
Connecticut	California	Colorado	Kansas	Colorado
Iowa	Iowa	Florida	Massachusetts	Minnesota
Louisiana	Kansas	Idaho	Montana	Virginia
Maine	Minnesota	Illinois	Nebraska	Washington
Michigan	Nebraska	Iowa	Oregon	
Minnesota	Nevada	Kansas	Pennsylvania	
Mississippi	New Mexico	Kentucky	Washington	
Rhode Island	S. Dakota	Maine		
S. Dakota	Wisconsin	Massachusetts		
Utah		Montana		
		Nebraska		
		New Jersey		
		Vermont		
		Washington		
		Wisconsin		
		Wyoming		

states had just had a fuel tax increase proposal defeated by the legislature; another is planning to request an increase in the next legislative session; and a third (Nebraska) expressed relative satisfaction with its system of variable tax rates. Two states expressed concern about evasion of fuel taxes, and one expressed concern that fuel taxes place an inequitable burden on automobiles relative to trucks.

Only three states identified alternative taxes that had been studied. California recently evaluated several potential changes in tax structure as part of its current cost allocation study, including fuel tax and other fee increases to substitute for current trailer fees; however, a fuel tax increase did not survive the preliminary screening, primarily because of feasibility considerations. Minnesota evaluated a wide range of tax alternatives using criteria described in the following section. Wisconsin studied and rejected the use of tolls or congestion pricing, but is undertaking a pilot program for evaluating infrastructure banks.

SELECTED STATE ACTIVITIES, STUDIES, AND REPORTS ON HEAVY VEHICLE TAXATION

This section describes a wide range of recent state activities, studies, and reports aimed at improving heavy vehicle tax systems. Table 11 lists the states and topics covered in this section. Most of the information and reports were obtained from the responses to the survey of all states that was conducted through AASHTO (which is described in detail in the next section). Some of the material is from state studies in which the authors have participated.

This section is not intended to be exhaustive of states' recent work in this field, but is intended to be representative—covering the range of issues of concern to the states. In addition to the activities covered in this section, several additional tax initiatives, particularly highway cost allocation studies, ITS commercial vehicle operations demonstration projects, and fuel evasion activities, have been performed in recent years. The activities covered here are also not necessarily intended to be the best examples or models for other states to follow. Some additional reports from interesting projects were not yet available or only became available from returns to the survey as this report was being completed. Others were excluded to avoid repetition of similar projects from other states, particularly in the three categories mentioned above. All of the findings, conclusions, and recommendations in this section are taken directly from the various state reports and discussion papers.

Arizona

In addition to a highway cost allocation study completed in 1991, the Arizona Department of Transportation (ADOT) has recently completed three studies on highway user tax issues that are quite relevant to this study. The studies included (1) an evaluation of diesel fuel tax evasion, (2) an overall evaluation of its weight-distance tax, and (3) an evaluation of existing and alternative revenue sources.

Fuel Tax Evasion Report

This report estimates fuel tax evasion to be between 3 and 7 percent for gasoline and between 15 and 25 percent for diesel, with an estimated loss of diesel revenues between $29 million and $55 million. These numbers may overestimate current tax evasion, the report notes, because recent evasion countermeasures imposed by the Federal government seem to have reduced evasion. It lists broad types of evasion schemes[6] that evaders use, including the following:

Adulteration of Motor Fuels—Using other fuels besides diesel to run engines;

Blending—Mixing of untaxable (in some states) gasohol with taxable diesel fuel;

Bootlegging Across State Lines—Shipment of fuel from a high-tax state to a low-tax state;

Claims of Exempt Use—Users file for an exemption (e.g., for farm use) to which they are not entitled;

Daisy Chains—Creating confusing paper trails of fuel sales tied to a nonoperating business; and,

Failure to File—Vendors do not file, and upon being discovered go 'out-of-business.'

It also lists a number of countermeasures[7] that may be invoked to reduce diesel fuel tax evasion, the nationwide costs of these countermeasures, and the amount of nationwide fuel tax evasion reduction that would be necessary to cover the costs of these reductions. These countermeasures are as follows:

Dyeing at the Refinery—Adding dyes at the refinery;

Elevated Point of Taxation—Moving the point of taxation to the terminal rack;

Marking at Terminal without Dyeing—Colorless marking of fuel;

Nationwide Fuel Tracking Systems—Computerized tracking of diesel fuel throughout distribution;

Reference Dye and Marker Program—Using both a dye and marker to mark tax-exempt fuel;

[6] Evasion schemes in the ADOT report are based on an FHWA project.
[7] Countermeasures in the ADOT report are based on an FHWA project.

TABLE 11 States and topics covered in case studies

Arizona	
	"The Weight-distance Tax in Arizona"
	Highway revenues review study
	Highway cost allocation study (1991)
	Diesel fuel tax evasion and countermeasures
	Evaluation of tax options study
Arkansas	
	Fuel tax evasion and countermeasures study
California	
	Highway cost allocation studies (1987 and 1996)
	Congestion pricing programs
Kentucky	
	"Report of Commission on Tax Policy"
	Highway cost allocation studies (1988 and 1992)
Maine	
	Highway cost allocation studies (1982 and 1989)
	Diesel fuel tax evasion and countermeasures
	Northern New England ITS/commercial vehicle operations study
Minnesota	
	Congestion pricing implementation study
	Public-private partnerships of a toll-financed freeway
	"Transportation and Economic Development in the Upper Midwest" (symposium on pricing and ITS program)
	"State Advisory Council on Major Transportation Projects" (pricing and a formal evaluation of tax alternatives)
Oregon	
	"Long-range Transportation Finance Issues and Opportunities" (public discussion paper for the Transportation Commission)
	"Oregon Weight-Mile Tax Study"
	"Diesel Fuel Fee Non-Compliance"
South Carolina	
	"Trucking Quality Team Report" (study of ways to reduce compliance burden)
Virginia	
	"Report of the Governor's Task Force on Fuel Tax Evasion"
	Weigh station avoidance study

State Enforcement Assistance—Coordination of state and Federal enforcement efforts;

Tax Refund—Tax exempt users would have to pay the tax and apply for a refund after proving they used the fuel for tax exempt purposes; and

Universal Registration—Nonregistered users of diesel fuel would have to register with the IRS.

The report notes that two of these countermeasures (elevated point of taxation and reference dye and marker program) have already been implemented by the Federal government and seem to have produced favorable results—Federal diesel fuel use tax collections have risen by 38 percent since implementation of the countermeasures.

The report recommends that ADOT take further steps to reduce evasion. Specifically, it should determine how fuel taxes are being evaded (i.e., evaluate evasion schemes), evaluate a list of countermeasures, and implement one of the countermeasures on a trial basis. After the trial period, the countermeasure should be evaluated (cost per benefit) and dropped or continued and the issue of whether any other countermeasures should be implemented should be addressed.

Weight-Distance Tax in Arizona

Note: This report was prepared in 1993. Later in 1993, the Arizona legislature enacted legislation to phase out the weight-distance tax. This involved increasing the motor-carrier fuel tax (collected through a surcharge paid with fuel-use reports) by 8 cents and making other adjustments while lowering the weight-distance tax annually. The phase-out was completed in 1997, and further adjustments have been made in an attempt to provide revenue neutrality. The fuel tax surcharge, paid at the pump by vehicles over 26,000 lb GVW, is now 9 cents (27 cents per gallon versus 18 cents

for lighter vehicles); and a graduated annual fee of up to $800 has been added to registration fees.

This report presents a summary of results from the 1991 cost allocation study. That study found that while all vehicle classes in Arizona, individually and as a whole, underpaid their fair share from 1988 to 1992, during the period of 1993 to 1997, combination vehicles were expected to be paying 101 percent of their cost responsibility. Single units and autos would be paying approximately two-thirds of their fair share.

According to the report, the administrative costs and compliance costs of the weight-distance tax are quite low. Administrative costs are estimated to be about 1.5 percent of revenue generated by the tax. Compliance costs are estimated to be 2 percent of revenues. The administrative cost to ADOT for collecting diesel fuel taxes is slightly less than 2 percent of revenues.

The study finds that it is unlikely that the weight-distance tax has had a significant negative impact on the trucking industry in Arizona and the state in general. One reason is that the weight-distance tax replaced a gross receipts tax. This has helped reduce the burden on contract carriers, who under the gross receipts tax paid an average of 6 cents per mile and under the weight-distance tax pay an average of 5.5 cents per mile. However, it has imposed a new cost on private carriers, who paid no gross receipts tax, and now also average weight-distance payments of 5.5 cents per mile. Adjusted for inflation, the weight-distance tax imposes a per mile tax burden that is less than the gross receipts tax for all weight classes. The study cites evidence that the trucking industry's growth is in line with overall growth in Arizona. From 1980 to 1990, the population of Arizona grew 35 percent, while growth in registrations of commercial vehicles (32 percent), diesel fuel consumed (59 percent), and truck traffic (84 percent) have each at least kept pace.

Overall, the report finds that the weight-distance tax has favorable impacts on Arizona. It judges the tax to be equitable, efficient, a good source of revenue, and to have little or no negative impacts on the economy and the trucking industry.

Highway Revenues Review Study

This study evaluates existing and alternative methods for raising revenue for highway purposes. Its intent is to identify ways to increase additional revenue and evaluate the sources in terms of the following:

- Effectiveness—Ability of the measure to raise revenue reliably;
- Structure—How much revenue can be raised;
- Impact—Economic impact;
- Equity—Relationship to use and burden; and
- Feasibility—Legal considerations and public acceptance.

Overall, 25 sources for raising additional revenues were ranked based on these qualities, and nine alternatives were selected as potential components of a revenue-raising package. Table 12 presents the outcome of the evaluation process.

In producing the overall ranking, the five evaluation criteria are all given equal weighting. The study report presents, in an appendix, scoring based on unequal weightings which allows one to judge an alternative if one were to emphasize one of the criteria more than the others (e.g., in one scenario equity is given 40 percent weighting and the other four are given 15 percent weighting). It contains no judgments as to which criteria are the most important.

A positive or neutral rank in feasibility is essential to make the list of recommended potential package components. This presents a much greater emphasis on existing tax structures (e.g., motor fuel tax increase, registration fee increase) and eliminates all new types of taxes (e.g., VMT tax, BTU/energy tax). However, the report does recommend that some of these sources ranked negatively in feasibility be studied further. Three taxes, VMT tax, tolls/congestion pricing, and BTU/energy tax, had higher overall rankings than some of the recommended taxes, but were ranked negative in feasibility and therefore were not recommended for inclusion in a current revenue package. The reasons these taxes were given negative feasibility rankings were that they require legislation to be enacted and involve overcoming some public acceptance barriers.

Arkansas

The Arkansas State Highway and Transportation Department recently completed a fuel tax evasion study, "Report and Recommendations: Motor Fuel Tax Compliance Quality Management Team." This report discusses the problems encountered with the evasion of state and Federal motor fuel taxes, particularly with respect to "special fuels," mostly diesel.

- FHWA reported in 1992 that Federal motor fuel tax evasion was believed to be on the order of 3 percent to 5 percent for gasoline and 15 percent to 25 percent for diesel fuel. Cross-border transactions are among the most common evasion schemes.
- "Dual use" of diesel fuel. Such schemes involve the illegal diversion of diesel from tax-exempt uses (e.g., home heating) to highway vehicles, whereby Federal and state fuel taxes are circumvented.
- Fuel-extender blending. Kerosene, transformer oil, and other petroleum products can be blended with taxed diesel fuel to extend the mileage per taxable unit. For example, 7,000 gallons of diesel, mixed with 1,000 gallons of untaxed kerosene, will yield 8,000 gallons of readily usable motor fuel.
- Taxpayer noncompliance or evasion.
- "Daisy chain." A front company is set up to serve as the intermediary between two agents, one being a duty-free wholesaler, the other being a retailer who purchases fuel for which the duty has supposedly been paid. Generally,

TABLE 12 Alternative revenue sources evaluated by Arizona DOT

Category	Revenue Source	Overall Ranking	Feasibility Score	Considered as Potential Package Component?
Existing Highway User Revenue Fund (HURF) Sources	Motor Vehicle Fuel Tax Increase	1	Positive	YES
	Use Fuel Tax Increase	9	Positive	YES
	Vehicle License Tax (VLT) Increase	15	Positive	
	Registration Fee Increase	5	Positive	YES
	Motor Carrier Tax Increase	13	Positive	YES
User-Type Alternatives	VLT Surcharge/Dedicated VLT	3	Neutral/ Negative	YES
	VMT Tax	7	Negative	
	Tolls/Congestion Pricing	8	Negative	
	Parking Tax	20	Negative	
	BTU/Energy Tax	10	Negative	
	Alternative Fuels Tax	24	Negative	
Sales Taxes	Motor Fuels	2	Neutral	YES
	Motor Vehicles	3	Neutral	YES
	Products and Services	17	Negative	
	General Statewide Surcharge	5	Neutral	YES
	County Surcharge	11	Neutral	YES
Income, Property and Utility Taxes	Personal Income Tax Surcharge	14	Negative	
	Corporate Income Tax Surcharge	19	Negative	
	Property Tax	12	Negative	
	Utility Fees	16	Negative	
Miscellaneous	Exactions	21	Negative	
	Value Capture	23	Negative	
	Public/Private Joint Ventures	N/A	Negative	
	Admissions Tax	22	Negative	
	Accommodations Tax	18	Negative	

Source: Arizona Department of Transportation, *Highway Revenues Review Study,* 1995.

the buying and selling agents are owned by the same party or two colluding parties who use the front (or "burn") intermediary until it is audited, at which time they allow the burn to go out of existence, leaving state and Federal revenue inspectors with a dead lead. Typically, burn companies will last for at least several months, all the while reporting false tax remittances. During this time the bootlegging owners or their co-conspirators are able to turn substantial profits in unpaid fuel taxes. Arkansas is considered to be less susceptible than most states to such an evasion scheme, because of an unspecified "statutory provision designed to prevent this kind of evasion."

Several fuel tax evasion countermeasures are recommended in the report:

- Terminal-level taxation. Fuel taxes should be paid at the terminal rack or at the point of importation. Fewer taxpayers would be filing reports; the "quality" of taxpayers would be improved (terminal operators tend to be large and often file reports electronically); Federal and state collection efforts would be easily merged; and "daisy-chain" operations would be eliminated under this scheme.
- Fuel dyeing. High-sulfur fuels sold for off-road use should be dyed, so as to facilitate on-the-road enforcement.
- Automation. The use of EDI and EFT technologies should be used to facilitate the prompt investigation of cross-border transactions involving motor fuels. In addition to expected improvements this would make in enforcement, electronic filing is also considered a substantial cost-saving measure because processing of unnecessary paperwork is avoided.
- More enforcement. Spot inspections of bulk fuel storage facilities or cargo tanks should be able to be made at any time by enforcement personnel. Illegally untaxed fuel should be confiscated and sold by the state, with proceeds going to the highway fund.

California

The major recent work in California relevant to highway user taxes includes two highway cost allocation studies (1987 and 1996) and several congestion pricing programs involving electronic toll collections.

Highway Cost Allocation Studies

The 1987 and 1996 California Highway Cost Allocation Studies represented significant advances in cost allocation

methods and software. The 1987 study is notable because it was one of the first state studies to take advantage of methods developed in the Federal Cost Allocation Study of 1982, though it did also include analysis based on the more traditional incremental method. Both studies are unusual in terms of the detailed involvement of motor-carrier industry representatives and the larger volume of data and documentation required to accommodate this involvement.

The 1996 study is notable because it evolved from a decision to base some required changes in tax structure on the findings of a new cost allocation study. It is using the results of a special survey and an extensive set of weigh-in-motion (WIM) and other data in converting the basis of California's registration fee structure from unladen weight to gross weight. It also includes significant advances in cost allocation study methods and software. The software allowed the study team to deal with hundreds of vehicle and weight classes and to separate vehicles by tax status (e.g., regular fee, apportioned, weight-fee exempt). Only the "Federal" method for allocating costs was performed for the 1996 study.

The major reason for conducting the 1996 Highway Cost Allocation Study was to convert the basis of California's registration and related fee structure from unladen weight of individual power units and trailers to gross combination weight so that California would be in compliance with the practices of other states under the IRP. This involved developing a bridge between the unladen weight of a power unit and the gross weight at which it would likely register. An additional complexity involved transferring ad valorem taxes from trailers to power units, because California would no longer be able to tax trailers and prorate revenues based on weight or value.

A special truck weight survey was performed by the California Highway Patrol for the 1996 study. This involved recording data on more than 13,000 truck movements at weigh stations throughout the state on representative routes. License plate number, operating weight, and body type were recorded for each observation of California-based and out-of-state vehicles. Additional data on approximately 10,000 vehicles were collected from computer files of California and the six other most common states of registration by the study team. (The remaining 3,000 vehicles were from the other 43 states). These data included California registered unladen weight, registered gross weight in other states, fuel type, body type, number of axles, and whether the vehicle is apportioned in California. These data allowed the study team to develop relationships between unladen weight and registered gross weight, as well as between operating weight and registered weight (unladen and gross).

Additionally, approximately 14 million WIM records were analyzed from representative functional classes throughout the state. Data were analyzed for each of 15 WIM sites for 1 week out of each month for an entire year. This allowed the study team to take into account day-of-week and seasonal variations in travel. This effort represented the most comprehensive utilization of WIM data used in any state study.

Congestion Pricing Programs

Four congestion pricing programs that take advantage of advanced technology (or will do so in the future) are underway in California:

- SR-91 Variable Toll Facility (Orange County),
- I-15 Priced Express Lanes Project (San Diego),
- San Francisco/Oakland Bay Bridge Pricing Project, and
- Southern California Association of Governments (SCAG) Regional Congestion Pricing/Market-Based Strategies Project (Los Angeles).

These projects may allow for flexible pricing of highway use in the future by breaking down technological and institutional barriers to innovative highway pricing. These projects address technological barriers by the establishment of advanced collection techniques. Institutional barriers will be addressed as these projects establish precedents for highway pricing methods. In addition, evaluations of these projects will lead to increased knowledge on operational, traffic, and travel behavior impacts of market-based pricing. Three of the four projects take advantage of a congestion pricing pilot program funding from FHWA, as do most other congestion pricing projects in other states. The Orange County project is the exception, as it is a private facility without Federal involvement. Brief descriptions of the studies follow.

SR-91 Variable Toll Facility (Orange County). This privately financed toll facility is fully operational and, as it provides the first tangible measurement of the impacts of congestion pricing in the United States and is the world's first fully automated toll road, is the object of much evaluation. The facility consists of high-occupancy vehicle (HOV) lanes within the median of heavily congested SR-91, which other automobiles can buy into using electronic equipment to pay variable tolls based on the level of congestion in the corridor.

I-15 Value Pricing Project (San Diego). This project allows single-occupancy vehicles (SOVs) to pay a per-trip fee to use the I-15 Express Lanes normally reserved for HOVs. All toll collection is conducted electronically, and solo driver participants must obtain a transponder. The pricing program, which is marketed under the term I-15 FasTrak™, began in late March 1998. FasTrak™ solo drivers pay tolls ranging from $0.50 to $4.00 based on real-time traffic in the Express Lanes and on time of day.

San Francisco/Oakland Bay Bridge Pricing Project. While the Metropolitan Transportation Commission (MTC) has not yet received permission from the State Legislature to implement congestion pricing on the Bay Bridge, the California Department of Transportation (Caltrans) has recently begun using electronic toll-collection equipment on the Carquinez Bridge on I-80 near Vallejo. MTC is seeking approval for a peak-period toll of $3 for westbound traffic, while keeping the off-peak toll at its current level of $1.

Southern California Association of Governments (SCAG) Regional Congestion Pricing/Market-Based Strategies Project (Los Angeles). This program consisted of a 2-year investigation of the feasibility of implementing market-based pricing strategies in the Los Angeles region, focusing on congestion pricing and emissions fees. A 75-member task force, comprised of a broad cross section of regional leaders, developed an ambitious program of recommendations to implement long-range solutions to the region's congestion and environmental problems. These include educational programs, high-occupancy/toll (HOT) lane projects, and alternative mobility programs for lower income travelers.

Kentucky

Report of the Kentucky Commission on Tax Policy

This report, published in November 1995, contains a broad overview of the state taxation system and prescribes measures to increase revenues and to improve equity and competitiveness for Kentucky firms. With respect to heavy vehicle taxation, significant points include the following:

- Fuel taxes should be indexed to the U.S. Consumer Price Index (CPI), with a first-year rate set such that it is rendered revenue-neutral. The special fuels tax is to be increased from 12 to 15 cents per gallon; the special fuels surtax is to be raised from 2.2 to 5.2 cents per gallon; the motor fuel surtax is to rise to 6.4 cents per gallon; and the exemption for liquefied petroleum (LP) gas is to be repealed. At the same time, the heavy vehicle fuel surtax is to be repealed, and the motor fuels tax is to rise from 15 to 17 cents per gallon to offset losses of revenue from other changes. The net effect of all of this is the equalization of fuel tax rates, which have been skewed in favor of certain fuel types since 1986. Equalization of the tax rate at the pump is intended to ensure that all non-motor-carrier users pay equally on gallons purchased, while equalization of the fuel surtax will, it is argued, eliminate the existing tax-discrimination based on the types of fuel used by different trucks. The surtax will continue to be levied because of the greater highway wear and tear caused by heavier vehicles.
- Allowing credit on trade-ins for new vehicles should equalize the trade-in credit for motor vehicle usage tax on new and used cars.
- The taxable value of vehicles less than 7 years old should be reduced from 100 percent to 90 percent of their National Automobile Dealers Association (NADA) book value, so as to reflect the real value of new vehicles more accurately.
- All trucks with GVWs above 26,000 lb should be exempt from the motor vehicle usage tax. The revenue loss from this exemption would be offset by the higher diesel tax.

Kentucky Highway Cost Allocation Studies

Kentucky completed cost allocation studies in 1988 and 1992. Kentucky used a modified Federal method of cost allocation. In 1986, trucks accounted for 31 percent of total attributed costs and paid 28 percent of total highway user taxes. Large combination trucks were found to underpay their cost responsibility significantly, with the heaviest trucks (82,000 lb GVW) posting a shortfall of $22.8 million, or roughly one-quarter of their estimated cost responsibility.

Following the submission of the 1988 report, a weight-distance tax was imposed on heavy trucks over 60,000 lb GVW using an ungraduated rate of 2.8 cents per mile, plus a "temporary" surcharge of 1.15 cents per mile. As a result of this tax, the 1992 Kentucky HCAS found heavy trucks to be responsible for 24.64 percent of costs and to be paying 25.46 percent of state highway revenues. Equity ratios (percent of total revenues to percent of total costs) were found to be as follows:

Cars	1.01
Buses	0.21
Pickups/Vans	1.10
Light Trucks	1.06
Medium Trucks	0.63
Heavy Trucks	1.03

The 1992 Kentucky report analyzes several proposals of the Kentucky Motor Transport Association (KMTA) which were submitted prior to the legislative session. The KMTA had argued that the relatively high level of taxation on heavy trucks operating in the state presented an unfair competitive disadvantage vis-à-vis carriers in neighboring states. Eight tax alternatives were proposed (1) Removal of the 1.15 cents per mile weight-distance tax surcharge; (2) Repeal of the 2.85 cents per mile weight-distance tax, as well as removal of the surcharge; (3) Repeal of the weight-distance tax and elimination of the usage tax for trucks over 32,000 lb GVW; (4) Repeal of the weight-distance tax, elimination of the usage tax for trucks over 32,000 lb GVW, and increasing the heavy vehicle fuel surtax by 12 cents per gallon; (5) Repeal of the weight-distance tax and the heavy truck usage tax, increasing the heavy vehicle fuel surtax by 7.7 cents per gallon, and increasing the special fuel tax by 3 cents per gallon; (6) Repeal of the weight-distance tax and heavy truck usage tax, increasing of the gasoline tax by 1 cent per gallon, and raising the special fuel tax by 5 cents per gallon; (7) Repeal of the weight-distance tax and the heavy truck usage tax, as well as increasing truck registration, permit, and license fees by 89 percent; and (8) Repeal of the weight-distance tax and heavy truck usage tax, with the raising of automobile registration fees by $21.50.

Each of the KMTA alternatives would increase the relative tax burden on automobiles, while reducing that on heavy trucks and would decrease the annual revenue deposited in the road fund. The repeal of both the tax and the surcharge

was projected to have the following, generally unfavorable, effects on the above equity ratios:

	Remove Surcharge	Repeal Tax
Cars	1.03	1.09
Buses	0.22	0.23
Pickups/Vans	1.12	1.19
Light Trucks	1.08	1.14
Medium Trucks	0.65	0.68
Heavy Trucks	0.97	0.80

The 1992 report also discussed recent state-level highway cost allocation activities in Kentucky and elsewhere. Detailed discussions were presented for Virginia (1991), Minnesota and Vermont (both 1990), California (1987), and Indiana (1984). Equity among user groups ranged considerably for these state studies, particularly with respect to trucks. Equity ratios for selected vehicle classes in the six studies are shown in Table 13.

Maine

1989 Maine Highway Cost Allocation Study

This study is the most recent of a number of highway cost allocation studies undertaken by the state since the mid-1950s. Overall, basic vehicles and combination trucks were found to be essentially paying their fair share. High axle weight limits are responsible for the persistent underpayment of certain truck classes, most notably 4-axle single units and 6-axle combinations. A weight-distance tax is believed to promote fair payment shares among vehicle classes, although this study does not explicitly prescribe one for use in Maine. Combination trucks are characterized by widely varying equity ratios and are difficult to tax equitably with existing revenue instruments. A weight-distance tax is considered to be the most effective way of mitigating some of the cross-subsidization between specific subclasses of combination trucks.

The two main arguments against a Maine weight-distance tax are (1) the overwhelming equity problem is regarded to be the underpayment by intrastate single-unit trucks, which would not be subject to a weight-distance tax unless very low weight thresholds were used, such as those used in Oregon—this would create an unmanageably large caseload for state auditors; and (2) considerable research would still be required to establish appropriate rate schedules, weight thresholds, and other factors, because many conditions differ greatly between Maine and those states currently using a weight-distance tax, thus preventing the easy adoption of other states' rates and methods.

A comparison of equity among user groups from two recent Maine cost allocation studies is shown in Table 14, along with a 1989 forecast for 1990–91.

The study makes several recommendations for remedying the user tax inequities:

- New legislation aimed at "fairer" highway user taxes. Specific options include establishing dual truck registration schedules (i.e., separating single-unit and combination trucks), increasing commodity permit fees, reducing axle-weight limits, reducing registration fees for basic vehicles (autos and light trucks), and raising the diesel fuel tax.
- An increase in the diesel fuel tax decal fee to cover administrative costs;
- Improvement of motor vehicle data collection;

TABLE 13 Equity ratios for selected vehicle classes in six state studies (1984-1991)

	Kentucky	Minnesota	Virginia	California[1]	Vermont	Indiana
Passenger Vehicles	1	1.05	1.1	0.87	1.02	1.2
Single-Unit Trucks	0.6	1.11	0.8	3.97	0.97	1.1
2-Axle	0.75	0.99	0.8	4.01	1.13	1.19
3+ Axles	0.46	1.31	0.9	3.94	0.8	1.04
Combinations	1.3	0.7	0.9	1	0.97	0.6
4 or Fewer Axles	1.13	1.07	n/a	2.35	1.04	0.51
5+ Axles	1.28	0.64	n/a	0.89	0.96	0.63

[1] In the current California highway cost allocation study, equity ratios have been found to be much closer to 1.00 for all major vehicle classes.

Source: Kentucky Department of Transportation, *1992 Kentucky Highway Cost Allocation Study*, 1992.

TABLE 14 Revenue to cost responsibility ratios in Maine for three time periods

	1980-81	1986-87	Forecast 1990-91
Single-Unit Trucks			
2-Axle, 4 tires	1.54	1.08	0.86
3-Axle	0.85	1.02	0.75
4-Axle	0.59	0.56	0.56
All Single-Unit Trucks	*1.16*	*0.94*	*0.76*
Combinations			
3 & 4-Axle	1.15	1.12	1.08
5-Axle	0.95	1.00	1.11
6-Axle	n/a	0.67	0.78
All Combinations	*0.97*	*0.96*	*1.02*

Source: Maine Department of Transportation, *1989 Maine Highway Cost Allocation Study,* 1989.

- The tightening of lift-axle regulations;
- Increased fuel tax auditing and enforcement;
- The conducting of regular cost allocation studies to track trends in equity among highway users; and
- Further study of a weight-distance tax.

Another finding was that a considerable difference exists between the equity ratios for state-funded roads compared with roads supported by "combined funds" (i.e., Federal and state), as shown in Table 15.

Motor Fuel Tax Evasion Committee Final Report

Insufficient data constituted the foremost obstacle to a proper assessment of state diesel fuel tax evasion. There was little in the way of verifiable mileage reporting from motor carriers operating in the state, which made evasion by bootlegging interstate truckers virtually impossible to evaluate. State auditing and monitoring efforts suffered from qualitative weaknesses, which the Committee characterized as "dispersed responsibility and uncoordinated leadership."

Out-of-state audits are regarded as showing "increasing returns in recent years" despite their expense. The estimate of the annual revenue recovery by a Bureau of Taxation auditor is $325,000. At the time of writing, Maine had only three full-time State Police officers on fuel tax enforcement detail, which was inadequate for covering the entire state. Penalties are not severe enough to serve as an adequate deterrent. Maine has never prosecuted any individual or business for fuel tax evasion. Operators often purchased inexpensive 5-day trip permits in lieu of filing fuel tax reports.

The Committee prescribed several possible fuel tax evasion countermeasures, including the appointing of a centralized fuel tax program leadership, stiffer penalties for evasion, the raising of trip permit rates from $5 to $50, with the time limit to be reduced from 5 to 3 days, and various new enforcement powers for the State Police fuel tax enforcement unit, including access to current carrier account status from the state department of motor vehicles (DMV).

The Committee recommends further study of a port of entry system. Maine is characterized as being geographically well-suited for such a system because most interstate commercial traffic enters the state on a single route, the I-95/Route 1 corridor into Kittery. The Committee also recommends further study of the use of cab-mounted transponders and roadside receivers to track vehicle mileage.

Northern New England Commercial Vehicle Operations Study

Maine DOT was the lead agency, on behalf of three states, for the "ITS/CVO Institutional Issues Study: Maine, New Hampshire, and Vermont—Final Report" dated October 1995. This report discusses the potential use of ITS/CVO in the upper New England states, including the possible use of such technologies to facilitate administration and enforcement activities for the payment of highway user taxes and fees.

ITS/CVO technologies are considered in terms of their applicability in the private sector (on-board computers, automatic debiting, electronic remitting of payments), as well as their potential use by public sector agencies for the collection of fuel taxes, tolls, registration fees, as well as the enforcement of size and weight restrictions, driver identification, vehicle inspections, and so forth. The report contains a comprehensive review of recent and proposed projects involving these technologies.

ETC has become increasingly common since the late 1980s, typically using vehicle-mounted transponders that communicate with roadside sensors at toll plazas. AVI and Vehicle-to-Roadside Communication (VRC) systems are in use in a number of states and offer potential time savings to carriers who choose to participate. The first Electronic Toll and Traffic Management (ETTM) system was installed in 1989 on the Crescent City Connection in New Orleans. As of

TABLE 15 Revenue to cost responsibility ratios in Maine for state-funded programs compared with combined (Federal and state) funds

	State Funds	Combined Funds
Basic Vehicle	0.99	1.03
Single-Unit Trucks		
2-Axle, 6 tires (#220)	1.12	1.08
3-Axle (#230)	0.95	1.02
4-Axle (#240)	0.58	0.56
All Single-Unit Trucks	*0.96*	*0.94*
Combinations		
3 & 4-Axle (#321/322/331)	1.34	1.12
5-Axle (#332)	1.13	1.00
6-Axle (#333)	0.78	0.67
All Combinations	*1.09*	*0.96*

Source: Maine Department of Transportation, *1989 Maine Highway Cost Allocation Study,* 1989.

1995, at least 10 toll agencies had installed such systems. ETTM systems are capable of "reading" vehicles at mainline speeds, which permits pre-cleared vehicles to pass through the appropriate lanes without stopping, saving time and fuel. ETTM lanes are capable of handling 1,800 vehicles/hour, more than five times the maximum capacity of a manual toll lane. ETTM lanes are estimated to be more than 33 times cheaper to operate than manual lanes.

At the time of writing, the Maine Turnpike Authority (MTA) was planning to integrate ETTM into its 100-mile toll road system by early 1996.

Minnesota

The state of Minnesota is actively pursuing alternative transportation financing mechanisms through a number of different studies and activities currently being conducted or completed during the last few years. A description of the current activities is provided below along with a more detailed summary of findings from completed work.

Congestion Pricing Study. As part of Minnesota's effort to identify alternative financing for highway projects, the state has been conducting an extensive congestion pricing study to gauge public reaction to this pricing mechanism. The study has gathered information through public workgroups and citizen jury hearings to measure the public tolerance for congestion pricing and how much people are willing to pay to avoid congestion.

Public-Private Partnership of a Toll-Financed Freeway. Minnesota is in the process of implementing a public-private financed toll road project located in the southwestern quadrant of the twin cities. The 12-mi toll-road will be a public-private partnership with the state contributing $70 million and the remaining $110 million coming from the private sector. Public-private financing has allowed the construction of the freeway 20 years before funds would have been available through traditional financing methods.

Other Activities. Other related activities in the state include participation in the Federal/state fuel dyeing and fuel tax evasion compliance project and efforts to move toward uniformity of IFTA forms and procedures with other states.

Symposium on Transportation and Economic Development in the Upper Midwest

Minnesota, along with Iowa, Montana, North Dakota, and South Dakota, participated in a research symposium in October 1992 that focused on transportation and economic development issues affecting the upper Midwest states. The symposium generated two broad conclusions: (1) strategic investment in efficient transportation systems leads to productive returns and (2) the greatest barriers to productivity are institutional and political. Specific recommendations from the symposium related to alternative forms of taxation are described below.

Arguments for Efficiency in Pricing and Investments. Current methods of financing transportation infrastructure do not adequately reflect the economic costs of highway users' use of the system. "More efficient pricing should result in (1) users being charged amounts according to the benefits they receive, (2) selection of transportation alternatives that reduce congestion, and (3) governments receiving additional revenues to invest in improvements in the efficiency of the system." Congestion pricing is one method proposed to achieve efficiency in pricing; however, careful planning is required before any new pricing strategy can be implemented. The examination of how users respond to pricing as a part of economic efficiency analysis will provide better information to transportation planners and policy makers.

ITS Transparent Borders and Multiregional Permit and Licensing System. The technology necessary to implement a transparent border system currently exists but the most difficult barriers are institutional problems related to the inability of states to cooperate on interjurisdictional and multijurisdictional motor-carrier regulations. ITS technology could be used to create a system of transparent borders and a more user-friendly permit system that would create a less burdensome regulatory environment for the motor-carrier industry. Compliance costs could be reduced by implementing a "one-stop-shopping" method where truckers would apply for all necessary permits at one service-oriented location.

State Advisory Council on Major Transportation Projects

In 1994, Minnesota established a State Advisory Council on Major Transportation Projects to provide input and advice to the Legislature on financing of projects. The Council was responsible for providing recommendations on identifying projects and evaluating various methods of financing. Several of the findings and recommendations from the final report provide important information on alternative taxation methods and the effects of these methods.

Recommendation for Implementing Road Pricing by the Year 2000. The Council recommended that the state should implement a system of road pricing which offers the potential to raise money for funding major transportation projects that cannot be funded by other methods. The most common form of road pricing is through toll collection at plazas, but new technology could allow for electronic collection of tolls. Road prices should attempt to recover the associated cost to the system of each class of vehicle and to encourage the use of public transportation and HOVs.

Criteria and Evaluation of a Wide Range of Finance Alternatives. The Council used a systematic method of evaluating funding alternatives which involved several criteria and weighting of the criteria to produce an overall evaluation. A wide range of potential revenue sources were considered including fuel-based revenue sources, vehicle-based revenue sources (e.g., license taxes, weight-distance tax, mileage tax), general sales taxes, property-based revenue sources, and highway-based revenue sources (e.g., toll financing and road pricing). Evaluation criteria identified by the Council were categorized as financial, economic, political/legal, social/environmental, and other. A brief description of measures under each category is provided below.

- Financial criteria included revenue yield, revenue certainty, administrative efficiency, state finance (effect on state general funds), and local finance (effect on finance of local governments);
- Economic criteria included equity among transportation users, progressivity (ability of people to pay), and transportation efficiency (promote the efficient use of the transportation system);
- Political/legal criteria included public acceptability and constitutional status (potential conflicts with constitutional restrictions);
- Social/environmental criteria included travel behavior, environmental effects, development (effects on development patterns in metropolitan areas), and energy consumption; and
- Other criteria included experience Minnesota and other states have had with that type of revenue source.

Table 16 presents selected results of the transportation financing alternatives evaluated. The grading scale used five ranks (++ best, + good, 0 average, – not good, and – – worst). Each criterion was assigned a weighting factor that was used to identify the most suitable alternative methods of financing.

Oregon

Oregon has prepared several papers and reports relating to heavy vehicle taxation issues:

- "Long-Range Transportation Finance Issues and Opportunities"—an August 1995 discussion paper prepared by the Oregon DOT for the Transportation Commission;
- A technical background report with the same title, date, and authorship, intended as a companion document for the discussion paper;
- "The Oregon Weight-Mile Tax Study"—a February 1996 report on a comprehensive study of all major issues relating to Oregon's weight-distance tax; and
- "Diesel Fuel Fee Noncompliance"—a March 1996 report on a study of the possible diesel tax evasion if Oregon were to enact such a tax to replace part or all of the weight-distance tax.

Long-Range Transportation Finance Issues and Opportunities

This paper was prepared by the Oregon Department of Transportation (ODOT) to address issues arising in future transportation financing and to generate further discussion of issues and opportunities. Three significant themes are in the paper:

1. Pricing as a fundamental premise of long-range transportation finance solutions.
2. Benefits received as a determinant of responsibility for supporting transportation when users cannot be directly charged.

TABLE 16 Selected results of Minnesota transportation financing alternatives evaluation

Finance Alternative	Revenue Yield	Public Acceptability	Ease of Administration	Equity	Sensitivity to Inflation	Progressivity	Effects on Travel Behavior
1. Gas Tax Increase	++ Each 1cent = $24 mill.	+ Previous inc. accepted, but larger ones phased in	++ Mechanism already exists	+ Generally related to highway use but not to cost imposed	--	-- Unrelated to ability to pay	-- Very large increases needed to have effect
2. Sales Tax Extended to Motor Fuel	++ Potentially $180 mill.	- Substantial immediate increase	+ Mechanism already exists; some adjustment needed	+ Generally related to highway use	++	-- Unrelated to ability to pay	- Only effect likely to be temporary
3. Indexed Fuel Tax	+ 3% inflation rate = $15 mill.	+ Same as for gas tax unless rate goes up rapidly	++ Mechanism already exists	+ Same as for gas tax	++	-- Unrelated to ability to pay	-- Annual increases not large enough to have effect
4. 10% License Tax Surcharge	+ $35 mill.	- Immediately noticeable	++ Mechanism already exists	- Auto taxes not related to use or cost imposed	+ Auto tax sensitive to inflation, others not	+ Somewhat progressive for autos, not for other vehicles	-- Unlikely to have any effect
5. Motor Vehicle Excise Tax	++ 25% share = $80 mill.	++ Has been popular option in past	++ Mechanism already exists	-- Unrelated to use or cost	++	+ Price-based	-- Unlikely to have any effect
6. 0.5% Statewide Sales Tax	++ $194 mill.	- Immediately noticeable	++ Mechanism already exists	-- Unrelated to use or cost	++	+ Related to price, exemptions reduce regressivity	- May encourage driving by shift of cost away from drivers
7. Sales Tax on Vehicle Repair Labor	+ $55-60 mill.	+ Most people may think it already applies	+ System in place already, minor adjustments needed	-- No relation to use or cost imposed	++	-- May fall heaviest on older vehicles	-- Unlikely to have any effect
8. Metro Sales Tax	++ 1% = $250 mill.	+ May be complaints regional discrimination	++ Mechanism already exists	-- No relation to use or cost imposed	++	+ Related to price, exemptions reduce regressivity	- May encourage driving by shift of cost away from drivers
9. Road Pricing	++ Can be set at any level market will bear	0 Untested; Much would depend on rate structure	-- Complex new system needed	++ Potentially near perfect relation to cost and use	+ If indexed to costs or price	-- Unrelated to ability to pay	++ Potential for extensive change in driving behavior
10. Transportation Benefit Districts	+ Depending on extent of district and benefits	+ May be perceived as equitable	-- New system needed	+ Unrelated use but relates to benefits	+ If benefits periodically reviewed	+ Related to ability to pay only by being value-related	-- Unlikely to have any effect

Source: State Advisory Council on Major Transportation Projects, *Final Report*, St. Paul, Minnesota, 1994.

3. The role of technology in meeting transportation needs and applying pricing solutions.

Much of the discussion about future transportation funding options revolves around the need to price facilities appropriately while providing subsidies needed to support environment, land use, and social goals. These and other key concepts were stated in the Oregon Transportation Plan. Highways and transit have many of the characteristics of public utilities. Both serve a set of fairly distinct customers through a combination of infrastructure and services. When the customers are clearly identified and the variable and fixed costs of serving these customers are sorted out, some interesting conclusions about future financing emerge.

Advances in technology provide the prospect of high-mileage, nearly pollution-free automobiles, intelligent automated road and transit systems, and faster, more efficient movement of freight using combinations of trucks, railroads, waterways, and aircraft.

Two technological advances have the potential to redefine transportation finance policy. First, motor vehicles will continue to improve fuel efficiency until the fuel tax is no longer the primary source of road funding. Meanwhile, the technology needed to charge mileage fees directly to road users is available, but has not been implemented.

Improved fuel efficiency also will substantially reduce potential air pollution problems. Public concern will shift from environmental issues to congestion and land use.

The alternative financing strategies listed below derive from considering long-term factors affecting needs and analyzing key concepts of utility pricing and cost responsibility. They are not recommendations per se, but are logical extensions of the expanded use of pricing and recognition of responsibility of users and non-users to support systems from which they benefit. They deserve further consideration in crafting an effective strategy for the next 20 years.

Three issues must be addressed before implementation of any of these strategies:

1. Collection and distribution mechanisms,
2. Revenue levels required to fill funding gaps, and
3. Public acceptance.

The alternative financing strategies discussed in the Oregon paper include the following:

Mileage Fees: Over the next 20 years it may be necessary to replace the gas tax with mileage fees on motor vehicles.

Weight-Mile Tax Alternatives: Because of perceived administrative and enforcement problems, serious attention should be given to identifying alternatives to the commercial weight-mile tax. A workable alternative would meet heavy vehicles' share of cost responsibility, reduce truck company compliance costs, and allow more revenue to reach the highway fund by reducing evasion. An alternative, for instance, is a single, registered ton-mile rate paid on a fleet basis, with prorated registration payments.

Variable Mileage Fees: As mileage fees are introduced, the possibility of charging different fees depending on the geographic area and road system should be considered.

Toll Facilities: Toll facilities should be the highest priority consideration for financing new facilities to solve congestion problems.

Congestion Pricing: Applying congestion pricing to roads in any comprehensive way depends on creating a situation in which road users paying the fees feel they get a benefit they would not otherwise receive.

System Access Fees: When they are first titled, vehicles could be charged a one-time fee to help compensate for new costs created by growth in system use.

Land Access Fees: Property owners desiring new access to arterial roads should be charged a fee that reflects the increased cost to the system or the increased property value the access will generate.

Utility Fees: Some local areas use utility fees to finance road maintenance and improvements. This concept could be expanded to include transit as well.

Public/Private Partnerships: Public/private partnerships can be used to finance and to take advantage of the private sector's ability to profit from increased land values that result from new projects, particularly land around rail transit stations and freeway interchanges.

Transportation Infrastructure Bank: This concept combines public, private, state, local, and Federal resources to create a flexible funding source for infrastructure projects.

Social and Environmental Costs: The new alternative sources could provide for the mitigation of social and environmental costs or compensation of injured parties.

Linking Planning and Finance: More closely linking project planning and financing achieves the aims of least-cost planning.

Dedicated Funding Sources: Alternative funding sources could provide the needed flexibility to overcome the inflexibility created by existing dedicated funding sources.

The above alternative strategies are expected to be evaluated and implemented over the next 20 years. There are several steps, however, that can be taken immediately:

Automate the road system: Introduce computer, navigation, and telecommunication technologies known as ITS.

Take advantage of incremental opportunities: such opportunities include tollway legislation passed by the 1995 Legislature and a Federal grant to evaluate the potential for congestion pricing in the Portland area.

Re-examine transportation needs: In view of the Legislature's reluctance to approve additional transportation funding, a consensus process on new transportation finance needs to be developed.

Undertake new cost responsibility analysis for roads and transit: Many questions about benefits and responsibilities remain unanswered.

Form new stakeholder consensus process: Six groups of stakeholders in Oregon's transportation system should be considered in developing a new consensus on transportation financing:

- Users,
- Providers,
- General public,
- Governor,
- Legislature, and
- Business community.

The technical background companion document provides technical supporting material under the following headings:

Transportation Revenues and Disbursements

Current Situation: Constrained Funding

A. Revenue Forecasts
B. Met and Unmet Needs

History and Philosophy of Transportation Funding in Oregon

Transportation Trends and Prospects

Key Issues
A. Cost Responsibility
B. Weight-Mile Tax Issues
C. Fuel Tax Substitutes
D. Environmental and Social Costs
E. User and Non-User Fees
F. Congestion Pricing
G. Public/Private Partnerships
H. Industry Competitiveness
I. Equity

Revenue Options

A. Public Finance Criteria
B. Revenue Assessment

Oregon Weight-Mile Tax Study[8]

The Weight-Mile Tax (WMT) Study was requested by the Oregon Legislature to investigate various issues that have been raised regarding the WMT and its impacts. The study was conducted as a cooperative effort of the Legislative Revenue Office, the Oregon Department of Transportation, and the Oregon Public Utilities Commission, under the guidance of a Technical Advisory Committee composed of representatives of various groups with direct interest in the WMT. The principal issues addressed by the WMT Study were:

- Evasion of the WMT,
- The cost to Oregon for administering the WMT,
- The cost of compliance to the motor carrier industry, and
- The economic impacts of the tax.

Oregon has been a leader on a national and worldwide basis in developing a tax structure that closely matches cost responsibility and follows principles of equity. The cost responsibility studies conducted by the Oregon Department of Transportation in 1937, 1947, 1963, 1974, 1980, 1984, 1986, 1990, 1992, and 1994 have resulted in continuing refinement of estimates of cost responsibility for Oregon highway programs and continuing refinement of the tax structure based on the equity principles. Because of adherence to these principles, Oregon collects a higher share (about 33 percent) of its total highway revenue from a usage tax (i.e., the WMT) than any other state.

The total estimated cost of administering the WMT for the 1993–1995 biennium is $18.7 million, including all costs of collection, auditing, and enforcement, and all associated overhead and support costs. This estimate is 4.8 percent of the total WMT revenue of $391 million for the biennium. The costs of complying with the WMT may represent a large burden to some carriers, and the WMT probably presents at least a slightly greater burden to most carriers than would a diesel fuel tax. Overall average compliance costs are estimated to be approximately 5.7 percent of actual WMT payment based on a survey of a cross-section of carriers. Improvements to the reporting systems are possible, but considering the specific information required under the WMT, large reductions in compliance costs are not possible for most carriers. Compliance costs for many carriers will be reduced in the future due to the increased use of onboard computers. Compliance costs could be reduced somewhat for some interstate carriers if all of the six weight-distance tax states participated in a base state system similar to IFTA and IRP.

Evasion of the WMT has been a major issue raised by the motor carrier industry, which cites evasion rates of over 30 percent in some other states for similar types of taxes.

[8] This subsection has been copied verbatim from the abstract of the report referenced above.

The analysis of all aspects of evasion of the WMT results in an estimate that it is about five percent of total tax liability. This estimate of evasion of the WMT is a result of a comprehensive series of analyses of all aspects of evasion. The evasion estimate is based primarily on analyses of four basic sets of field data collected by ODOT staff during the summer, fall, and winter of 1994–1995 as part of this study. These included a set of data collected to provide substantial refinements in estimates of travel on Oregon highways for all vehicle classes, to provide a more accurate comparison with mileage reported for the WMT. Another major data collection effort involved about 35,000 statewide observations of trucks and recording of their license plate numbers, as input to a special auditing process used to assess evasion of the WMT. Other field data collection efforts focused on specific types of evasion, such as night operations, overweight operations near an urban terminal, and bypassing of weigh stations and ports of entry.

An analysis of truck taxes and fees in twelve western states found that Oregon's taxes were the highest for a typical 250-mile trip by a typical tractor trailer registered at 80,000 pounds. A corresponding analysis of truck taxes and fees in those twelve western states for a typical smaller truck (a flat bed truck registered at 40,000 pounds.) traveling fewer miles (15,000 miles/year) found that Oregon truck taxes and fees fall below the average of the twelve states, ranking seventh highest of the twelve states. This significant difference in ranking is due to the fact that the Oregon WMT structure is based primarily on mileage-related taxes and that WMT rates for heavy vehicles increase with weight at a greater rate than diesel tax payments per mile.

The study found that the Oregon truck tax structure is one of the most equitable in the country for intrastate carriers in terms of its impact on competition with interstate carriers. This is true for two basic reasons: (1) intrastate carriers travel far fewer average miles per year than interstate carriers, in some cases only 10 to 20 percent as many miles and (2) Oregon's truck tax structure has one of the lowest ratios of fixed-rate-to-mileage-related taxes of any state, primarily because of the very low registration fee ($320 for an 80,000 pound combination). Therefore, on a cents per mile basis, intrastate carriers and all low mileage trucks pay only a very slight amount more than interstate carriers and all high mileage trucks. Most other states have much higher flat fees (registration fees, weight fees, ad valorem taxes, or other fees not related to vehicle use), and therefore put intrastate carriers and all low mileage vehicles at a disadvantage with significantly higher taxes per mile.

The study concluded that Oregon PUC's audit process is very well organized and administered and is highly productive and cost effective. However, the study has led to findings that major improvements can, and should be made to the current system of tax reporting, administration, and enforcement of the WMT. Several improvements could be implemented to reduce WMT evasion, while decreasing the costs borne by carriers and taxpayers, including:

- Collect traffic data through existing programs in a manner designed to more accurately monitor truck travel and WMT evasion.
- Use ODOT's "Green Light" program technologies to optimize the reduction of evasion on the basis of the WMT evasion patterns uncovered in this study.
- Develop a management information system to monitor progress in reducing evasion and assess the benefits of various options for additional audit efforts to recover WMT revenue.

A review of the PUC audit and enforcement program suggests that a substantially higher level of effort in monitoring and enforcement would be able to reduce evasion significantly and more than pay for any added costs of the new program.

Diesel Tax Evasion Study

The final report of the Oregon Diesel Fee Noncompliance Study documents the findings and conclusions of an investigation of potential diesel fuel fee noncompliance under alternative potential Oregon fuel tax scenarios.

Oregon's current user fee system relies heavily upon a weight-distance tax to ensure equity among various types of vehicles and does not even collect a fuel fee from heavy vehicles. It was found that alternative user fee systems that include a diesel fee of some form could maintain equity only if they continued to include a weight-distance tax. Any combination of diesel fees and registration fees without a weight-distance tax would seriously compromise equity. Nonetheless, this study examined scenarios in which a diesel tax would replace some or all of the weight-distance tax. This might involve a diesel tax more than double that of any other state in order to raise an equivalent amount of revenue.

The report found that diesel taxes have the lowest compliance rates of any form of highway user fees. Evasion strategies have taken many forms and have adapted to changes in regulations intended to increase compliance rates. Besides the evasion of individual highway users, which exists to a minor degree for every form of highway user fee, diesel fee evasion schemes have involved distributors, wholesalers, transporters, and retailers. Significant opportunities for evasion of state-level user fees continue to exist despite recent changes in Federal regulations.

A comparison of reported diesel fuel use with estimates of diesel fuel consumption based on state truck travel estimates indicated a national noncompliance rate of just more than 30 percent. After adjusting estimated diesel consumption based on best available data and careful analysis of truck VMT, the report reduced this estimate of the national noncompliance rate to about 21 percent. Some states, however, report collections of only half the fees that their truck travel indicates they should collect, while others report more collections than their truck travel indicates. States around Oregon collect a somewhat lower proportion than the national average.

Recent changes in regulations at the Federal level have greatly increased Federal diesel fee collections but appear to have had little effect on state diesel fee collections. In fact,

the Federal government now collects diesel taxes on about the same number of gallons as the states, while previously they successfully collected taxes on a much lower number of gallons.

Diesel fees require considerable administrative and enforcement efforts for successful collection. While the level of administrative and enforcement effort almost axiomatically affects the expected compliance rate, other, more easily quantifiable factors can explain most of the difference in compliance rates among states.

A regression model produced in this study identified several descriptive characteristics of a state that affect compliance rates. The most important characteristics seem to be (1) whether or not a state is a coastal or border state, (2) the diesel tax rates of nearby states and the proximities of their population centers, (3) the intensity of truck ownership and usage within a state, and (4) the relative rates of other truck taxes within a state. Together, these characteristics can explain three-fourths of the variation in compliance rates among states.

The state's recommended noncompliance model suggests that a 24-cent diesel tax, implemented with normal enforcement efforts and assuming no change in diesel tax rates in surrounding states, would result in a noncompliance rate of 24 percent. Extra enforcement (beyond typical state programs) could reduce this noncompliance rate to some degree, but the study was not able to quantify the relationship between enforcement effort and noncompliance rate.

Noncompliance rates would increase with diesel tax rates greater than 24 cents per gallon. Collected diesel tax receipts would decay rapidly, so that a 30-cent diesel fee would result in about a 33 percent noncompliance rate, a 48-cent fee would result in about a 55 percent noncompliance rate, and a 70-cent fee would result in about a 74 percent noncompliance rate. Given the current diesel tax rates of Oregon's bordering states, maximum yields would probably occur at a tax rate of approximately 45 cents per gallon, with higher rates resulting in such a high level of noncompliance that total revenues to the state would probably decline.

Because no precedents exist for diesel tax rates as high as Oregon might possibly consider to maintain revenue neutrality, the model's reliability decreases as hypothetical rates rise. Based on the experience of some states, however, the study concluded that diesel tax rates much higher than surrounding states would probably result in very high levels of noncompliance.

South Carolina

The South Carolina Department of Revenue prepared a December 1994 "Trucking Quality Team Report," which presents the Team's findings after exploring various alternative measures aimed at the reduction of the burden of compliance for commercial vehicles. The Team was established after all tax-related commercial vehicle functions were to be consolidated in a new Division of Commercial Vehicle Services.

An overriding objective, according to the Team's report, should be a reduction in the number of permits, plates, stickers, decals, and so forth, that are required to operate a commercial vehicle in a state. One first step might be a single color-coded IRP/IFTA sticker, which would be prominently placed on a vehicle where it could be checked while the vehicle was in motion. The elimination of fuel decals for intrastate trucking should also be a high priority.

Fuel taxes should be levied at the terminal rack, and exemptions should be eliminated. Fuel reporting for intrastate trucks should be eliminated. Highway-use tax reporting as required under IFTA should be repealed. There should also be 100 percent reciprocity for all fuel taxation including all special fuels.

"One-stop-shop" truck registration would offer substantial savings to both government and motor carriers. For example, the Department of Revenue could collect all appropriate taxes, fees, and charges at one location, and then remit the appropriate amounts to other agencies that currently maintain parallel, overlapping auditing and enforcement systems.

Sample forms and a diagrammatic depiction of the proposed streamlined accreditation and tax-collection process are included as appendixes.

Virginia

Virginia has recently addressed two areas related to taxation of heavy vehicles, fuel tax evasion and truck avoidance of weigh stations. The principal findings from these studies are summarized below.

Report of Governor's Task Force on Fuel Tax Evasion

In 1992, the Governor established a task force on fuel tax evasion to address weaknesses in existing fuel tax statutes. The task force held meetings with interested parties and work sessions with state agency and industry representatives and also reviewed current administrative processes. Key points covered in the study are summarized below.

Fuel Tax Evasion Schemes and Options for Controlling Evasion. The study identified typical schemes for evading fuel taxes which included failure to file information, reports, or returns; filing false information; falsely claiming a tax exemption; and failure to pay taxes that have been assessed. The most effective strategies that have been used by states to control evasion include monitoring fuel transfer information, bonding and licensing of fuel tax payers, raising the point of taxation to a higher level in the distribution chain, additional field checks and auditing, intergovernmental cooperation, and increasing fines or penalties.

"Operation Total Commitment." In 1992, the Virginia DMV led a multijurisdictional operation to coordinate an intensive program of enforcement activities for fuel tax evasion among state agencies. Prior to the initiation of Operation Total Commitment, DMV investigators uncovered and videotaped clear examples of fuel tax evasion of home heating oil deliveries. The operation combined efforts among DMV investigators, State Police, Department of Taxation, and DOT. A month after the initial meeting of the operation, coordinated raids were conducted in Virginia and New Jersey resulting in seven truck stops/service stations being closed down and arrests of individuals. Estimates of the unpaid fuel taxes and penalties resulting from the operation were more than $700,000.

Survey of Other States' Practices. As part of the Virginia study, a survey was conducted of practices in surrounding states that were identified as having recently taken initiatives to address fuel tax evasion. Thirteen states were surveyed and 12 states responded to the questionnaire. On the issue of civil and criminal penalties for fuel tax evasion, six states had stronger civil penalties than Virginia, and all but one had stronger criminal penalties. Other topics covered by the survey included point of taxation, bonding requirements, and tax payment period.

Budget and Revenue Impacts of Recommendations. The task force developed six broad categories of recommendations that called for strengthening of licensing, reporting and record keeping requirements; increasing penalties; and expanding enforcement activities. The additional measures would require 15 extra positions at a cost of $1.1 million for the first year and $0.8 million each subsequent year. A conservative estimate of the anticipated revenues expected from the added enforcement is $1.6 million for the first year and $3.3 million for subsequent years.

The Avoidance of Weigh Stations in Virginia by Overweight Trucks

In 1992, Virginia performed a study on avoidance of weigh stations by overweight trucks to determine the magnitude of overweight truck activity on specific routes. Trucks avoid weigh stations by either taking an alternative route or waiting at truck stops or rest areas until the weigh station is closed. To analyze both types of weigh station avoidance, data were collected from weigh stations and WIM devices placed on bypass routes around the stations. Data were collected for 48 hours in both directions and analyzed using concurrent main line and bypass recordings.

Summary of Findings. Results of the analysis from two weigh stations located on I-81 found that between 11 and 14 percent of the trucks using bypass routes around the stations were overweight. Findings from other locations indicated a range of 12 to 27 percent of overweight trucks. At a particular station, 50 percent of the trucks that traveled past a weigh station because the entrance lane to the station was filled with a queue of trucks were found to be overweight, indicating a need to increase capacity at weigh stations.

Weigh Station Avoidance Because of Tax Evasion. Avoidance of weigh stations may be a form of tax evasion by (a) failure to pay registration and related fees required to operate at that weight, (b) failure to pay permit fees required to operate over regular weight limits, or (c) intent to report fewer miles than actual miles operated in the state for registration fees, fuel taxes, and mileage taxes. Perhaps the most common reason that trucks avoid weigh stations is because they are traveling overweight or have safety violations; however, the other forms of tax evasion may be factors in weigh station avoidance. Although the Virginia study did not address the reasons trucks avoid weigh stations, studies performed by other states have examined this issue. The Wisconsin DOT conducted a truck avoidance study in 1989[9] which found that 59 percent of vehicles that avoided scales had weight or safety violations, 28 percent had driver or registration violations, and 13 percent had no violation, indicating that they may be avoiding scales because of tax evasion. Oregon's Weight-Mile Tax Study[10] also addressed the issue of truck tax evasion through inspections of trucks stopped at random hours and locations along potential bypass routes and found that out of total truck traffic 0.3 percent were traveling without a PUC permit, indicating evasion of the weight-mile tax. The study estimated that the percentage of tax evaded by trucks traveling overweight or traveling without a PUC permit was approximately 0.5 percent of the total weight-mile tax due to be paid. Other forms of tax evasion by trucks using bypass routes were estimated to be more important, adding to a total of about 5 percent, with an overall error tolerance of plus or minus 2.5 percent.

SUMMARY OF THE EQUITY OF HEAVY VEHICLE TAX STRUCTURES

This section provides an overview of the equity of Federal and state highway user tax structures studies, with emphasis on heavy vehicle taxes in relation to their cost responsibility.

As described in Chapter 6 of this report, equity is recognized as just one of several criteria for good tax structures in most of the more comprehensive highway tax studies. However, it is the one criterion that has been used as the primary criterion in the vast majority of studies of Federal and state tax systems. The only other criterion that has received substantial attention in these studies is the economic efficiency

[9] Wisconsin DOT; *Truck Avoidance of Enforcement Scales*: Field Study Results from a Combined Enforcement/Planning Perspective; U.S. DOT; April 1989.

[10] Oregon Legislative Review Office; *Oregon Weight-Mile Tax Study;* prepared by Cambridge Systematics, SYDEC, Inc., and Pacific Rim Resources; February 1996.

criterion,[11] which was given secondary attention in the 1982 *Final Report on the Federal Highway Cost Allocation Study* and will be given somewhat more attention in the 1996 Federal HCAS report. Both Federal studies, however, have emphasized the similarities in the applications of these two criteria, despite substantial differences in the conceptual bases for the two criteria.

The vast majority of Federal and state tax studies have implemented the equity criterion by allocating the costs of highway programs among user classes based on estimated costs associated with their use of the highway system. These are usually referred to as cost allocation studies, but are also known as cost responsibility or cost-occasioned studies.

An alternative equity criterion, based on benefits of highway programs to user classes, was seriously considered at the Federal level during the 1950s and 1960s but never implemented because of the difficulties of estimating non-user benefits (such as economies of scale resulting from enlarged markets) and shortcomings of data on both user and non-user benefits.

Within the scope of the Federal and state cost allocation studies actually performed, there exists a great deal of consistency of methods at the general level, particularly among the more carefully done studies. Nonetheless, there are significant variations in methods among these studies, and some changes in methods over time need to be recognized, as discussed briefly below.

Results of Federal Studies

Table 17 summarizes the key findings from three early (1965, 1969, and 1975) Federal HCASs for selected vehicle classes. In this table and the tables that follow, the focus is on achieving equity ratios (revenue-to-cost-responsibility ratios) as close to 1.0 as feasible.

The conclusions from Table 17 are that (a) automobiles were paying their fair share of revenues in the earliest study, but were slightly underpaying after an excise tax on new auto sales was reduced and then repealed; (b) single-unit trucks were overpaying throughout the period, and heavier single-unit trucks were overpaying substantially; and (c) heavier combination trucks went from substantially underpaying to slightly underpaying as revenue from excise taxes on sales of new trucks and parts rose with rapidly rising prices, and as Federal spending began to shift from the Interstate system to other highways with lower proportions of heavy combination trucks.

[11] The economic efficiency criterion requires that highway user fees be equal to marginal costs associated with the use of highways by each vehicle to achieve the most efficient use of highways by all users. It is the criterion most emphasized by economists as being necessary for an efficient economy.

As indicated in Table 17, the early Federal HCASs had all used the "incremental method" for allocating shares of program expenditures. This method involved a detailed analysis of the cost of accommodating incrementally heavier and larger vehicles on every part of the highway system and an allocation of the cost of accommodating each increment based on the VMT of each vehicle class in each weight or size class. This method, which was actually a set of several procedures for allocating each major component of program costs, had been developed principally to allocate costs of new construction, which was the focus of most Federal aid expenditures through that period.

Beginning with the report referenced in Table 17, however, a 4-year multimillion dollar Federal HCAS was initiated, resulting in the development of a new "Federal method," which is described in detail in the 1982 report to Congress. The principal findings of that report are summarized in Table 18. This new Federal method made many refinements to the incremental method, making use of new research findings and better reflecting actual program practices; however, in practical terms, it was essentially a refined version of the older method except for three new procedures:

- New pavement construction costs are allocated based on the latest AASHTO design procedures. This has the effect of eliminating an economy of scale benefit for vehicles with heavier axle loads in the incremental method, thereby increasing the cost responsibility of vehicles with heavier axle loads.
- Pavement rehabilitation costs are allocated based on a set of statistical models of pavement deterioration developed from a major field test performed in the early 1960s. This set of models, which gave rise to the term "consumption method," was the most important change in the new Federal method in terms of shifting cost responsibility to heavy axle loads, because of the large shift that was occurring in Federal funding for rehabilitation and related projects, and because these models result in allocating much higher shares of cost responsibility to vehicles with heavier axle loads than does the previously used pavement cost allocation procedure in the incremental method.
- Bridge replacement costs are allocated in part based on the reasons bridges have to be replaced. This has the effect of shifting some cost responsibility to heavy vehicles for bridges that have to be replaced because of loss of load-carrying capacity.

These changes in cost allocation methods have been controversial because of their consequences but have become generally accepted by practicing professionals over the last 15 years. The debate will continue over many aspects of

TABLE 17 Summary of results of early federal highway cost allocation studies for selected vehicle classes

	Ratio of Highway Trust Fund Tax Payments to Cost Responsibility by Incremental Method		
	1965	1969	1975
Automobiles	1.0	0.9	0.9
Single-Unit Trucks			
2-axle, 4 tires	1.7	1.7	1.1
2-axle, 6 tires	1.5	1.8	1.8
3-axle	1.6	1.8	1.9
Combinations			
3-axle	1.0	1.1	2.2
4-axle	0.8	0.8	1.3
5 or more axles		0.5	0.9

Source: Congressional Budget Office, *Who Pays for Highways: Is a New Study of Highway Cost Allocation Needed?,* 1978, summarized from Table A-7, p. 72.

these methods, but the general tendency will probably be to refine the procedures used in the Federal method. That is generally what is occurring in the current Federal HCAS.

The results shown in Table 18 can be compared with the earlier Federal HCAS shown in Table 17. With the new Federal method and with Federal expenditures shifting to resurfacing, rehabilitation, reconstruction, and replacement, the 1982 Federal HCAS report showed the following:

- Autos as a whole had been overpaying slightly, but were expected to just meet their cost responsibility in the short term (1985).

TABLE 18 Summary results of 1982 federal highway cost allocation study

	Ratios of User Charges to Allocated Costs by Vehicle Class under Current User Charge Structure	
	1977	1985
Autos	(1.1)	(1.0)
Large	1.2	1.2
Small	0.7	0.7
Motorcycles	0.5	0.6
Buses	(0.5)	(0)
Intercity	1.2	0.2
Other	0.3	0
Pickups/vans	1.2	1.1
Total Passenger Vehicles	(1.1)	(1.0)
Other Single-Unit Trucks	(1.5)	(2.0)
Less than 26,000 GVW	1.3	1.7
Greater than 26,000 GVW	1.7	2.2
Combination Trucks	(0.6)	(0.8)
Less than 50,000 GVW	0.8	1.2
50,000-70,000 GVW	0.9	1.3
70,000-75,000 GVW	0.6	0.8
Greater than 75,000 GVW	0.5	0.6
Total Trucks	(0.8)	(1.0)
All Vehicles	1.0	1.0

Source: FHWA, *Final Report on the Federal Highway Cost Allocation Study,* Report to Congress, 1982, Table I-7, p. I-13.

Note: Numbers in parentheses are the overall ratios for the categories.

- Single-unit trucks were expected to be overpaying by an increasing percentage.
- Heavy combination trucks were substantially underpaying and were expected to continue to underpay substantially in 1985, particularly the heaviest class, over 75,000 lb GVW.

The only major Federal HCAS published between the benchmark 1982 report and the 1997 report was the 1988 *Heavy Vehicle Cost Responsibility Study* report, the results of which are summarized in Table 19. Note that, despite the caveat in the table's footnote, the results are fairly similar to the 1985 estimates in the 1982 report for combinations that can be compared in approximate terms (e.g., an equity ratio of 1.3 for 50,000- to 70,000-lb GVW combinations for 1985 vs. 1.38 and 1.34 for the same weight range for 5-axle semis and doubles respectively in the 1988 study; and a ratio of 0.8 for 70,000- to 75,000-lb GVW combinations for 1985 versus 0.86 and 0.79 for 70,000- to 80,000-lb 5-axle semis and doubles respectively in the 1988 study). The 1988 findings also showed that, for any given weight range, the equity ratios for combinations with more axles were substantially higher than those for combinations with fewer axles.

Table 20 shows the equity ratios developed in the *1997 Federal Highway Cost Allocation Study*. Separate sets of ratios are shown for Federal costs and user charges, costs and user charges for all states (as a group), costs and user charges for all local governments, and costs and user charges for all three levels of government combined. The table indicates that revenue received from all trucks as a class approximately equals their responsibility for all state-level costs but falls short of their responsibility for Federal and local costs. When distinctions are made by registered weight, the table indicates that vehicles with low registered weights generally overpay while vehicles with high registered weights generally underpay. The low equity ratios shown for local governments indicate that only about one-tenth of the expenditures of these governments on streets and roads are provided by highway users. Considering all levels of government, highway users underpay their cost responsibility by about 20 percent, primarily because of their low payments to local governments.

Results of State Studies

Some comparisons of the results of state HCASs have been made by individual states, and some of these comparisons are presented in the reports described in the previous section. These past comparisons have been limited to a few state studies, and most of the more recent studies have not been included.

Table 21 summarizes the results of the 23 state HCASs that are known to have been conducted since the 1982 Federal HCAS, excluding multiple studies in any given state. It shows which states have had heavy vehicle equity ratios in ranges of less than 0.60, between 0.60 and 0.80, between 0.80 and 1.00, and greater than 1.00. In all cases these ratios are shares of revenues divided by shares of cost responsibility for heavy vehicles. However, the definitions of "heavy vehicles" vary significantly among the studies, as do the methods used. Nonetheless, most of the studies used methods that are

TABLE 19 Summary results of 1988 heavy vehicle cost responsibility study

Weight Group (kips)	Ratio of Shares of User Fee Contributions to Shares of Highway Costs Occasioned by Trucks over 10,000 lb by Configuration and Operating Weight[1]					
	Tractor-semitrailers			Multiple Trailers		
	4 axles	5 axles	6 axles	5 axles	7 axles	9 axles
50-70	0.62	1.38	2.08	1.34	2.72	3.10
70-80	0.19	0.86	1.50	0.79	2.40	2.96
80-100	0.09	0.43	0.94	0.38	1.46	2.49
>100		0.13	0.42		0.89	1.30

[1]These ratios are not directly comparable to revenue/cost ratios developed in the 1982 HCAS. Ratios are based on relative shares of user fees and costs attributable to various weight groups, and only the user fees and highway costs attributable to trucks are considered in estimating shares attributable to each weight group. Furthermore, revenues and costs are based on operating weight distributions, not registered weight. The comparisons in this table of user fee and highway cost shares are strictly relative and do not indicate whether vehicles in particular weight groups pay the full costs occasioned by their operations. They do indicate, however, which weight groups pay the most user fees relative to the costs they occasion compared with vehicles in other weight groups.

Source: U.S. DOT, *Heavy Vehicle Cost Responsibility Study: Report to Congress,* 1988, Table V-1, p. V-7.

TABLE 20 Ratios of revenues to allocated costs by vehicle class for all levels of government

Vehicle Class/Registered Weight	Federal	State	Local	All Levels
Autos	0.9	1.0	0.1	0.7
Pickups/Vans	1.2	1.2	0.1	0.9
Buses	0.1	0.8	0.0	0.4
All Passenger Vehicles	1.0	1.0	0.1	0.8
Single-Unit Trucks				
≤ 25,000 lb	1.4	2.2	0.1	1.5
25,001 - 50,000 lb	0.6	1.0	0.0	0.6
> 50,000 lb	0.5	0.5	0.0	0.4
Total Single Unit	0.8	1.2	0.1	0.8
Combination Trucks				
≤50,000 lb	1.4	1.7	0.1	1.3
50,001 - 70,000 lb	1.0	1.3	0.1	0.9
70,001 - 75,000 lb	0.9	1.1	0.1	0.8
75,001 - 80,000 lb	0.9	0.9	0.1	0.8
>80,000 lb	0.6	1.0	0.0	0.7
All Combinations	0.9	1.0	0.1	0.8
All Trucks	0.9	1.0	0.1	0.8
All Vehicles	0.9	1.0	0.1	0.8

Source: FHWA, *1997 Federal Highway Cost Allocation Study*, August 1997, Table ES-5.

similar to the Federal studies, with some tendency for more recent studies to use refined procedures and to use procedures similar to the Federal method.

Table 21 shows that 16 state HCASs have found that heavy vehicles are underpaying and seven have found that they are overpaying. The reasons for the differences in the results are often complex and sometimes cannot be adequately derived from the available reports. Several of the states with low equity ratios are states which have low overall tax rates for heavy vehicles. Of the seven states where heavy vehicles were overpaying, four of them have weight-distance taxes (Arizona, Kentucky, Idaho, and Oregon); whereas only one state (Colorado) where heavy vehicles were underpaying had a weight-distance tax at the time of the study, but repealed the tax at about the time of the study or shortly afterward. Delaware's heavy vehicles were found to be overpaying the most in terms of the equity ratio for combinations; however, this can be attributed in large part to the

TABLE 21 Summary of results of recent state highway cost allocation studies regarding equity of tax structure for heavy vehicles

Revenue-to-Cost-Responsibility Ratio	State and Year of Study
<0.60	Maryland (1982), Colorado (1988), Georgia (1991), Texas (1995)
0.60 - 0.80	Connecticut (1982), Missouri (1984), Indiana (1988), Minnesota (1990), Nevada (1994)
0.80 - 1.00	Wisconsin (1982), North Carolina (1983), Kansas (1985), California (1987), Pennsylvania (1990), Vermont (1990), Virginia (1992)
>1.00	Maine (1989), Delaware (1992), Arizona (1992), Kentucky (1992), Montana (1992), Idaho (1994), Oregon (1995)

See text for discussion of important differences among studies.

Sources: Individual state study reports.

fact that these vehicles were credited with a large amount of trailer revenue from out-of-state-based trailers that register in Delaware because no annual registration or other fees have to be paid. A similar factor occurred in Maine.

High equity ratios for heavy vehicles in Maine, Delaware, and Montana can also be attributed, at least in part, to favorable procedures or assumptions used in the cost allocation process in comparison with other states. Because of careful monitoring of most of these studies by motor-carrier industry representatives, it is unlikely that procedures or assumptions unfavorable to heavy vehicles have been used in any of the studies that have been open to critical review by interested groups (which occurs in most state studies).

Most of the studies define user groups in a manner similar to the Federal HCASs, that is, by vehicle class (auto, bus, etc.) and by axle configuration; and a few of the more careful studies provide breakdowns of trucks by several registered weight ranges to provide a basis for adjusting graduated truck fees by registered weight. However, very few state HCASs provide breakdowns of vehicle classes by annual mileage or by industry groups that differ substantially in annual mileage or other aspects of operations that may affect their tax payments or cost responsibility.

One exception to this is Oregon, which has performed special analyses of the cost responsibility of firms operating in selected industries (e.g., logging and chip haulers) as a basis for setting special flat fees in lieu of weight-distance taxes. A few states have performed comparative analyses of equity ratios of intrastate vs. interstate operators. These analyses highlight the inequity to intrastate operators of a state's dependence on any fees that are not prorated (such as most ad valorem taxes) and the inequity of a state's dependence on any nonmileage-related fixed fees for trucks.

Table 22 shows selected results from the California HCAS which highlight the relative effects on equity of total annual mileage, percent of miles in state, and registered weight. Because California has a very high proportion of its truck taxes in nonmileage-related fixed fees, the equity ratios are

TABLE 22 Equity ratios for five-axle doubles with 50 percent and 100 percent of their mileage in California

Total Annual Mileage[2]	Equity Ratios with 50 Percent of Annual Mileage in California[1] – Federal Method					
	Registered Weight (in thousands of pounds)					
	55	60	65	70	75	80
20,000	3.24	2.93	2.60	2.25	2.00	1.71
40,000	2.06	1.85	1.64	1.41	1.25	1.06
60,000	1.62	1.46	1.29	1.11	0.98	0.83
80,000	1.40	1.26	1.11	0.95	0.84	0.71
100,000	1.25	1.13	1.00	0.86	0.76	0.64
120,000	1.16	1.04	0.92	0.79	0.70	0.59
140,000	1.09	0.98	0.87	0.75	0.66	0.56
160,000	1.04	0.94	0.83	0.71	0.63	0.53
180,000	1.00	0.90	0.80	0.68	0.60	0.51

Annual Mileage	Equity Ratios with 100 Percent of Annual Mileage in California[1] – Federal Method					
	Registered Weight (in thousands of pounds)					
	55	60	65	70	75	80
10,000	5.44	4.92	4.36	3.77	3.35	2.85
20,000	3.26	2.92	2.58	2.21	1.95	1.66
30,000	2.44	2.19	1.93	1.65	1.46	1.23
40,000	2.02	1.81	1.59	1.36	1.20	1.02
50,000	1.76	1.58	1.39	1.19	1.05	0.89
60,000	1.58	1.42	1.25	1.07	0.94	0.80
70,000	1.46	1.31	1.15	0.98	0.87	0.74
80,000	1.36	1.22	1.07	0.92	0.81	0.69
90,000	1.28	1.15	1.02	0.87	0.77	0.65

[1]Ratios are for state and local levels combined.

[2]Annual mileage in California is 50 percent of the values shown in this column.

Source: California Department of Transportation, *Highway Cost Allocation Study Technical Report,* July 1987, from Exhibit XII-29 (p. XII-38) and Exhibit XII-30 (p. XII-39).

quite sensitive to both total annual mileage and percent of miles in California. Within common ranges of these three variables for any given vehicle configuration, equity ratios vary most in California by annual mileage, next by registered weight, and least by percent of miles in California.

The studies differ substantially in terms of the scope of expenditure programs included. Some include Federal funds (e.g., Georgia, North Carolina, and Maine) in their analysis without separating out Federal and state programs. This can be expected to lower the resulting equity ratios for heavy vehicles because Federal funds tend to be concentrated on heavy truck routes. Only a few studies have provided separate analyses of equity ratios for all three levels of government (Arizona, California, Idaho, Minnesota, and Vermont), and another (Kentucky) has provided separate analyses for the state and Federal levels. Good arguments can be made for focusing attention on state revenues and state expenditures (including state aid to local governments), but the trend toward flexibility in the use of Federal aid argues strongly for providing a separate analysis of both state and Federal programs.

Many studies limit their analyses to the programs of the agency conducting the study, which tends to result in a focus on highway construction and maintenance and also tends to limit revenues to those that fund that agency. More comprehensive studies (e.g., Arizona, California, Idaho, Minnesota, and Vermont) include all highway-related programs and all highway user revenues. All other things being equal, including all highway-related programs increases user cost responsibility and decreases equity ratios, but including all user revenues in addition to those funding highway agency programs increases revenues credited to user classes and increases their equity ratio. The net result of enlarging the scope of the studies may tend to increase the relative equity ratios of heavy vehicles if no additional revenues are added or it may tend to decrease equity ratios if additional ad valorem revenues are added or if other revenues are added that are not weight related.

CHAPTER 3

INTERNATIONAL EXPERIENCE

To identify new or different ideas relating to heavy vehicle taxation, a review was conducted of tax systems in several other countries. This review involved examining the literature on international trucking fees, telephone and written contacts with knowledgeable professionals in state and Federal government in the United States, inquiries directed through foreign embassies in Washington, and by numerous contacts with referrals in the finance and transportation ministries of the countries involved. A telephone survey format was developed and administered in several cases where appropriate English-speaking officials could be contacted.

The results of the review of heavy vehicle taxation systems in other countries are presented in this chapter. The first section presents an overview of the systems used in Western Europe and the philosophy and effects of the harmonization effort currently being undertaken by the EU. This section also includes information about systems in Eastern Europe. The second section presents more detailed descriptions of the systems used in seven European countries (the United Kingdom, France, Germany, Sweden, Norway, Switzerland, and Austria), and in Japan, Australia, and New Zealand; and the third section lists the references used. The following are some of the more interesting findings:

- The harmonization effort undertaken by the EU is having a major effect on the heavy vehicle taxes used by the member states. The EU has set conditions under which several taxes can be imposed, including minimum and maximum rates.
- A recent EU proposal would require that motorway permit fees ("user charges") vary with road-damage class and emissions class. Three road-damage classes would be distinguished, based on axle configuration, GVW, and whether or not the vehicle has an air suspension. Motorway permit fees and tolls would not be allowed to exceed the cost of related infrastructure development, but additional surcharges could be imposed for use of congested or environmentally sensitive routes.
- EU states apparently do not have any tax regulations, such as apportionment or fuel tax reporting, that require information about distance traveled by jurisdiction. Sweden and Denmark have discontinued their weight-distance taxes because, as the only taxes that required odometer readings at border crossings, these taxes put their carriers at a competitive disadvantage with carriers from other states.
- New Zealand continues to use an axle-configuration weight-distance tax. Also, several countries in Eastern Europe apply weight-distance taxes (at least) to foreign vehicles, and the EU is considering such taxes for possible future implementation.
- Germany is exploring the use of electronic equipment for administering distance-based permit fees for the use of motorways. Such distance-based fees would replace the time-based motorway permit fees now used by several EU states.
- The United Kingdom has a relatively sophisticated system of registration fees that varies with axle configuration as well as with GVW.
- Motorways in France are built primarily by public-private partnerships and paid for by tolls. Tolls are set to discourage motorway use by private automobiles and to encourage use by heavy trucks.
- Western European countries generally collect substantially more revenue from highway users than is needed to build and maintain their road systems.

Most, but not all, of the information presented was obtained from knowledgeable sources and has been verified by secondary confirmation. Each country's approach has been outlined based on the information obtained. Special thanks are due to the embassy and ministry personnel of many countries and to the staff of multicountry organizations around the world for responding to the numerous and relatively specific inquiries needed to develop information for this report.

EUROPEAN TAX SYSTEMS

The U.S. system of heavy vehicle charges initially had a state-based orientation with full reciprocity between states, usually formalized into bilateral agreements. The state-based approach in the United States continued for automobiles; however, for trucks, this approach generally has been displaced by multistate compacts such as IRP and IFTA. These compacts operate by allocating truck charges (registration fees and fuel taxes) among the individual states in which the trucks operate, usually by proportionate mileage.

Europe and most other areas initially developed along similar lines, with each nation setting the fees for vehicles registered and operating within its borders. Fees set in this way follow what Europeans call the "nationality principle," where the charging system of the country is applicable to vehicles domiciled in that country, irrespective of where transport services are performed. European geography, however, is characterized by a major difference: Europe has a large number of small sovereign nations (many comparable in size to states in the United States).

Though any intergovernmental agreement is difficult, multinational agreements pose a higher hurdle than multistate cooperation in the United States. As a result, many charges continue to be levied on the basis of the sovereign territory where the truck is operating, in essence applying the charging system of that country. In Europe, this system, in which only limited reciprocity is granted, is called a "territoriality system" of charges.

All members of the EU rely on annual vehicle taxes and fuel excise duties, but the levels and structure of those taxes vary considerably. Further, there are a variety of other taxes used in the individual countries. Since the mid-1980s, this system has been evolving as a result of the EU open-border policies and major harmonization efforts, and several other European countries have become parties to cooperative agreements with the EU.

Most registration fees (called motor vehicle taxes in Europe) have been levied in the country of origin, and, in accordance with the nationality principle, vehicles have been given full reciprocity when traveling in most foreign countries. However, until recently, at least three Western European countries (Austria, Italy, and Switzerland) did not follow reciprocity for trucks and levied fixed charges on foreign vehicles.

Fuel taxes are paid when acquiring fuel, usually at the pump for individual truck operators. By their nature, fuel taxes are largely territorial, levied where the vehicle is operating and presumed to be causing costs. However, since distances across countries are relatively small in Europe, and the fuel tax is paid by users primarily at purchase points, fuel duties are not cleanly linked to territory of use. Trucks have been generally permitted to carry a full load of fuel in their tanks duty-free from one country to the next, weakening the linkage to the country of operation.

Tolls for bridges and motorways and truck permit fees ("user charges") are purely territorial charges.

Recent Survey of Road Taxation Systems

A survey was undertaken in early 1996 by the European Conference of Ministers of Transport (ECMT), an intergovernmental organization made up of the Transport Ministers of 31 European countries. Representatives of members of the Organization for Economic Cooperation and Development (OECD) including the U.S. are associates of the ECMT as well. This group encompasses but is much larger than the EU. The initial survey compilation, *Taxation of International Goods Transport by Road*, provides a complete and up-to-date overview of the European truck taxes and fees.

The survey responded to a 1995 resolution of the Council of Ministers in which top priority was given to fiscal arrangements and charging of roadway users as a problem area hampering commercial transactions and economic integration. The survey was initiated in December 1995. It was sent to all 31 ECMT countries, of which 21 replied. A few nonrespondent countries appear to have been categorized for certain charges based on information already available to ECMT.

Highlights of the ECMT Survey

Key findings of the ECMT survey that relate to truck taxes are summarized in the following bullets and then described below:

- Tax systems differ considerably between the various responding countries. Of the 27 countries that can be categorized by type of tax, the results are as follows:
  –27 countries have a diesel fuel tax,
  –25 countries have a registration fee (motor vehicle tax),
  –15 countries have significant permit fees, and
  –11 countries have substantial reliance on tolls.
  Table 27 shows schematically the various combinations of the four types of taxes used in the 27 countries.
- The registration fee (motor vehicle tax) is assessed using a variety of criteria. The most common criterion is permissible gross laden weight (GVW), but other factors including number of axles and emission levels are also used.
- All respondent countries have a diesel fuel tax and except for two Baltic States all have registration fees. The tax rates vary over a relatively wide range:
  –Annual registration fees range from U.S. $120 to $4,920, though the minimum fee in EU countries is $875 per year, and
  –Diesel fuel tax rates range from U.S. 11 cents per gallon to $2.46 per gallon.
- These differences mean, ultimately, that both territorial and national taxes vary considerably from one country to another.
- The tax burden has increased since 1990, but there continues to be considerable variation between countries.

All the EU member countries rely on collection of both motor vehicle and fuel taxes. Of the broader ECMT group, only Estonia and Lithuania do not show a registration/motor vehicle tax, though Lithuania reports a road usage fee that applies to all roads for both local and foreign vehicles, which may well substitute for a truck registration fee.

TABLE 23 Taxation systems in ECMT survey countries (1996)

Diesel Fuel Tax				
	Registration/Motor Vehicle Tax			
		Permit (Road Usage) Fees		
			Tolls	
Estonia Lithuania[1]	Finland Ireland Sweden[2] Latvia	Belgium Denmark Germany Luxembourg Netherlands Bulgaria Croatia Slovakia Switzerland Poland	Austria Greece Czech Republic Slovenia	France United Kingdom Italy Norway Portugal Spain Hungary

[1]Lithuania also has a permit fee.
[2]Sweden had plans to implement a permit fee in January 1997.
Source: ECMT, *Taxation of International Goods Transport by Road,* Draft Report, April 1996, p. 6.

Annual registration fees (motor vehicle taxes) are summarized below for a 40-tonne[1] reference vehicle across the 24 countries reporting their tax rates. Two other countries, Estonia and Lithuania, do not levy such a tax. (Forty (metric) tonnes is the GVW limit in most EU countries, though it is 38 tonnes in the United Kingdom.)

Annual Registration Fees—1995 (U.S. $)	*No. of Countries*	*Countries in Range*
Less than $1,000 per year	8	Bulgaria, Denmark, France, Hungary, Italy, Latvia, Luxembourg, Portugal
$1,000 to $1,800 per year	6	Belgium, Czech Rep., Spain, Greece, Netherlands, Slovakia
Exceeding $1,800 per year	10	Austria, Switzerland, Germany, Finland, United Kingdom, Croatia, Ireland, Norway, Sweden, Slovenia

Source: ECMT, *Taxation of International Goods Transport by Road,* June 1996, pp. 15–17.

Several countries charge higher fees for older vehicles or provide discounts for air suspensions for vehicles used in intermodal rail movements or for vehicles meeting specific European emissions standards.

Diesel Fuel Taxes. Diesel fuel tax rates, excluding value-added taxes (VATs), are substantially higher in Western Europe (up to U.S. $2.46 per gallon) than in this country, but they are only 11 to 26 U.S. cents per gallon in the Baltic States. The ranges are shown below and the rates for individual countries are presented in Table 24.

Diesel Tax Rates—1995	*No. of Countries*	*Countries in Range*
Less than 26¢/gal (7¢/ltr)	3	Estonia, Lithuania, Latvia
61¢ to 98¢/gal (16¢ to 26¢/ltr)	3	Bulgaria, Czech Rep., Romania
$1.17 to $1.51/gal (31¢ to 40¢/ltr)	13	Austria, Germany, Denmark, Spain, Finland, Greece, Hungary, Ireland, Luxembourg, Netherlands, Portugal, Sweden, Slovenia
More than $1.60/gal (42¢/ltr) [1 gal = 3.785 liters]	7	Switzerland, Germany, France, UK, Ireland, Netherlands, and Slovakia

Source: ECMT, *Taxation of International Goods Transport by Road,* June 1996, pp. 20–21.

There is an upward trend in diesel fuel tax rates in all countries, particularly in Switzerland (up 62 percent between 1992 and 1994) and Norway (almost quintupled between 1992 and 1994). Only fuel tax gallonage taxes are shown; most Western European countries add a VAT above and beyond the fuel tax, at rates ranging from 6.5 percent (Switzerland) to 25 percent (Belgium, Denmark, and Sweden).

ECMT compared the registration fees and diesel tax rates in the countries reporting and found an inverse relationship

[1] One metric tonne = 1,000 kilograms (kg) = 2,200 pounds = 1.1 short tons. All weights used in this chapter are metric.

TABLE 24 Diesel fuel tax rates in Europe (1995) (U.S. $ per gallon)

Country	Rate	Country	Rate
Austria	$1.51	Bosnia-Herzegovina	NA
Belgium	1.51	Bulgaria	$0.61
Denmark	1.48	Croatia	NA
Finland	1.48	Czech Republic	0.98
France	1.63	Estonia	0.26
Germany	1.67	Hungary	1.48
Greece	1.17	Latvia	0.15
Ireland	1.44	Lithuania	0.11
Italy	2.20	Moldava	NA
Luxembourg	1.25	Poland	NA
Netherlands	1.51	Romania	0.79
Norway	2.04	Slovakia	2.20
Portugal	1.48	Slovenia	1.48
Spain	1.29	Turkey	NA
Sweden	1.40		
Switzerland	2.46		
United Kingdom	2.04		

Rates exclude VAT.

NA = not available

Source: ECMT, *Taxation of International Goods Transport By Road,* June 1996, p. 21.

in Western Europe: countries with the highest registration fees tend to show relatively low levels of diesel fuel tax.

Other Truck Taxes. ECMT includes both tolls and permit fees in the "other" category.

Twelve countries charge road tolls on major motorways (as shown in Table 23). In Austria, these tolls are differentiated by vehicle noise and emissions levels and also by day or night use of the Brenner pass.

A large number of ECMT countries obtain significant amounts of revenue from permit fees (called road user charges). These fees apply to trucks using their major motorways or in some cases their entire road network. The fees vary substantially, especially outside the EU. They generally can be paid annually or for a more limited time period or for an individual trip. The fees may apply to national or foreign vehicles, or in many cases to all trucks, and they may differ according to transit versus local traffic. Moldova charges foreign vehicles a fee based on distance traveled; and in Romania, Ukraine, Croatia, Slovenia, and Yugoslavia the road user charges applied to foreign vehicles take the form of weight-distance taxes. Several countries, especially the Alpine countries of Austria and Switzerland, have discounts and exemptions for vehicles moving to and from intermodal rail terminals.

Five EU member states, Germany, Denmark, and the Benelux countries (Belgium, the Netherlands and Luxembourg) introduced a new set of permit fees for trucks in 1995. This fee is for use of the major motorway systems in all five countries, including the German autobahns. It is an annual fee with daily and monthly permits available as well. The charge is over and above the registration and fuel taxes levied. This regional fee is called the Eurovignette and is described in some detail below.

Prior to joining the EU, Sweden and Denmark applied weight-distance taxes to diesel-fueled vehicles; these distance charges were complementary to their fuel taxes (which were significantly lower than those in other EU countries) and varied with weight and number of axles. However, both countries eliminated these taxes in 1994, primarily because manual enforcement was inconsistent with open borders. Denmark is participating in the Eurovignette system and Sweden will be joining in 1997.

Common Market and Open Borders

In 1992, the EU did away with virtually all of the border-crossing formalities between nations. In essence, they opened their "internal" borders to form a "common market." The opening of borders in Western Europe caused intense scrutiny for commercial traffic issues, especially vehicle taxation and tested the multinational direction of the EU. For international traffic, the registration fee (annual vehicle tax) is generally paid in the home country of the vehicle, and countries mutually exempt or reciprocate on foreign vehicles with respect to this fee. Fuel taxes are paid where the fuel is purchased, which is where the immediate road usage is occurring. Fuel can be consumed while operating in a different country (from purchase) as the fuel supply in the vehicle permits.

Several EU countries viewed the opening of borders while leaving truck charges to each nation's discretion as giving an advantage to heavy goods vehicle (HGV) owners resident in a country with low annual registration fees and presenting a disadvantage to owners of HGVs based in countries with high registration fees, especially when the latter countries have large numbers of foreign vehicles using their roads.

In theory, the harmonization of taxes should have preceded any liberalization of border formalities in international road transport, but the common market goal took priority. As a result, belated discussions ensued between EU countries on harmonization of taxes and on the continuation of a variety of special road user charges that in many cases appear to discriminate against foreign trucks.

The removal of frontier formalities in 1992 in fact preceded harmonization of HGV taxes, so that most HGVs are currently able to move freely from one EU country to another. In addition, EU policy is set and does not allow discrimination against other EU members in transportation or commerce. Hence, the current debate is somewhat constrained by the timing of common market implementation within the EU. That is, a country that proposes a change from the status quo is subject to accusations of unfairness if foreign vehicles appear to be disadvantaged by the change.

Internal frontier checks on EU-registered vehicles were discontinued in January 1992, while fuel inspections (of the amount of diesel carried from one country to the next in HGVs) for tax purposes were abolished in January 1993. This has made it difficult to perform frontier checks on road transport. EU member countries are seriously considering electronic monitoring to replace border checks with an alternative control system in conjunction with proposed truck charges.

The need for alternative controls has in turn heightened interest in deployment of a standardized electronic identity device and charging system that might eliminate these monitoring problems and existing constraints on road user charges. With electronic controls and AVI, every country can determine charges for use of its main road system as they determine to be appropriate, then let HGV users pay without any discrimination based on nationality.

EU Minimum Fuel Tax

In an attempt to render open borders more workable, the EU has adopted minimum rates of fuel taxes. This is regarded as one of the first serious steps in the harmonization process. In Council Directive 92/81/EEC (19 October 1992), the EU established procedures and definitions underlying a harmonized duty. Article 1.1 of the Directive says: "Member States shall impose a harmonized excise duty on mineral oils in accordance with the Directive."

Immediately following, in Council Directive 92/82/EEC (19 October 1992), the EU prescribed the actual minimum that states shall apply to each type of fuel, setting a minimum rate for diesel (used as a propellant) at 245 ECU per 1,000 liters (U.S. $1.16 per gallon) as of January 1993. This Directive includes numerous special exceptions to account for anticipated problems, in particular for Luxembourg and Greece. Further, as evidenced in the recent ECMT report, the actual fuel tax levels still differ considerably, as do retail prices for diesel fuel across countries.

Registration Fees, User Charges, and Tolls

Adoption of Council Directive 93/89/EEC (19 June 1993) represents another important step in the harmonization process for HGV charges. Here the EU Council established minimum registration fees (vehicle taxes) for HGVs and granted permission for member states to impose permit fees (road usage charges) or tolls for major roads. This latter action was permissive, in response to initiatives in several countries to add new HGV charges. In doing so, the Council stated that the "elimination of distortions of competition between transport undertakings in the Member States calls for both the harmonization of levy systems and the establishment of fair mechanisms for charging infrastructure costs to haulers."

The minimum registration fee for heavy trucks was set at 700 ECU/year (U.S. $875 per year) to be applied according to whatever structure was already in place in the specific country. Importantly, registration fees continue to be "charged solely by the Member State of registration."

Permit fees for motorways (i.e., limited-access multiple-lane roadways such as the German autobahn) were also allowed, as were new tolls, with the stipulation that they should be nondiscriminatory and not create obstacles at internal EU borders. Daily, weekly, monthly or annual permits are available. The maximum charge for annual use was set at 1,250 ECU/per year (U.S. $1,563 per year), with corresponding maximum charges for shorter time periods. The EU also directed that, where used, tolls should be related to the costs of constructing and operating the motorway concerned. Countries instituting user charges are allowed to institute tolls only on bridges, tunnels, mountain passes, and congested or environmentally sensitive routes.

An important facet of this directive called for a Commission Report to the Council on implementation "taking account of developments in technology and traffic congestion" no later than the end of 1997, with the renewal or adjustment of minimum and maximum tax rates also scheduled for the end of 1997. This report is expected to be an impetus for future harmonization and for moving the EU toward identifying attractive alternatives for monitoring trucks and assessing fees by the application of electronic technology.

Recommendations of "Green Paper"

The continuing discussion about harmonization of truck charges within the EU has produced a series of analyses and policy papers. An important recent policy paper is the "Green Paper" presented by the Commission of the European Union (the multinational governmental body) entitled: *Towards Fair and Efficient Pricing in Transport* (December 1995). This paper addresses a broad range of policy options for pricing to internalize the costs of transport, including special attention for HGVs and the external costs of noise,

emissions, and congestion. Whereas the ECMT is an advisory body, the Commission is the multinational government and can act to implement these policy directives subject to the approval of the EU Council.

Several key points emerge from the recent Commission Green Paper:

- The Community's objective of ensuring sustainable transport requires that prices reflect underlying scarcities.
- Prices have to be right in order to get transport right. Equitable conditions of competition are essential.
- The need to make more progress on fair and efficient pricing is reinforced by the ongoing efforts to harmonize transport within the common market and to move toward intermodal transport systems in Europe.

In this Green Paper, the Commission strongly supported transport charges that are closely linked to underlying costs, including highly differentiated charges subject to scrutiny to ensure their nondiscriminatory nature. The Commission recognized that many changes will be long term in implementation. However, it identified several promising possibilities that can be introduced on short notice:

- Adjusting existing legislation on HGV annual registration fees, fuel taxes, permit fees and tolls;
- More differentiated fuel taxes and registration fees reflecting differences in environmental characteristics (emissions and noise), possibly linked with distance charges for all vehicles including HGVs; and
- Distance-based kilometer charges based on infrastructure damage and possibly other parameters, specifically for HGVs.

The Commission noted that the most attractive long-term solution appears to be electronic road pricing and tolling systems that have the potential to register the relevant cost determinants, such as vehicle characteristics, mileage operated, and emissions. In addition, the Commission noted that emerging smart card technologies seem capable of protecting the privacy of private motorists, a major concern in Europe. A status report is provided suggesting that technical feasibility for electronic systems is within reach, but not yet operational, and that installation and operating costs need further investigation focused on a system which meets the pricing requirements.

Current Proposals

In July 1996, the Commission proposed a set of modifications to Council Directive 93/89 (adopted in 1993) addressing truck taxes. These changes would introduce maximum registration fees (vehicle taxes), thus reducing these fees in many states, while allowing increases in truck motorway permit fees and tolls and also allowing additional charges for the use of congested or environmentally sensitive routes. The net effect of the proposed changes was estimated to be a 2 percent increase in average truck taxes (IP/96/617). The four proposals are described below.

Annual Registration Fees. In addition to the existing minimum fees, maximum annual registration fees (vehicle taxes) would be established by vehicle weight and configuration. Fee structures would be required to incorporate a 10 percent discount for vehicles meeting specified emission standards. Member states with motorway permit fee systems (described below) would be allowed to reduce registration fees below the EU minimum.

Permit Fees. Current systems of permit fees for using motorway systems would be modified to distinguish three vehicle "damage classes" and three emissions classes. The damage classes would be based on GVW, number of axles, and type of suspension. For the highest emissions class (applying to pre-1988 trucks), the maximum annual fees for the three damage classes would be 1,000, 1,500, and 2,000 ECU (U.S.$1,250, $1,875, and $2,500), respectively (instead of the current 1,250 ECU per year). For the two lower emissions classes, annual fees would be reduced by 150 or 250 ECU (U.S.$188 or $313). The ratio of the fees for daily, weekly, or monthly permits to the fee for annual permits would be reduced somewhat. Minimum permit fees, at one-half the maximum levels, would apply to all member states choosing to implement permit fees.

Tolls. In states not instituting permit fees, tolls would be available as an alternative; and in states with permit fees, tolls would continue to be available as a supplement on bridges, tunnels, and mountain passes. However, the size of tolls would be limited to recovering construction, development, and operating costs plus a small surcharge for environmental costs and other external costs.

Sensitive Routes. Supplemental charges would also be allowed on routes that are congested or which create air-quality or noise problems. On toll facilities, these charges could take the form of a surcharge of up to 0.5 ECU per km (U.S.$1.01 per mile). On other facilities, daily fees of up to 15 ECU (U.S.$22.50) could be imposed. EU members planning to institute such sensitive-route charges would be required to document the sensitivity of the routes to which they would apply.

COUNTRY-SPECIFIC INFORMATION

United Kingdom

Cost Allocation

The allocation of road expenditures to various vehicle classes in the United Kingdom (U.K.) is based on an assess-

ment of cost responsibility for each class. The expenditures allocated to vehicle types are known as "road track costs" and are used as the basis for taxation. The responsibility is calculated using five parameters:

1. *Vehicle kilometers:* Measures the kilometers traveled by vehicles during the year. It is used to allocate costs that are unrelated to vehicle size or weight, such as traffic policing.
2. *Standard axle kilometers:* "Standard axles" multiplied by kilometers traveled. Standard axles correspond to the U.S. concept of equivalent single-axle loadings (ESALs). Standard axles measure relative road damage caused by axle loadings. This parameter is used to allocate the costs of repairing the road surface.
3. *Average gross vehicle weight kilometers:* Vehicle kilometers multiplied by the average GVW. It is used to allocate load-related costs, such as bridge maintenance.
4. *Maximum gross vehicle weight kilometers:* Maximum permitted weight for a vehicle multiplied by the annual kilometers run traveled by the vehicle. Used to allocate part of the capital expenditure, because the weight of the vehicle means that the roads have to be built to a higher standard. It is used to allocate a portion of the capital expenditures under the rationale that roads and bridges are built to a higher standard to accommodate heavier vehicles.
5. *Passenger car units (PCUs):* The relative amount of road space used by different vehicles. PCUs correspond to the U.S. concept of passenger-car equivalents. PCUs are multiplied by kilometers to allocate capacity-related expenditures.

It has been the government's policy that payments from road users should at least cover the road costs for which they are responsible.

Tax levels are determined by the Treasury based on advice from the Department of Transport's annual Road Track Costs allocation. The original 1968 Road Track Costs Report divided costs into three broad categories namely: user costs, public costs, and community costs. User costs, which fall directly on road users, include the cost of fuel, tires, and other direct vehicular costs associated with road use, as well as travel time. Public costs are borne by the central and local governments and consist largely of road construction and maintenance. Community costs are externalities. Some costs (e.g., those associated with accidents) fall into more than one category.

The general procedure for allocating road expenditures has basically remained unchanged since the 1968 Report. This procedure attributes public costs (but not community costs) to road users using a long run marginal cost (LRMC) pricing approach. Fifteen percent of total capital costs are shared among heavy vehicles according to GVW-kilometers, the balance being attributed by PCUs. Heavy vehicles are assigned 2.5 PCUs, a significantly smaller value than used in most North American studies. Pavement maintenance costs (resurfacing, reconstruction, etc.) are assigned according to "standard axle kilometers" which are set according to the fourth-power rule of pavement damage. Bridge maintenance costs and some other maintenance costs are assigned according to average GVW-kilometers. Remaining variable costs are generally shared between road users according to vehicle-kilometers independently of vehicle weight. Since 1984, the road track cost allocation has distinguished four roadway types: Motorway, Trunk, Principal, and Other. Community costs (externalities) are not explicitly analyzed but they are implicitly covered by setting tax rates to generate revenue that exceeds allocated public costs by 30 percent.

The Department of Transport considers each item of the road track cost and isolates any component which should be allocated to a particular vehicle class. The remaining costs are shared among all vehicle classes by some measure related to their use of the roads. The results represent fully allocated average costs.

Taxes and Fees

There are two principal taxes: a registration fee, known as a "Vehicle Excise Duty" and a fuel tax. Tolls are charged only on certain major bridges and tunnels.

Registration fees are assessed against the power unit and vary significantly with both maximum GVW and axle configuration. Fees charged power units reflect both the number of axles on the power unit and the minimum number of axles on the trailer to be towed. The most common tractor is a very short two-axle tractor. When such a tractor is registered to operate with a three-axle trailer at 38 tonnes (the maximum allowed), the fee is U.S. $4,838; however, the same tractor can be registered to operate at this weight with trailers having one, two, or three axles for a fee of U.S. $7,803. Similarly, a three-axle tractor pays U.S. $1,935 to operate at 38 tonnes with a three-axle trailer and U.S. $4,260 to operate at this weight with trailers having one, two, or three axles. A four-axle truck pays a U.S. $6,632 fee to operate at 32 tonnes (the maximum allowed); while five-axle combinations pay U.S. $1,514 or U.S. $2,621 to operate at this weight (depending on the number of axles on the power unit), and six-axle combinations pay only U.S. $687.

The diesel fuel tax is U.S. $2.04 per gallon and contributes substantially more revenue than the registration fee. A typical combination truck that operates 55,000 miles per year pays about U.S. $16,000 per year in fuel taxes.

Interesting Features

- Sophisticated cost allocation methods are used to allocate road costs to road users.

- Registration fees vary significantly with both maximum GVW and axle configuration.

France

Taxes and Fees

Fuel Tax. Diesel fuel for highway use is taxed (at the refinery) at a rate of U.S. $1.63 per gallon and gasoline is taxed at nearly twice this rate. The substantial difference in the two tax rates has resulted in very high penetration rates for diesel automobiles, which accounted for 49 percent of new car sales in 1994. Altogether, fuel taxes account for more than 10 percent of all revenues received by the central government, with more than 75 percent of this revenue generated from highway fuels. In addition to the taxes on gasoline and diesel fuel, there is an 18.6 percent VAT on both fuel and vehicles.

Tolls. France has the most extensive toll-road system in Europe. This system was developed by eight public-private joint ventures (seven *sociétés d'economie mixte [SEM]* or "mixed economy companies," and one national mixed-economy company [STMB]) and by one private sector company (COFIROUTE). About 85 percent of the network is operated by the seven SEM. French toll roads have been built with widely spaced interchanges, making toll roads a practical alternative for intercity travel to the older, free public road system. The toll roads generally do not provide access to urban or suburban areas, terminating instead at the urban fringe.

Trucks typically make up about 20 percent of total annual traffic on the toll roads, which, because of their high design standards, are well suited for the operation of heavy vehicles. To simplifyied toll collections, and hence and thereby reduced overhead, vehicle categories have been reduced over the years from 12 to 5, (including a single class for all vehicles with three or more axles). Equipment has recently been installed for the automatic vehicle classification based on the number of axles and height of the front axle cap. Tolls are not set on the basis of costs incurred but rather to discourage automobile travel and to encourage heavy trucks to use the well-constructed toll roads. Tolls for the heaviest trucks are only moderately higher than those for automobiles. However, because of the extensive use that trucks make of toll roads, total tolls paid by trucks equal about 80 percent of their fuel tax payments (exclusive of VAT) (Darbéra, Table 9).

Vehicle Insurance Tax. To compensate for the loss incurred by the national social security system because of road accidents, a special earmarked tax was imposed on vehicle insurance fees and its revenues transferred to the social security fund. Over time, this tax has been increased to the point where it produces about 50 percent more revenue from trucks than is required to cover social security expenditures on truck accidents.

Other Central Government Taxes. Other taxes levied by the central government, such as an axle-load tax, yield minor contributions to the Treasury.

Local Government Road Taxes. There are three local and subnational government taxes: the annual vehicle tax (vignette) corresponding to a registration fee in the United States, a one-time vehicle "registration fee" that corresponds to a titling tax in the United States, and a fee for the issuance of drivers' licenses. Together, these taxes represent about 6 percent of the local governments' tax revenues. The annual vehicle tax rates are set locally and depend on horsepower, age, and use of the vehicle. Vehicles more than 25 years old are exempt. The vehicle registration fee is paid when a vehicle is first registered in the country and whenever ownership changes. The driver's license fee is paid when a new license is issued.

Interesting Features

- The fuel tax is set at a high rate and provides a significant portion of overall governmental revenues.
- Substantial reliance is placed on toll roads.
- Toll roads are built by public-private partnerships.
- Tolls are set to encourage use of these roads by trucks and to discourage their use by automobiles.

Germany

Germany has a highly developed national highway system, famous for its early establishment of limited-access autobahn freeways. The road system is financed by a combination of Federal, state, and local funding, supported by registration fees, fuel taxes, and special road charges. German roads were built largely without toll financing, except for a few bridges and tunnels. Germany has no speed limits for passenger cars on its autobahns but does impose a speed limit for trucks.

The fees and taxes imposed on highway users are motivated by the cost of providing roads; however, German tax administrators do not consider these fees to be a levy on the use of public roads. In particular, registration fees are considered to be a "genuine tax," with the revenue going exclusively to the individual German states. In 1994, the registration fee generated about U.S. $9.4 billion (DM 14.2 billion).

Specific Taxes and Fees

Germany has a "motor vehicle tax" similar to an annual vehicle registration fee. Registration fees for motorcars vary

with engine capacity, with separate schedules used for cars first registered before or after 1986. Also, cars classed as low polluting receive a discount of about 30 percent. The motor vehicle taxes are higher for diesel-engine vehicles than for gasoline-powered vehicles to compensate for a lower tax rate on diesel fuel.

For trucks and trailers, the motor vehicle tax is assessed on the basis of GVW. There are also separate step variations for heavier trucks on the basis of exhaust and noise emissions. For truck tractors and single-unit trucks there are five different rates, all of which progress for each 200-kilogram (kg) increment in GVW. The heaviest vehicles in the higher emissions and noise categories with weights up to and over 16,000 kg (35,200 lb) are subject to a maximum registration fee of U.S. $1,980 or $2,310 (DM 3,000 or DM 3,500) respectively. For trailers, the rate is linear with weight, in 200 kg increments, not to exceed U.S. $1,155 (DM 1,750).

Registration fees are payable on an annual basis in advance, but fleet owners of more than 50 vehicles may apply for special payment procedures. Bilateral agreements with most countries provide exemptions from registration fees for foreign vehicles on a reciprocal basis. Generally, registration fees are collected by the country in which the vehicle is registered and are not shared with other countries.

Motor fuel, termed "mineral oil" in Europe, is the most important excise duty for the federal government and yielded revenue of about U.S. $43.2 billion (DM 65.5 billion) in 1995. Fuel tax is charged only on mineral oil used as motor (and furnace) fuel; most other uses are exempt. To minimize the administrative effort, the tax is collected at the producer-refiner level and presumed to be passed on to the consumer at the pump.

German policy explicitly recognizes that fuel taxes can change consumer and producer behavior. For example, a higher fuel tax was placed on leaded gasoline to reduce consumption, and use of leaded fuel has declined continuously over recent years. Also, a duty on heating oil was introduced as a step toward achieving energy policy objectives (including helping the German coal mining industry to adapt to changes in energy markets).

Fuel taxes were revised in December 1992, in part in response to the EU Directives on harmonization. As of January 1993, the duties are charged as follows:

- Unleaded gasoline: U.S. $2.4 per gallon (DM 980 per 1,000 liters),
- Leaded gasoline: U.S. $2.70 per gallon (DM 1,080 per 1,000 liters), and
- Diesel fuel: U.S. $1.55 (DM 620 per 1,000 liters).

German Autobahn Tax

Germany introduced an "Autobahn fee" or "Eurovignette" on January 1, 1995. This fee is a motorway permit fee for all heavy vehicles with registered GVW over 12 tonnes, whether loaded or not. The fee applies equally to domestic and foreign heavy trucks. These special truck charges were developed in concert with Denmark and the Benelux nations under Directive 93/89/EEC. German charges were introduced first, in concert with Belgium and Denmark. Permits issued in Germany are valid for use of motorways in all five countries and Sweden is joining the system in January 1997. Eventually there will be one multinational permit; the charges paid in each of the countries will be shared among the six countries, apparently using a pre-set negotiated formula.

The Autobahn fee varies with number of axles and duration (time) of use and can be paid either by the day, week, month, or year. Rates are set annually in ECU but paid in local currency. Germany introduced these time-based charges while continuing to examine other distance-based options.

Rates for 1995 are shown in the following chart.

Motorway Permit Fees for Trucks over 12 Tonnes—1995 (in U.S.$)

Vehicle type	*Daily*	*Weekly*	*Monthly*	*Annual*
Up to three axles	$7.61	$25.37	$95.15	$951.46
Four or more axles	7.61	41.86	158.58	1,586.76

Source: Motorway Charges for Lorries, Bundesministerium für Verkehr.

Electronic Collection Field Trail

The Transport Ministry of Germany conducted a field trial (in connection with a review of toll options and at about the same time as the compact was being negotiated on truck charges with the Benelux nations) to ascertain the workability, practicality, and risks associated with *automatic fee collection* on motorways, primarily in the context of evaluating application of distance-related charges to pursue objectives in transport, environment, and fiscal policy. The ministry had rejected manual toll plazas as unsuitable for autobahn charges and recognized that the Benelux countries were not yet ready for electronic tolls.

An English summary of the report was provided by the German Ministry, dated November 1995. The Ministry expressed concern about the opening of borders within the EU countries and to Eastern Europe and the resulting substantial 59 percent projected growth of goods transport. Even though convinced that its existing motorways were not compatible with manual or automatic tolling systems ready for use in the near term, Germany proceeded with the trial, noting its specific objective "to create a basis for decision on the introduction of automatic, distance-related road user charging systems on motorways in Germany."

The Ministry report suggests trucks exceeding 12 tonnes as a possible candidate group for automatic distance-related charges on motorways, with requirements for on-board equipment and some manual enforcement. A phased procedure to

achieve all the preconditions for implementation was proposed. The report notes that enforcement problems have not been fully resolved, but could be within acceptable risk levels. Ministry officials have subsequently indicated that they are endorsing introduction of a distance-based charging system for heavy trucks by the year 2002, and they believe that a fully automated electronic system is the only possible way to accomplish their objectives.

Interesting Features

- The vehicle tax has environmental components. Low-polluting, low-noise vehicles get a lower rate class.
- The diesel fuel tax is much lower (over one-third less) than the tax on regular gasoline.
- A special Autobahn fee was introduced in 1995 and is essentially a truck permit system for use of the autobahns, running up to U.S.$1,587 per year.
- There is a high level of experimentation with electronic tolling and fee collection, especially as applied to heavy trucks, as an eventual replacement for the autobahn fee.
- The ministry has endorsed distance-based charges and plans to use electronic charging to implement them by 2002.
- Privacy concerns and multinational issues are the main hindrances to adoption of electronic, distance-related truck charges.

Sweden

Sweden has been known over the years for its high road taxes. Motor vehicle and fuel taxes are considered general revenues and go into the general fund. User charges, however, were historically based on analyses of costs occasioned.

For trucks, Sweden applied a conventional diesel fuel tax until 1974. At that time, a government commission recommended that a weight-distance tax (called a kilometer tax) was better suited to the allocation of infrastructure costs. Such a tax was instituted, and all vehicles with diesel engines were required to have a sealed kilometer recorder. Vehicle owners had to read and submit data on distance traveled regularly during the year. The diesel fuel tax was retained, but at a reduced level; in 1984, for example, the Swedish diesel tax was less than one-half that in France and Germany.

In October 1993, Sweden replaced its weight-distance tax with a higher diesel fuel tax, in essence doubling its fuel tax rate into a range comparable to, but still somewhat below, other EU countries. Swedish tax authorities state that this change was not required by EU harmonization, but was instead a response to a competitive disadvantage of Swedish HGVs operating in other European countries. Their stated reasoning reflects administrative provisions of the Swedish tax: Swedish HGVs had to stop to record their mileage at each border exit and entry, whereas Europe's open-borders policy removed most similar requirements for HGVs from other countries.

Specific Taxes and Fees

Vehicle registration fee. Sweden's vehicle registration fee is called a "motor vehicle tax." It is a tax on vehicles, based on vehicle type, weight, and fuel type, with rates varying by 100-kilogram steps. Diesel-engined trucks face a higher rate schedule than gasoline-fueled trucks. Registration fees are payable in advance for the entire year.

The Swedish fees are imposed separately for tractors and trailers, with higher rates for the higher weight classes. The rates for the heaviest class of tractors, over 7,000 kg (15,400 lb), is U.S. $774 (5,160 SEK) plus $25.20 (168 SEK) per 100 kg (220 lb). For a heavy-class, two-axle trailer over 17,000 kg (37,400 lb), the tax rate is U.S. $1,988 (13,250 SEK) plus $37.50 (250 SEK) per 100 kg.

Fuel Taxes. As in most European countries, taxes are a substantial portion of the pump price of fuel. A new Fuel Tax Act became effective January 1995, in part to harmonize Swedish legislation with EU directives. The general principle is that excise duties are only to be paid if the fuel is used as motor fuel or for heating purposes. Both gasoline and diesel taxes have several components that reflect the Swedish effort to incorporate environmental concerns and to reduce the external effects of traffic.

The three different excise duties levied on fuels are an energy tax, a carbon dioxide tax, and a sulfur tax. The carbon dioxide and sulfur taxes were introduced in 1991. Also, since 1991, there has been a further differentiation of the energy tax in terms of three environmental categories. Leaded gasoline is penalized with an effective surcharge of about 18 percent, and the diesel fuel tax is reduced for cleaner types of diesel fuel. The intent is to encourage the use of more environmentally friendly fuels. According to an OECD/ECMT profile of Sweden, it was noted:

> "The differentiation . . . has proven to be an effective way of encouraging the use of cleaner fuels and lowering emissions from buses, truck, and tractors. Now 80 percent of Diesel traffic uses cleaner fuels and standard Diesel oil is disappearing from the market. Tax reduction on cleaner Diesel oil was the crucial factor in this rapid transition." [*OECD/ECMT*, p. 204]

For standard diesel fuel (Class 3), the combined energy and carbon dioxide tax is $1.71 per gallon (3.009 SEK per liter), while cleaner diesels are taxed at a lower rates of U.S. $1.55 per gallon (2.736 SEK) for light diesel (Class 2), and U.S. $1.44 per gallon (2.530 SEK) for urban area diesel (Class 1). Hence Class 1 is taxed about 16 percent less than standard diesel. A recent profile of Sweden stated that "virtually 100 percent of the diesel sold for vehicle use now consists of Class 1." [EU Green Paper]

The gasoline tax level, by contrast, is U.S. $2.36 (unleaded) to U.S. $2.70 (leaded) per gallon, 64 percent and 87 percent higher respectively than the tax on Class 1 diesel. Distillate oil intended for use in stationary motors or for heating purposes must be dyed (to distinguish it from highway diesel fuel) and this fuel has a much lower tax rate than highway diesel.

The Swedish Government may also apply fuel tax exemptions or reductions for pilot projects encouraging technological development of more environmentally friendly products. The Government has given relief to pure ethyl alcohol and methyl alcohol used as motor fuels, and has set a reduced energy tax rate for alcohol fuel used in mixtures. All excise taxes were harmonized with the EU in January 1995.

Other taxes. Sweden imposes the equivalent of a titling tax on vehicles that are registered in the country for the first time. This tax (apparently called a sales tax) varies with weight and environmental class but is independent of vehicle value. For vehicles that weigh more than 7000 kg (15,400 lb), the tax is U.S. $3,000 (SEK 20,000) for Environmental Class 2 and U.S. $9,750 (SEK 65,000) for Environmental Class 3.

In January 1997, Sweden is planning to join the Eurovignette user charge system currently operated by Germany, Denmark, and the Benelux countries. Under this system, heavy trucks using motorways in any of the six countries must purchase a daily, weekly, monthly, or annual permit. A permit purchased from any of the six countries is valid for use on motorways in all six countries.

Sweden has a 25 percent VAT that is levied on all goods including vehicles and energy products (with the exception of fuels used for air navigation).

Interesting Features

- Sweden has recently raised its diesel fuel tax, in part to meet EU minimum standards, in part to replace its distance fees on HGVs.
- Sweden has tax rates for fuel that vary by environmental classification to encourage the use of cleaner fuels and to raise the cost of pollutant emissions such as carbon dioxide and sulfur compounds.
- Sweden has made it possible for communities to restrict heavy vehicles from entering their inner areas. These restrictions are based on an environmental index implemented through registration by environmental classification since 1994.
- Sweden has given tax relief to environmentally friendly motor fuels and imposes tax penalties on vehicles and fuels that are less desirable. These economic incentives have had a significant effect on emissions.
- In 1997, Sweden is joining Germany, Denmark, and the Benelux countries in a jointly administered system of permit fees charged to heavy trucks using the motorways in the six countries.

Norway

The principal national truck taxes in Norway are a registration fee and a fuel tax. The revenue from both taxes goes into the country's general fund and substantially exceeds expenditures on roads. Two major cities, Bergen and Trondheim, have instituted toll rings to generate additional revenue that they use directly for road construction.

Specific Taxes and Fees

Registration Fee. Operators of heavy trucks pay a registration fee based on the maximum GVW of the power unit and a separate registration fee for trailers, also based on maximum GVW. The tax increases with GVW; it is higher for two-axle power units than for power units with three or more axles, and, for a given GVW, it is higher for trailers than for power units. The maximum rates apply to power units and trailers with GVWs above 25 tonnes and are U.S. $1,629 for a two-axle power unit, U.S. $1,186 for a three-axle power unit, and U.S. $1,927 for a trailer.

Fuel Tax. The diesel fuel tax rate has three components: a conventional tax rate of U.S. $1.73 per gallon (2.93 NoK per liter), a carbon dioxide surcharge of U.S. $0.25 per gallon (0.425 NoK per liter), and a variable surcharge on high-sulfur fuel. Since most diesel fuel is low sulfur, the second surcharge is zero, and the overall tax rate is U.S. $1.98 per gallon.

Tolls. The Trondheim and Bergen Toll Rings are the only downtown toll schemes currently in place other than Singapore's Area Licensing Scheme (ALS). Such urban congestion pricing programs usually are advanced to reduce peak-period traffic by bringing the private costs borne by peak-period users more in line with the social costs caused by their use of scarce road space. However, the purpose of the Bergen Toll Ring is the raising of revenue for a major road construction program; reducing traffic was not an objective.

In Bergen, tolls are collected from all motor vehicles (except regularly scheduled buses and light motorcycles) entering the downtown area on weekdays between 6 a.m. and 10 p.m. Tolls are manually collected at the tollbooths through a ticket system; tickets are sold singly or prepaid in books of twenty. Monthly, semiannual, and annual passes are also available. Single-entry toll rates for vehicles registered to carry payloads of 3.5 tonnes or more are U.S. $1.30 (10 NoK) and half that for lighter vehicles. Annual passes for heavy vehicles are U.S. $286 (2200 NoK).

Toll collection costs appear to be about 18 to 20 percent of revenues. About 5 percent of vehicles using the lanes for vehicles with annual passes have been found not to have valid passes.

Austria and Switzerland

The two trans-Alpine countries, Switzerland and Austria, are not members of the EU and have long been regarded as barrier states between Western and Southern Europe. Trucks have been treated separately in both countries, have required transit permits, and have paid relatively high fees. Both countries have lower weight limits than the EU and both have a history of applying "inventive charges" to transiting vehicles, including excess weight fees, clerical fees, overtime charges, and various additional administrative fees.

Heavy Vehicle Taxes and Fees

GVW limits and the major heavy vehicle taxes in Austria and Switzerland are summarized in the table below. Austria has a 38 tonne (metric) weight limit, slightly below the EU standard of 40 tonnes, and Switzerland has an unusually low limit of 28 tonnes (61,600 lb).

Austria has a relatively high registration fee (vehicle tax) that varies with GVW and that is reduced for vehicles used in rail intermodal service. In Switzerland, registration fees are set by individual cantons (provinces) and they may vary by GVW, payload, engine capacity, or horsepower. The typical fee shown for Switzerland in the table (U.S. $1,870) is more modest than the fee in Austria, but it applies to trucks that are subject to Switzerland's 28 tonne GVW limit.

Heavy Vehicle Taxes in Austria and Switzerland—1995 (in U.S. $)

	Austria	*Switzerland*
Maximum GVW	38 Tonnes	28 Tonnes[1]
Typical registration fee	$3,140	$1,870
Motorway usage fee[2] (annual cost)	$3,125	$3,430
Diesel fuel tax per gallon	$1.51	$2.46
VAT on fuel	20%	6.5%

[1] Limit is 40 tonnes within 10 km of Switzerland's border.
[2] Fixed fee with daily permits.
Source: ECMT, 1996.

Both countries impose "road usage fees" (permit fees) on trucks using their motorways. These charges are similar to the Eurovignette imposed by Germany, Denmark, the Benelux countries, and (effective January 1997) Sweden, but the Austrian and Swiss fees cover motorways in only a single country. The rates for annual permits are shown in the table, though most foreign trucks are likely to purchase temporary permits.

The diesel fuel tax in Switzerland is the highest in Europe, U.S. $2.46 per gallon, while in Austria it is U.S. $1.51 per gallon.

1987 Transit Agreements

In 1987, agreements regarding transit of HGVs through the signatory countries were reached between both Austria and Switzerland and the European Economic Community (EEC, a predecessor to the EU). Two standard forms were adopted for declaring goods being transported. These common transit procedures formed the model for agreements with other non-EEC countries for the ease of moving goods.

Emissions Quotas for Trucks Transiting Austria

In 1991, Austria reached an agreement with the EU countries limiting total nitrogen oxide emissions of HGVs registered in an EU member state while these vehicles are transiting through Austria. An initial emissions quota was assigned to each EU country based on 1991 transits, and the quotas are decreased annually through 2003, when they will be 40 percent of their original level. Ecopoint cards are used to distribute each country's quota across trucks planning to transit Austria. These trucks are then required to carry these cards and also to document their emissions rates. Ecopoints are then charged to these cards for each transit.

Other Environmental Provisions

The Austrian and Swiss agreements with the EU have also provided for rapid expansion of rail capacity in the two countries, increases in rail tunnel clearances, and harmonization of intermodal equipment. The goal is to provide a more environmentally benign option for transporting goods through the two countries. Improvements to the Swiss rail system have already resulted in a substantial diversion of trans-Alpine goods movements to intermodal carriage.

The EU has also accepted Swiss bans on night and Sunday truck traffic and the stringent Swiss and Austrian standards on emissions and noise from heavy trucks.

Japan

The Japanese trucking industry is widely regarded as protected and was highly regulated for about 40 years under the Road Transport Law (adopted in 1951). Several deregulatory initiatives have been implemented in the 1990s, replacing the former fixed route, fixed schedule system. The Japan Development Bank quotes major industries as stating: "The protection that the government has provided the distribution and freight industries has made them expensive and unable to compete." Yet, the same Bank report views trucks as favored because of the extremely low share of financing for infrastructure work that is imposed on the truck companies.

For the latest year shown by Ministry of Transport figures, commercial trucks continued to carry about 90 percent of

domestic freight tonnage and about 52 percent of tonne-km volumes. Rail is not a significant factor in overall domestic freight. Because of the island nature of Japan, coastal maritime shipping carries almost 44 percent of overall tonne-km.

Truck weight issues. As part of an economic stimulus package in 1993, the upper limit of total truck weight was raised to 25 tonnes (from 20 tonnes), and some exceptions were later added for equipment such as refrigeration. One Japanese report assumes that excess freight will be carried and uses weights that are twice the legal limit in several examples. Weight enforcement has been upgraded recently. Under the Road Traffic Act, as amended in 1994, haulage of excess cargo comes under police control and penalties have been increased. These "vicious offenders . . . used to load more than double the legal capacity, and had accounted earlier for roughly 30 percent of all offenders (arrests)" (Japan Trucking Association, p. 34).

Specific Taxes and Fees

Registration Fees. There are two separate registration fees. First, there is the Vehicle Tax for trucks on the basis of carrying capacity. For trucks over 8 tonnes in business use, the vehicle tax is ¥29,500 (U.S. $270) plus ¥4,700 (U.S. $43) per tonne over 8 tonnes. This appears to be a payload tax. For a truck with a 15 tonne payload, the vehicle tax amounts to ¥62,400 (U.S. $573).

Second, there is a weight tax on trucks for business use which is levied on gross weight at the rate of ¥2,800 (U.S. $26) per tonne. For the legal limit of 25 tonnes, this tax is ¥70,000 (about U.S. $650).

Taxes on Fuel. Gasoline taxes are relatively high, with national and local taxes totaling ¥53,200 per kiloliter (kL) (U.S. $1.83 per gal.) for vehicles using gasoline. The diesel fuel tax is ¥32,100 per kL (U.S. $1.10 per gal.), about 60 percent of the level applied to gasoline.

Sales Tax. For new vehicles, there is a purchase tax of 3 percent applied to the price of vehicles for business use (such as trucks) and 5 percent for personal use, with some reductions available for certain environmentally friendly vehicles.

Tolls. A significant portion of major intercity roads in Japan are toll roads, generally built under public authority supervision, with funding from the Fiscal Investment and Loans Program. This debt finance program accounts for about 24 percent of road spending in Japan. A comparison of highway tolls for different types of vehicles is available, and some summary results are shown in the table below. These toll figures were calculated per vehicle-km and per ton-km. Toll payments by trucks per ton-km are less than one-tenth the level for automobiles (Japan Development Bank, page 78).

Highway Tolls for Automobiles and Large Trucks—1996 (yen and dollars per vehicle-km and per ton-km)

Measurement Base	*Distance*	*Passenger Car*	*Very Large Truck*
Per Vehicle-km	100 km	¥26.4 (U.S. $0.24)	¥67.5 (U.S. $0.61)
	500 km	¥18.7 (U.S. $0.17)	¥50.8 (U.S. $0.46)
Per Ton-km	100 km	¥18.9 (U.S. $0.17)	¥1.6 (U.S. $0.015)
	500 km	¥13.4 (U.S. $0.12)	¥1.2 (U.S. $0.011)

Source: Japan Development Bank.

Interesting Features

- There is a distinction in vehicle taxes by business versus personal use, with business tax levels much lower. Trucks are mostly registered for business use.
- As part of an economic stimulus package in 1993, the upper limit of total truck weight was raised to 25 tonnes (from 20 tonnes) and some exceptions were later added for equipment such as refrigeration. An immediate problem was encountered—some bridges were not designed to carry the extra weight.
- Weight enforcement is known to be poor, but penalties for violations have recently been increased. A Japanese source assumes that trucks commonly operate at twice the legal GVW limit.
- Japan put into effect an "Automobile NO_x Law" at the end of 1992. The law urges truck owners to replace vehicles with less polluting ones, with enforcement to suspend trucks that fail to reduce exhaust fumes. Governments and local bodies provided some funding to promote introduction of low-emissions trucks.

Australia

Australia has a federal system of government relatively similar to the U.S. system. There is shared responsibility for the road system between the Federal government and the states and territories, with the Federal government collecting about two-thirds of all taxes paid by vehicles with GVWs above 4.5 tonnes. Australia's analyses of the tax burden on motor carriers consider all types of taxes; however, they make a distinction between highway user fees (which they call "charges" and which they set to approximately match directly caused costs) and other taxes (such as sales and payroll taxes and customs duties). The government has been investigating the appropriate level for user charges for several years without reaching a final conclusion. However, some changes in heavy-vehicle taxes proposed by the National Road Transport Commission (NRTC) took effect in July 1995.

Specific Taxes and Fees

Registration Fees. Although most highway vehicles are registered in the state or territory in which they are based, vehicles engaged in interstate transport are federally regulated and pay a Federal registration fee (known as the Federal Interstate Registration Charge). About 2 percent of trucks with GVWs above 4.5 tonnes pay this Federal fee. Historically, the states and territories have set their own registration fees, which varied by as much as a factor of five (between the Northern Territory and the Australian Capital Territory). To eliminate these substantial disparities, uniform national registration fees were established by the NRTC and took effect in July 1995. Although these fees are set nationally, it appears that the fees (except for those of Federally regulated vehicles) are paid to the states and territories.

Under the new system, registration fees for power units vary with the number of axles on the power unit and the combined length of any trailing units. Trucks registered to pull trailers pay slightly lower fees than tractors registered to pull the same trailers. For trucks over 4.5 tonnes (9900 lb) not registered to pull trailers, there are separate rates for "light" trucks and "heavy" trucks, where the definition of a heavy truck depends on the number of axles: over 12 tonnes for a two-axle truck; over 16.5 and 20 tonnes for three and four-axle trucks, respectively. In addition, a separate registration fee is paid for trailers at the rate of U.S. $200 per axle.

For a two-axle tractor and a two-axle trailer (a common configuration), the total registration fee is U.S. $1,040 ($A 1,300). For a three-axle tractor and a two-axle trailer, it is U.S. $3,000. For a four-axle tractor registered to operate in triple-trailer configuration, the registration fee is U.S. $6,875 plus the fee for the trailers. Registration fees for buses range from U.S. $240 to U.S. $1,000 per year.

Fuel Tax. Diesel fuel is subject to both Federal and state taxes. The Federal tax (called an excise tax) is 92 cents (U.S.) per gallon. State taxes (called "franchise fees") are levied in all states and territories except Queensland and range from 18 to 31 cents (U.S.) per gallon. The fuel tax levied by South Australia is higher in urban areas than in rural areas.

Sales Taxes. A 21 percent Federal sales tax is levied on new trucks, new tires, and spare parts. Buses are exempt from this tax. In addition, the states and territories levy sales taxes (called "stamp duties") of 2 to 3 percent on the sale of both new and used vehicles.

Customs Duty. The Federal government levies customs duties on imported heavy vehicles, tires, and parts. These duties range up to 17 percent and average about 7 percent.

Payroll Tax. Payroll taxes account for about 30 percent of the revenue states and territories receive from heavy vehicles.

Interesting Features

- Australia has a single national schedule of registration fees administered by the individual states and territories.
- A small number of heavy trucks engaged in interstate transport are federally regulated and pay a Federal registration fee.
- The primary determinants of registration fees are number of axles and trailer configuration. GVW affects registration fees for single-unit trucks but not for combinations.

New Zealand

Weight Distance Tax. All diesel engine highway vehicles and all other highway vehicles with GVWs above 3.5 tonnes are subject to New Zealand's Road User Charges. For most such vehicles, these charges take the form of an axle-configuration weight-distance tax (called a "distance license fee"). For the purpose of this tax, 14 classes of vehicles are distinguished on the basis of number and spacing of axles and number of tires, with trailers treated differently from power units. For each class, the tax per kilometer rises steeply with GVW. For a given GVW, the tax rate drops by a factor of about four when one goes from a six-tire power unit to a three-axle (ten-tire) power unit, and by a factor of about two for each additional axle up to five. Also, for a given GVW, the tax rate for trailers with single tires is about 120 percent higher than the rate for trailers with dual tires. The fee schedule is adjusted annually on the basis of a cost allocation study and incorporates a 10 percent goods and services tax. The current (1996–1997) rate for a three-axle tractor and two-axle dual-tired trailer with a combined maximum weight of 37 tonnes (81,400 lb) is about 65 cents (U.S.) per mile.

Operators of vehicles subject to the weight-distance tax are required to equip each vehicle with a sealed hub odometer and to purchase a distance license which must be displayed on the vehicle's windshield. The operators identify each vehicle's class, maximum GVW, and starting and ending odometer readings; and the price of the distance license is determined accordingly. The maximum GVW can be changed whenever a new license is purchased, and a supplementary license can be purchased (at a premium rate) to pay for a temporary increase in maximum GVW.

Public-sector costs for administering and enforcing the tax have been estimated to be 2 to 3 percent of revenues (Starkie, p. 244), with some additional costs incurred for private-sector compliance. Estimates of evasion range up to 8 percent (Laird, p. 223).

Other Taxes. Off-road vehicles and specialized vehicles (such as mobile cranes) pay a "time license" instead of the above mentioned weight-distance tax. Owners of gasoline-fueled vehicles that are subject to the weight-distance tax

receive a rebate of the gasoline taxes that they pay, and there is no tax on diesel fuel. Accordingly, the weight-distance tax is apparently the only significant tax paid by highway vehicles with GVWs above 3.5 tonnes.

Interesting Features

- New Zealand has a weight-distance tax that is paid in advance and requires the use of hub odometers.
- The tax rate varies with axle configuration and the use of single or dual tires.

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CHAPTER 4

STATE TAXES PAID BY HEAVY VEHICLES

This chapter compares the amount of state taxes paid by heavy vehicles and the composition of state tax structures. The analyses use a tax-rate database prepared for this study to estimate taxes paid in each state by four vehicles with different registered GVWs. This analysis provides a basis for comparison of state tax structures from the perspective of truck operators, in contrast to the comparisons of revenue collected by the states that were presented in Chapter 2. These analyses also provide a basis for understanding the competitive aspects of comparative state tax structures.

The five major taxes paid by heavy vehicles are registration fees, fuel taxes, weight-distance taxes, property taxes, and sales taxes on vehicles. The analyses of this chapter focus on these five taxes plus sales taxes on fuel. They include all property taxes and sales taxes imposed on heavy vehicles, regardless of whether or not they are considered by the state to be a highway user tax. The principal reasons for the decision to include property and sales taxes are that they play a potential role in the competitiveness of vehicles based in different states and carriers have some ability to avoid these taxes when they choose where to register their interstate vehicles. Another reason is that, when determining whether or not a class of vehicles is being publicly subsidized, it may be appropriate to consider all taxes paid by the class and not just those taxes that are considered to be highway user taxes. Also, the decision improves the comparability of tax payments across states, because sales and property taxes paid in all states are included in the analysis, regardless of the states' treatment of these taxes.

The sales and property taxes analyzed include all ad valorem taxes on the sale or ownership of motor vehicles. These taxes are called a variety of names. Sales taxes include general sales taxes (which usually are not considered highway user taxes) as well as vehicle transfer taxes and other ad valorem taxes on the sale of motor vehicles. Similarly, property taxes include personal property taxes applied to motor vehicles (again, usually not considered highway user taxes) as well as ad valorem vehicle license fees and other ad valorem taxes applied to motor vehicles. In some states (e.g., California and Washington), these ad valorem taxes are collected as part of the vehicle-registration process along with conventional registration fees.

The analyses in this chapter exclude tolls as well as several minor highway user taxes, such as drivers' license fees and gross receipts taxes, that contribute only a small portion of highway revenue.

Registration fees and ad valorem taxes on vehicles are paid regardless of VMT, while fuel and weight-distance taxes paid depend on VMT. We shall distinguish the latter VMT-dependent taxes from the former by referring to registration fees and ad valorem taxes on vehicles as "fixed fees" and to fuel taxes and weight-distance taxes as "mileage-related taxes."

The first section of this chapter describes four prototypical vehicles that are used in most of the analyses of this chapter and also describes the conduct of the analyses. The second and third sections analyze the tax liabilities of the four prototypical vehicles, and the fourth section presents additional details on the effect of GVW on tax liabilities using data for eight GVWs. The fifth section presents information on how average tax liabilities vary with other vehicle characteristics: configuration, body and trailer type, private/for-hire operation, and interstate/intrastate operation. The final section describes the effects that variations in state tax systems have on competition among motor carriers.

PROTOTYPICAL VEHICLES AND ANALYTIC PROCEDURES

For most of these analyses, the focus is on prototypical vehicles registered at weights of 30,000, 50,000, 60,000 and 80,000 lb. The assumed characteristics of these four prototypical vehicles that most affect their tax liabilities are summarized in Table 25.

The annual VMT shown in Table 25 for each of the prototypical vehicles was derived using the 1992 Truck Inventory and Use Survey (TIUS)[1] data file and averaging the annual VMT for all vehicles (regardless of configuration) in 35 states registered at or slightly below the indicated GVWs. The fuel efficiencies used were similarly obtained as the harmonic mean[2] of the TIUS fuel consumption rates for these vehicles. The prices shown are those used in the current

[1] U.S. Bureau of the Census, *1992 Census of Transportation, Truck Inventory and Use Survey*, microdata file, 1995.

[2] The harmonic mean is used (instead of the arithmetic mean) to obtain a proper estimate of overall fuel consumption rate. This value is obtained by inverting the TIUS fuel consumption rates (in miles per gallon) to obtain gallons per mile, averaging, and reinverting to obtain average miles per gallon.

TABLE 25 Prototypical vehicles

Registered GVW (lb)	30,000	50,000	60,000	80,000
Annual VMT	13,310	18,176	28,050	70,414
Miles per Gallon	7.23	5.93	5.54	5.43
Price (Power Unit)	$55,000	$75,000	$76,700	$83,600
Trailer Price	N/A	N/A	$17,900	$17,900
Average Age (years)	8	8	8	8
Ages when Sold and Resold	0, 5, 10	0, 5, 10	0, 5, 10	0, 5, 10

Federal Highway Cost Allocation Study[3] for typical vehicles that are commonly registered at the indicated weights: a six-tire van at 30,000 lb; a three-axle dump truck at 50,000 lb; and 48-foot tandem-axle van trailers operating with two- or three-axle tractors at 60,000 lb and 80,000 lb, respectively.

In those states where registration fees depend on whether or not the fees are apportioned or whether the vehicle is in private operation or for hire, the 80,000-lb vehicle was assumed to be for hire and was usually assumed to be apportioned, and the other vehicles were assumed to be private and usually assumed to be nonapportioned. The exceptions to this rule occur in the next section and Table 26 where (for reasons discussed in that section) a *nonapportioned* 80,000-lb vehicle is assumed; in the fourth section and Figures 4 and 5 where, for comparison purposes, all vehicles are assumed to be apportioned; and in the fifth section and Table 32, where comparisons are made between apportioned and nonapportioned vehicles.

As would be expected, VMT is positively correlated with vehicle weight, with the greatest increase occurring between 60,000 and 80,000 lb. This correlation is significant because, for the fixed fees, payments per mile decline as annual VMT increases. Similarly, the fuel consumption rates drop with increasing GVW. The relatively small decline in the fuel consumption rates between the 60,000- and 80,000-lb vehicles occurs because of the very substantial decline between these two weights in the percentage of vehicles used for local service.

For each prototypical vehicle and each state, most annual taxes were computed as the annual taxes that would be paid by a vehicle based in the state if it operated entirely in the state for 1 year, and per-mile taxes were computed by dividing annual taxes by annual VMT. For most taxes, February 1996 tax rates were used. Computations for gallonage taxes on fuel, weight-distance taxes, and most annual registration fees are straightforward. Annual sales taxes on fuel were obtained by multiplying annual fuel consumption by the July 1996 retail price of fuel in the state (from the American Trucking Associations' [ATA's] *Trucking Activity Report*), appropriately adjusted for the inclusion or exclusion of Federal and state gallonage taxes, and then multiplying by the state sales tax rate. It was assumed that apportioned vehicles pay no sales tax on fuel,[4] because most such vehicles can avoid purchasing fuel in states with such a sales tax.

Property taxes were estimated by (1) obtaining a weighted average depreciation rate using age distribution data from the American Automobile Manufactures Association and statutory depreciation schedules from several states, (2) applying this depreciation rate to the (new) vehicle price, and (3) multiplying by the state property tax rate. A similar procedure was used for the few registration fees that reflect vehicle age. Average annual vehicle sales taxes were estimated by (1) assuming that all vehicles are sold three times—when new, and after 5 and 10 years, (2) obtaining lifetime sales taxes paid by applying the state sales tax to the estimated value of the vehicle at each sale, and (3) dividing by an average vehicle life of 16 years.

TAXES PAID BY A TYPICAL 80,000-POUND VEHICLE

Taxes Per Mile

For each of the six taxes covered and each state, Table 26 shows estimated tax payments per mile of operation in that state for a nonapportioned 80,000-lb vehicle that is based in that state and that has the characteristics shown in Table 25. In this table, and in all succeeding figures and tables in this chapter, estimated taxes per mile are shown to the nearest

[3] FHWA, *1997 Federal Highway Cost Allocation Study*, August 1997.

[4] The assumption that apportioned vehicles pay no ad valorem sales tax on fuel is the one exception to the assumption that taxes are computed for vehicles that operate entirely within a given state.

TABLE 26 State taxes per mile paid by an 80,000-lb vehicle (1996)[a]

	Registration & Related Fees	Fuel Tax	Weight - Distance Tax	Ad Valorem Taxes			Total
				Property Taxes	Sales Taxes		
					Vehicle	Fuel	
Alabama	1.1¢	3.5¢	0.0¢	1.4[f]¢	0.5¢	0.0¢	5.5¢
Alaska	0.5	1.5	0.0	0.1[f,j]	0.0	0.0	2.1
Arizona	1.4[b]	4.8	4.5	1.1[f,j]	0.5	0.0	12.3
Arkansas	1.9	3.4	0.0	0.2[h]	0.5	0.9	6.9
California	2.8	3.3	0.0	1.0[h,j,k]	0.8	1.6	9.6
Colorado	3.4	3.8	0.0	0.5[h,j]	0.5	0.0	8.1
Connecticut	2.2	3.3	0.0	1.0[f]	0.6	0.0	6.2
Delaware	1.9	4.1	0.0	0.0	0.5[l]	0.0	6.5
Dist. of Col.	1.2	3.7	0.0	0.0	0.6[l]	0.0	5.4
Florida	1.4	4.3	0.0	0.0	0.6	0.0	6.3
Georgia	1.0[c]	1.4	0.0	0.1[g]	0.6	0.8	3.9
Hawaii	2.6	2.9	0.0	0.0	0.4	0.8	6.7
Idaho	0.2	3.9	4.5	0.0	0.5	0.0	9.0
Illinois	3.1	4.0	0.0	0.0	0.7	0.7	8.5
Indiana	2.0	5.0	0.0	0.8[g,j]	0.5	0.7	8.9
Iowa	2.4	4.1	0.0	0.0	0.5	0.0	7.0
Kansas	2.8	3.7	0.0	1.3[h,j]	0.6	0.0	8.3
Kentucky	1.8	3.2	2.9	2.1[h]	0.6[l]	0.0	10.5
Louisiana	0.7	3.7	0.0	0.0	0.8	0.0	5.2
Maine	1.3	3.7	0.0	0.9[f,j]	0.6	0.0	6.4
Maryland	1.8	4.5	0.0	0.0	0.5[l]	0.0	6.8
Massachusetts	1.7	3.9	0.0	0.6[f,j]	0.5	0.0	6.7
Michigan	1.9	2.8	0.0	0.0	0.6	1.3	6.5
Minnesota	2.5	3.7	0.0	0.0	0.6	0.0	6.8
Mississippi	2.7[d]	3.3	0.0	0.0	0.7	0.0	6.7
Missouri	2.5	2.8	0.0	0.7[g]	0.5	0.0	6.4
Montana	1.1	5.2	0.0	1.6[h,j]	0.0	0.0	7.8
Nebraska	1.3[b]	4.6	0.0	1.0[i]	0.6	0.0	7.4
Nevada	2.0	5.0	0.0	0.5[h]	0.6	0.0	8.1
New Hampshire	1.7	3.3	0.0	0.6[f,j]	0.0	0.0	5.6

(*continued on next page*)

TABLE 26 (Continued)

	Registration & Related Fees	Fuel Tax	Weight - Distance Tax	Ad Valorem Taxes			Total
				Property Taxes	Sales Taxes		
					Vehicle	Fuel	
New Jersey	1.4	2.5	0.0	0.0	0.6	0.0	4.5
New Mexico	0.2	3.3	3.2	0.0	0.0	0.0	6.7
New York	1.4	4.5	3.9	0.0	0.7	1.0	11.5
North Carolina	1.4	4.0	0.0	0.3[g]	0.5	0.0	6.1
North Dakota	1.3[d]	3.3	0.0	0.0	0.5	0.0	5.1
Ohio	1.9	4.1	0.0	0.0	0.6	0.0	6.5
Oklahoma	1.4	2.4	0.0	0.0	0.4	0.0	4.2
Oregon	0.5	0.0	14.6	0.0	0.0	0.0	15.0
Pennsylvania	1.6	3.3[e]	0.0	0.0	0.6	0.0	5.5
Rhode Island	1.2	5.2	0.0	1.1[f]	0.7	0.0	8.2
South Carolina	1.2	2.9	0.0	0.4[f]	0.5	0.0	5.0
South Dakota	2.1	3.3	0.0	0.0	0.4	0.0	5.8
Tennessee	1.9	3.3	0.0	0.4[g]	0.8	0.0	6.4
Texas	1.2	3.7	0.0	1.0[g]	0.8[l]	0.0	6.6
Utah	0.9	3.5	0.0	0.5[i]	0.6	0.0	5.4
Vermont	2.4	4.6	0.0	0.0	0.5[l]	0.0	7.4
Virginia	1.7[c]	3.6	0.0	1.4[g]	0.4[l]	0.4	7.6
Washington	2.4	4.2	0.0	0.8[h,k]	0.7	0.0	8.2
West Virginia	1.6	3.8	0.0	0.8[f]	0.5[l]	0.0	6.7
Wisconsin	2.6	4.3	0.0	0.0	0.3	0.0	7.5
Wyoming	1.2	1.7	0.0	0.5[i,j]	0.2	0.0	3.6

a Vehicle is for hire, nonapportioned with other characteristics shown in Table 25.

b For apportioned vehicles: 2.9 cents per mile in Arizona and 1.8 cents per mile in Nebraska.

c For private carriers: 0.6 cents per mile in Georgia and 1.4 cents per mile in Virginia.

d Varies with vehicle age.

e 5.2 cents per mile in Pennsylvania for vehicles subject to fuel tax reporting.

f Applies only to vehicles based in state (including apportioned vehicles).

g Applies only to in-state mileage of vehicles based in state.

h Applies to all vehicles; for apportioned vehicles based on percent of miles in state.

i Applies only to nonapportioned vehicles based in state.

j Based on statutory depreciation rate.

k Identified by the state as a motor vehicle tax.

l Ad valorem titling tax or similar motor vehicle tax.

Sources: Derived from Table 25 and American Trucking Associations, *Motor Carrier Advisory Service*, Volume III, State Service, updat February 1996.

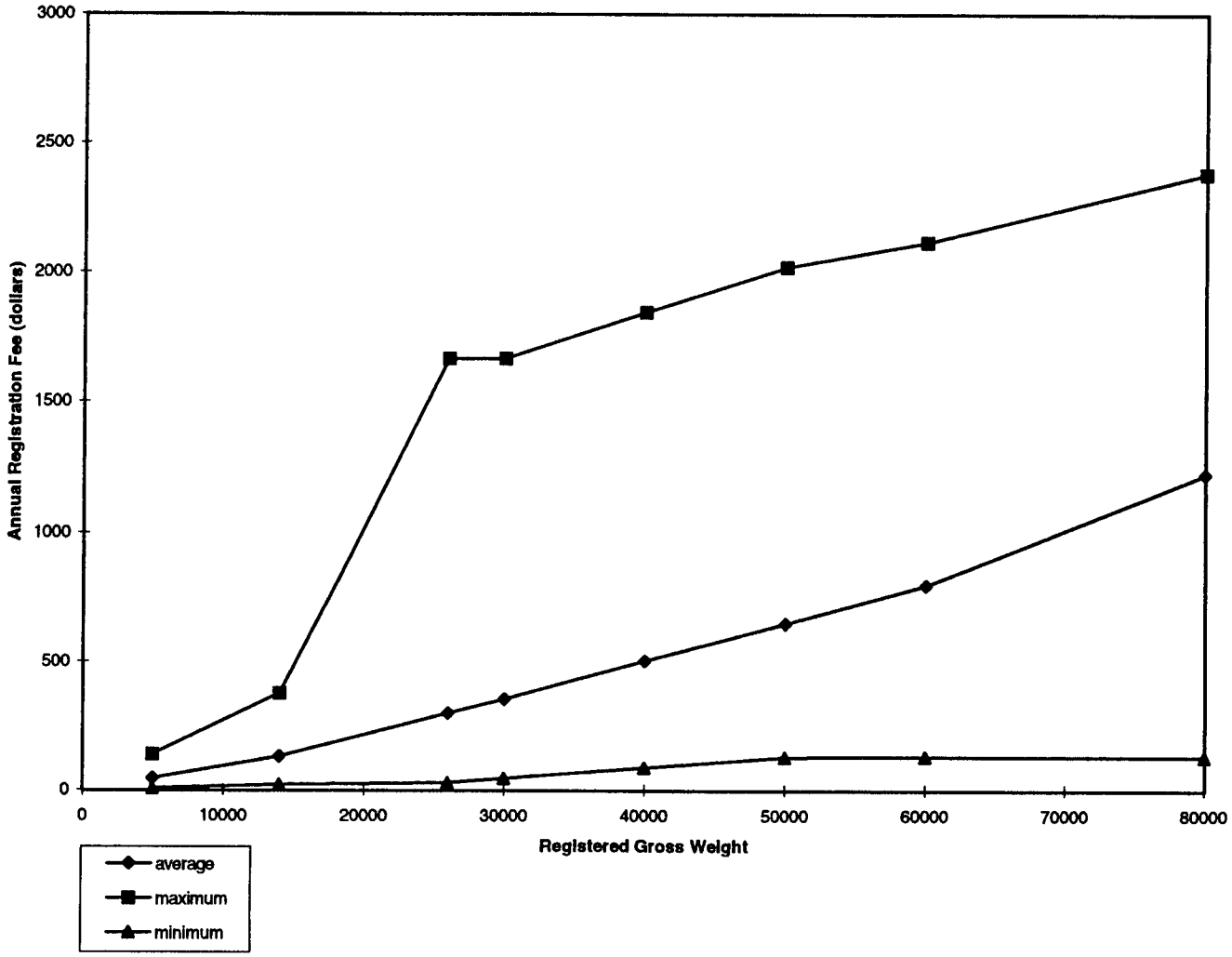

Figure 4. State registration fees as a function of registered gross weight.

one-tenth of 1 cent, although the data used do not always support this level of accuracy.

For Table 26, a nonapportioned vehicle was assumed to show the property tax payments of these vehicles. As indicated in the footnotes, apportioned vehicles are exempt from property taxes in some states. (In all subsequent exhibits, the 80,000-lb vehicle is assumed to be apportioned.) Property taxes and sales taxes shown are estimates of the average payment per mile over the life of the vehicle[5]; for owners of new and relatively new vehicles, these taxes may be appreciably higher. As discussed earlier, the figures in Table 26 exclude various taxes (such as permit fees) that contribute only a small portion of highway revenue.

Table 26 indicates that total tax payments per mile range from 2.1 cents in Alaska to 15 cents in Oregon. However, the figure for Alaska excludes substantial state revenue obtained from ferry fees. Five of the six states with the highest taxes have weight-distance taxes.[6]

Comparisons with Other Sources

The figures in the first three columns of Table 26 are similar to corresponding information published quarterly by the ATA[7] and formerly published by the Association of American Railroads[8] (AAR). However, the ATA publication shows annual taxes rather than taxes per mile, and both the ATA and the AAR publications exclude consideration

[5] Also, for several states, property taxes were estimated using a generic depreciation schedule rather than the state's statutory schedule. States for which the statutory depreciation schedule was used are indicated by Footnote j in Table 26.

[6] Weight-distance taxes are not inherently high, and in fact low rates per mile usually apply for lighter vehicles. States that have the highest tax rates for heavier trucks generally are states that have focused on meeting cost responsibility for these trucks in their tax structure, and some of these states have concluded that a weight-distance tax is the most effective and equitable means of achieving this goal.

[7] American Trucking Associations, "Annual State Highway User Taxes on Typical 5-Axle Tractor-Semitrailer Combination as of July 1996," no date.

[8] Association of American Railroads, "Apportioned State Highway User Fees for Heavy Interstate Trucks" (using January 1995 tax rates), no date.

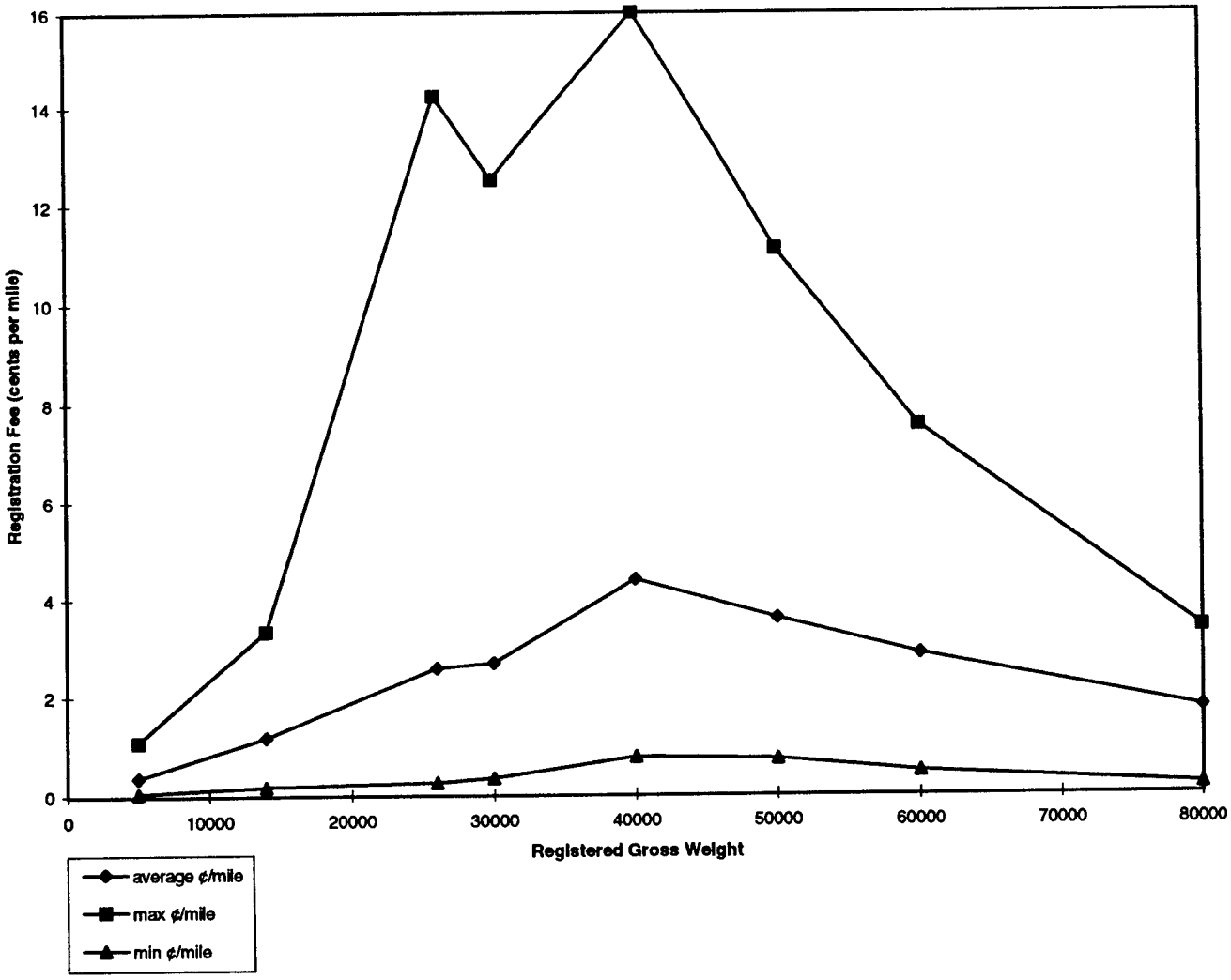

Figure 5. State registration fees per mile as a function of registered gross weight.

of ad valorem taxes[9] and use somewhat different assumptions about annual mileage and fuel efficiency.[10]

The ATA estimates are for a vehicle traveling 80,000 mi per year with a fuel efficiency of 5.7 mpg. On an annual basis, these assumptions produce estimates that are higher than the ones in this report by 8 percent for fuel taxes and by 14 percent for weight-distance taxes. The registration fees are the same. On a per-mile basis, the ATA assumptions produce estimates that are lower than the ones in this report by 5 percent for fuel taxes and by 12 percent for registration fees. The weight-distance taxes are the same.

The AAR estimates are for a typical long-distance interstate truck. Such a truck has characteristics that are quite different from most other trucks. AAR developed its estimates for a vehicle traveling 122,487 mi per year with a fuel efficiency of 6.2 mpg. On a per-mile basis, these assumptions produce estimates that are lower than the project team's by 12 percent for fuel taxes and by 43 percent for registration fees. On an annual basis, the AAR assumptions produce estimates that are higher by 52 percent for fuel taxes and by 74 percent for weight-distance taxes.

TAXES PAID BY FOUR PROTOTYPICAL VEHICLES

Total Taxes

For each state, Table 27 lists estimates of total annual and per-mile state taxes for the four prototypical vehicles. The

[9] The AAR fuel tax rates apparently include the sales tax in California, Georgia, Illinois and New York but exclude it in Arkansas, Indiana, Michigan, and Virginia. (The AAR table does not cover Hawaii, which also applies a sales tax to fuel.)

[10] Also, both ATA and AAR use vehicles that are subject to apportionment of registration fees and to fuel tax reporting. As indicated in the footnotes to Table 26 (and directly reflected in the summary data presented in all subsequent tables in this chapter), these vehicles pay higher registration fees in Nebraska and higher fuel taxes in Pennsylvania.

TABLE 27 State taxes paid by four prototypical vehicles (1996)[1]

	Registered GVW							
	30,000 lb		50,000 lb		60,000 lb		80,000 lb	
	Annual	Per-Mile	Annual	Per-Mile	Annual	Per-Mile	Annual	Per-Mile
Alabama	$988	7.4¢	$1629	9.0¢	$2226	7.9¢	$3902	5.5¢
Alaska	356	2.7	519	2.9	797	2.8	1500	2.1
Arizona	1533	11.5	2457	13.5	3821	13.6	9751	13.8
Arkansas	843	6.3	1459	8.0	2203	7.9	4229	6.0
California	1595	12.0	2514	13.8	2909	10.4	5588	7.9
Colorado	2409	18.1	3149	17.3	3794	13.5	5727	8.1
Connecticut	937	7.0	1757	9.7	2427	8.7	4352	6.2
Delaware	1081	8.1	1754	9.7	2451	8.7	4549	6.5
D.C.	914	6.9	1374	7.6	1837	6.5	3832	5.4
Florida	901	6.8	1603	8.8	2293	8.2	4459	6.3
Georgia	431	3.2	758	4.2	1125	4.0	2175	3.1
Hawaii	1219	9.2	1872	10.3	2398	8.5	4179	5.9
Idaho	782	5.9	1239	6.8	1902	6.8	6367	9.0
Illinois	1312	9.9	2221	12.2	3110	11.1	5468	7.8
Indiana	1336	10.0	2165	11.9	3039	10.8	5747	8.2
Iowa	1071	8.0	1935	10.6	2703	9.6	4955	7.0
Kansas	1233	9.3	1965	10.8	3245	11.6	5839	8.3
Kentucky	1537	11.5	2441	13.4	4296	15.3	7368	10.5
Louisiana	748	5.6	1164	6.4	1895	6.8	3638	5.2
Maine	1211	9.1	1878	10.3	2601	9.3	4488	6.4
Maryland	840	6.3	1705	9.4	2429	8.7	4784	6.8
Massachusetts	1250	9.4	1958	10.8	2718	9.7	4732	6.7
Michigan	982	7.4	1615	8.9	2144	7.6	3659	5.2
Minnesota	952	7.1	1634	9.0	2430	8.7	4786	6.8
Mississippi	1019	7.7	1738	9.6	2428	8.7	4712	6.7
Missouri	781	5.9	1257	6.9	2393	8.5	4532	6.4
Montana	1259	9.5	2030	11.2	2915	10.4	5516	7.8
Nebraska	1317	9.9	2081	11.4	2918	10.4	5012	7.1
Nevada	1448	10.9	2279	12.5	3185	11.4	5716	8.1
New Hampshire	812	6.1	1285	7.1	1834	6.5	3935	5.6
New Jersey	830	6.2	1321	7.3	1882	6.7	3166	4.5
New Mexico	534	4.0	987	5.4	1651	5.9	4697	6.7
New York	1101	8.3	1844	10.1	3070	10.9	7412	10.5
North Carolina	1038	7.8	1644	9.0	2317	8.3	4309	6.1
North Dakota	702	5.3	1256	6.9	1858	6.6	3569	5.1
Ohio	966	7.3	1616	8.9	2342	8.3	4594	6.5
Oklahoma	654	4.9	1060	5.8	1621	5.8	2936	4.2
Oregon	777	5.8	1464	8.1	2597	9.3	10566	15.0
Pennsylvania	1044	7.8	1705	9.4	2502	8.9	5234	7.4
Rhode Island	1434	10.8	2301	12.7	3271	11.7	5730	8.1
South Carolina	840	6.3	1304	7.2	1845	6.6	3488	5.0
South Dakota	936	7.0	1613	8.9	2240	8.0	4084	5.8
Tennessee	1264	9.5	1931	10.6	2611	9.3	4526	6.4
Texas	1316	9.9	2056	11.3	2737	9.8	4637	6.6
Utah	951	7.1	1504	8.3	2069	7.4	3525	5.0
Vermont	1135	8.5	1966	10.8	2827	10.1	5234	7.4
Virginia	1212	9.1	1930	10.6	2821	10.1	5052	7.2
Washington	1314	9.9	2100	11.6	3083	11.0	5797	8.2
West Virginia	1069	8.0	1692	9.3	2688	9.6	4684	6.7
Wisconsin	1056	7.9	1737	9.6	2536	9.0	5265	7.5
Wyoming	626	4.7	1026	5.6	1414	5.0	2254	3.2

[1] Vehicles have characteristics shown in Table 25.

Sources: Derived from Table 25 and American Trucking Associations, *Motor Carrier Advisory Service,* Volume III, State Service, updated to February 1996.

three lighter vehicles are assumed to be nonapportioned and, in this and all succeeding tables, the 80,000-lb vehicle is assumed to be apportioned. This last assumption results in some differences between the taxes per mile shown for an 80,000-lb vehicle in this exhibit and those shown for a nonapportioned 80,000-lb vehicle in Table 26. The apportioned vehicle pays a higher registration fee in Arizona and Nebraska and a higher fuel tax in Pennsylvania (as indicated in Footnotes b and e in Table 26), and apportioned vehicles pay no property taxes in several states (indicated by Footnote i in Table 26). Also, the project team has assumed that apportioned vehicles pay no ad valorem sales tax on fuel, because most such vehicles can avoid purchasing fuel in states that have such a tax.

The appropriate treatment is less clear for the property tax paid by apportioned vehicles in states denoted by Footnotes f, g, and h in Table 26. In several states (denoted by Footnote f), this tax is paid by all vehicles based in the state but not by out-of-state vehicles. In other states (denoted by Footnote h), this tax is effectively paid by all vehicles at the Table 26 rate per mile for operations in the state, but not for operations elsewhere; and in still other states (denoted by Footnote g), the tax is paid at this rate per mile for in-state operations only by vehicles based in the state. For the purpose of estimating property taxes paid by apportioned vehicles, the project team has chosen to treat these vehicles as being both based in the state and operating entirely in that state. This assumption clearly overstates property taxes paid by apportioned vehicles in several states (by up to 1.6 cents per mile). For some of the comparisons made below, this overstatement proves to be more helpful than the alternative of understating taxes by ignoring property taxes paid by apportioned vehicles.

Table 28 summarizes the information presented in Table 27. The first three lines list the average of annual taxes paid by the four prototypical vehicles in the five states in which these vehicles pay the highest taxes, in the five states in which they pay the lowest taxes, and the overall (unweighted) average of taxes paid. The remaining three lines of this table list the corresponding taxes paid per mile of operation.

Table 27 lists very substantial differences between taxes paid in different states, and Table 28 indicates that for each prototypical vehicle, there is roughly a three-to-one ratio between taxes in the five highest tax states and in the five lowest tax states. Annual taxes range from $356 for the 30,000-lb vehicle in Alaska to $10,566 for the 80,000-lb vehicle in Oregon; and taxes per mile range from 2.1 cents for the 80,000-lb vehicle in Alaska to 18.1 cents for the 30,000-lb vehicle in Colorado. The taxes paid by the three lighter vehicles in Wyoming reflect the state's reduced registration fee applied to vehicles that operate less than 30,000 mi per year.[11]

[11] Two other states have reduced registration fees for low annual mileage vehicles: Colorado has reduced fees for vehicles operating less than 10,000 mi per year, and Illinois allows low annual mileage vehicles that operate entirely in-state the option of paying a "mileage weight tax." This option is equivalent to allowing low annual mileage vehicles to pay a tax that is partly prorated on the basis of annual mileage; the break-even point varies with weight and generally is less than 13,000 mi per year.

Cost responsibility per mile rises with GVW, and so it would be desirable for taxes per mile also to rise with GVW. The two tables indicate that annual tax payments do rise with GVW. However, because annual mileage goes up with GVW, taxes per mile generally fall with increasing GVW for GVWs above 50,000 lb. There are only three states (Arizona, Idaho, and Oregon) in which taxes per mile are higher for 80,000-lb vehicles than for 60,000-lb vehicles. In most states, taxes per mile are lower for 80,000-lb vehicles than they are for 30,000-lb vehicles, and in one state (Colorado) they are higher for the 30,000-lb vehicle than for any of the other vehicles. The tendency for taxes per mile to be lower for the 80,000-lb vehicle (which is assumed to be apportioned) than for the lighter vehicles (which are assumed to be nonapportioned) occurs despite the decision to overstate property taxes paid by apportioned vehicles.

Composition of Taxes

For each of the prototypical vehicles and each of the five major taxes[12], Table 29 lists estimates of the (unweighted) average percentage of payments of these taxes coming from the tax in question. Also shown are the corresponding percentages for the five states with the highest percentages for this tax and the five states with the lowest percentages. Thus, on average, 31 percent of the relevant tax payments of a 30,000-lb vehicle comes from registration fees; but, for the five states placing the greatest reliance on registration fees, this figure rises to 56 percent; and, for the five states placing the least reliance on these fees, this figure is only 11 percent. For the 50,000- and 60,000-lb vehicles, the percentages are fairly similar; however, they are moderately lower for the 80,000-lb vehicle.

Table 29 shows that each of the five taxes is at least a moderately important source of revenue in at least some states, but that the importance of individual taxes tends to vary with GVW. The share of tax payments from the two ad valorem taxes on vehicles and, to a lesser extent, from registration fees, tends to decline with GVW, in part because these fixed fees are independent of annual mileage. On the other hand, the share of tax payments from weight-distance taxes and, to a lesser extent, fuel taxes, tends to increase with GVW, in part because these are mileage-related taxes.

The last six lines of Table 29 are the shares of tax payments obtained from the three fixed fees and from the three mileage-related taxes (the weight-distance tax and the two taxes on fuel that have been combined in the table). It can be seen that some states place greater reliance on fixed fees and others on mileage-related taxes. However, in most states, fixed fees account for a majority of the tax payments from the

[12] For the purpose of the Table 22 analysis, the gallonage and ad valorem fuel taxes have been combined into a single category.

TABLE 28 Annual taxes and taxes per pile in states with high, low, and average tax rates (1996)[1]

	Registered GVW			
	30,000 lb	50,000 lb	60,000 lb	80,000 lb
Annual Taxes				
Five highest states	$1704	$2572	$3685	$8293
Average	1057	1715	2479	4828
Five lowest states	520	870	1322	2406
Taxes per Mile				
Five highest states	12.8¢	14.2¢	13.1¢	11.8¢
Average	7.9	9.4	8.8	6.9
Five lowest states	3.9	4.8	4.7	3.4

[1] Vehicles have characteristics shown in Table 25.

Sources: Derived from Table 25 and American Trucking Associations, *Motor Carrier Advisory Service*, Volume III, State Service, updated to February 1996.

three lighter vehicles while mileage-related taxes account for a majority of the tax payments from the 80,000-lb vehicle.

SENSITIVITY OF TAXES PAID TO WEIGHT

Registration fees and weight-distance tax rates normally increase with vehicle weight. Although fuel tax rates and ad valorem tax rates normally are the same for all trucks,[13] revenue from these taxes also tends to increase with weight because of increases in fuel consumption and value with vehicle weight.

Figure 4 shows the average, maximum, and minimum registration fees paid by apportioned vehicles of various registered gross weights. To improve comparability across vehicle weights, all vehicles in this analysis have been assumed to be apportioned.[14] The figure includes data for 5,000-, 14,000-, 26,000-, and 40,000-lb vehicles as well as for vehicles with the four weights analyzed above. Average annual registration fees for an 80,000-lb vehicle are 326 percent of fees for a 30,000-lb vehicle.

Although registration fees increase with weight and ad valorem taxes on vehicles increase indirectly with weight, these taxes are insensitive to mileage. Furthermore, because heavier vehicles travel significantly more than do lighter vehicles, on a per-mile basis, registration fees and ad valorem taxes on vehicles actually decrease with increasing weights. Figure 5 shows the average, maximum, and minimum registration fees per mile based on the national average of miles traveled by the vehicles in the tax rate database. Average registration fees per mile for an 80,000-lb vehicle are 62 percent of fees for a 30,000-lb vehicle, and they are only 38 percent of the fees on a 40,000-lb vehicle.

Because ad valorem taxes on vehicles do not increase with weight as much as do registration fees, ad valorem taxes per mile drop more dramatically with weight than do registration fees. The average value (and hence average ad valorem tax payment) of an 80,000-lb vehicle is only about 70 percent more than the average value of a 30,000-lb vehicle, while an 80,000-lb vehicle pays an average of 326 percent more in registration fees than a 30,000-lb vehicle.

Some states have lower registration fees for vehicles that travel fewer miles or that have characteristics (e.g., farm, nonapportioned, intrastate, private) that suggest that they travel fewer miles. For example, Colorado and Wyoming have reduced registration fees for vehicles that travel less than 10,000 mi (Colorado) or 30,000 mi (Wyoming) per year, and Tennessee has reduced fees for private (not-for-hire) vehicles. These provisions allow registration fees in these states to have at least a gross sensitivity to annual mileage. Travel and per-mile taxes paid by vehicles with these characteristics are discussed further in the next section.

Although the above fixed fees decline on a per-mile basis as GVWs increase, this is not the case for the mileage-related taxes. Figure 6 shows the low, high, and average fuel tax payment per mile as a function of GVW. Because Oregon exempts vehicles with GVWs over 26,000 lb from the tax (levying a weight-distance tax instead), the lowest value goes to zero above 26,000 lb. However, the average and high values for fuel taxes per mile show a steady increase. The average fuel tax paid per mile is 34 percent higher for the 80,000-lb vehicle than for the 30,000-lb vehicle.

[13] In each state, only one fuel tax rate can be applied to vehicles covered by IFTA (i.e., interstate vehicles with GVWs above 26,000 lb).

[14] The registration fees used in this analysis are the rates that trucks would pay as for-hire, non-farm, apportioned trucks traveling more than 30,000 mi per year. Some states have lower fees for vehicles with other characteristics.

TABLE 29 Composition of taxes paid by prototypical vehicles (1996)[1]

	Percent of Five Major Taxes			
	Registered GVW			
	30,000 lb	50,000 lb	60,000 lb	80,000 lb
Registration Fees				
Five highest states	56%	58%	51%	41%
Average	31	35	32	26
Five lowest states	11	15	15	7
Fuel Taxes[2]				
Five highest states	53%	52%	55%	70%
Average	35	36	41	55
Five lowest states	16	18	22	30
Weight-Distance Taxes				
Five highest states	25%	29%	37%	53%
Average	2	3	4	6
Five lowest states	0	0	0	0
Property Taxes				
Five highest states	44%	38%	30%	18%
Average	13	11	10	5
Five lowest states	0	0	0	0
Sales Tax on Vehicles				
Five highest states	32%	26%	24%	14%
Average	18	15	14	8
Five lowest states	0	0	0	0
Fixed Fees				
Five highest states	79%	77%	69%	56%
Average	62	61	55	39
Five lowest states	35	33	29	12
Mileage-Related Taxes				
Five highest states	65%	67%	71%	88%
Average	38	39	45	61
Five lowest states	21	23	31	44

[1]Vehicles have characteristics shown in Table 25.
[2]Includes ad valorem sales tax on fuel.
Sources: Derived from Table 25 and American Trucking Associations, *Motor Carrier Advisory Service*, Volume III, State Service, updated to February 1996.

Figure 7 shows the average, maximum, and minimum weight-distance tax rates for the six states that have weight-distance taxes. This tax is applied only to vehicles registered above a certain minimum weight. This minimum weight is 18,001 lb in New York; 26,001 lb in Arizona, New Mexico, and Oregon; and 60,000 lb in Idaho and Kentucky. As can be seen from the figure, the average weight-distance tax per mile on an 80,000-lb vehicle is 48 percent higher than the tax on a 60,000-lb vehicle and nearly triple the tax on a 30,000-lb vehicle.

TAXES PAID BY DIFFERENT VEHICLES AT THE SAME WEIGHT

Because fixed fees are spread over all the miles a vehicle travels, and not all vehicles at the same weight travel the same number of miles, taxes paid per mile by vehicles of a given weight vary with annual mileage. This section describes how average taxes paid by vehicles of a given gross weight are affected by configuration, private versus for-hire operation, apportioned versus nonapportioned status, and body and trailer type.

Configuration

Configuration is a significant influence on a vehicle's annual mileage. Table 30 presents average miles traveled and estimated taxes paid per mile by two typical configurations for each weight. Tractor-trailer combinations generally travel significantly more than do single-unit vehicles. As shown in the table, for the two intermediate weights, average annual mileage for four-axle combinations is twice that of trucks with three or more axles; and, at 80,000 lb, average annual mileage of five-axle combinations is three times that of

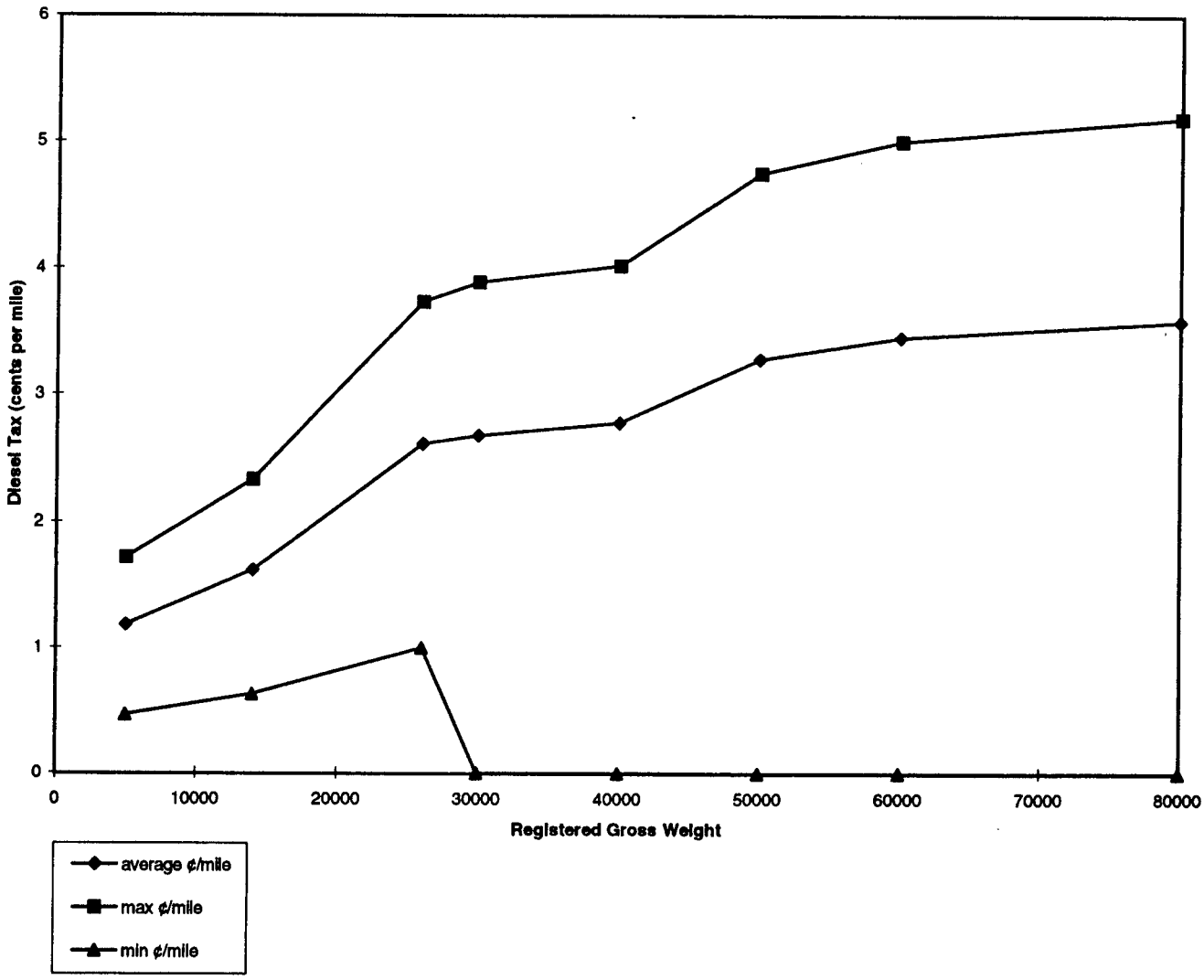

Figure 6. State diesel taxes per mile as a function of registered gross weight.

single-unit trucks. These differences have a significant effect on average taxes paid per mile by the various vehicles. At the two intermediate weights, the average single-unit truck pays 45 to 50 percent more per mile than the average combination; and at the highest weight, the average single-unit truck pays 81 percent more than the average combination.

Private Versus For-Hire

There is also a significant difference in annual mileage between private and for-hire vehicles, though the difference is not as great as that between combinations and single-unit trucks. Table 31 presents average annual miles and estimated taxes paid per mile by private and for-hire vehicles at each weight. Average annual mileage for private vehicles is between 42 percent and 65 percent of annual mileage for the for-hire vehicles at corresponding weights. Because of these differences, for-hire vehicles pay average taxes per mile that are between 61 percent and 84 percent of the taxes paid by private vehicles at corresponding weights.

Nonapportioned Versus Apportioned

Apportioned vehicles generally have higher annual mileages than nonapportioned vehicles. For vehicles weighing 50,000 or 60,000 lb, the ratio between the two average annual mileages is similar to the ratio between the average annual mileages of combinations and single-unit vehicles; however, at 80,000 lb, the ratio between the average annual mileages of combinations and single-unit vehicles is appreciably greater than the corresponding ratio between apportioned and nonapportioned vehicles.

Table 32 presents average annual mileages and estimated taxes paid per mile by vehicles operating with more than 10 percent of their mileage in their home state (assumed to be nonapportioned) and vehicles with less than this percentage

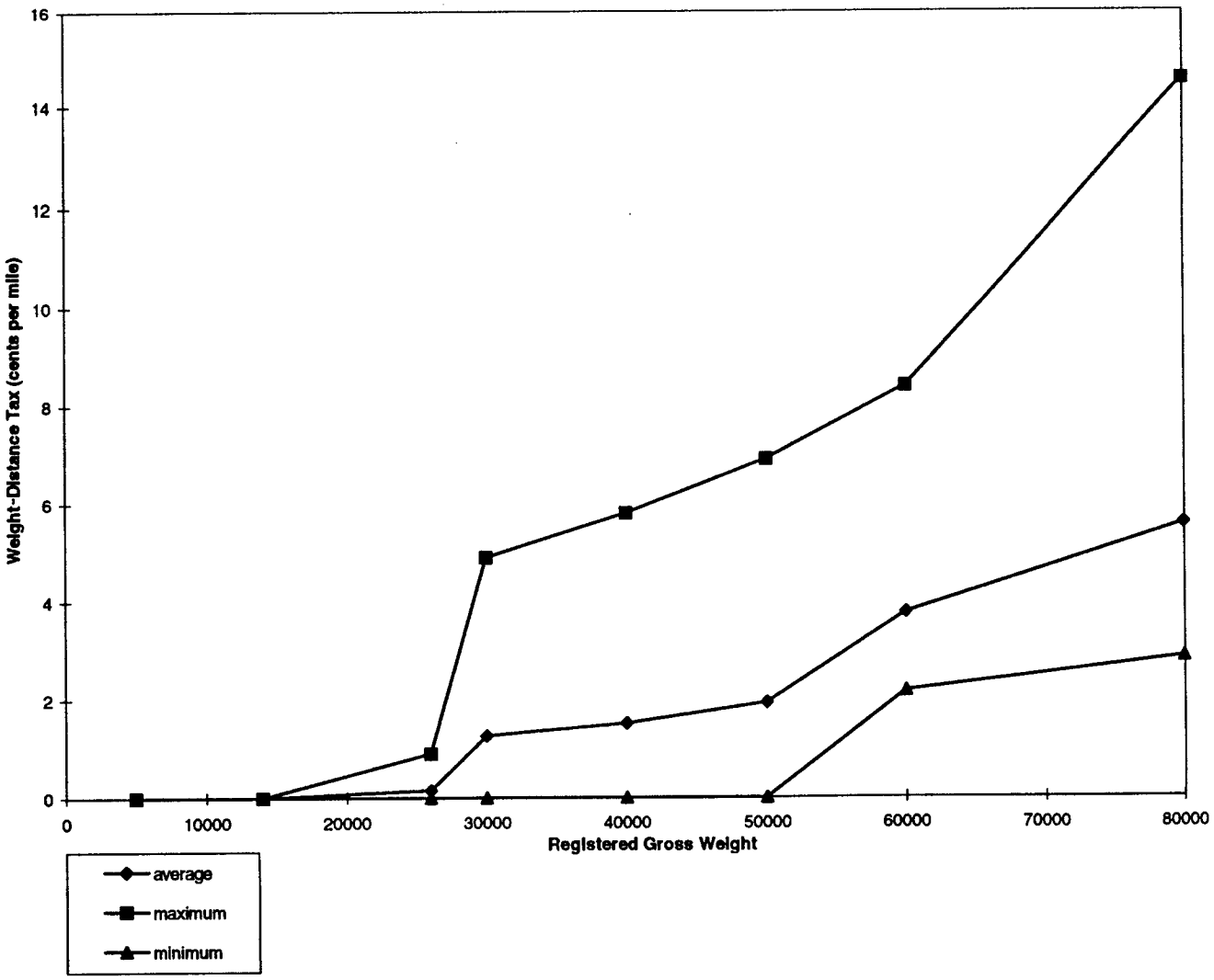

Figure 7. State weight-distance tax rates as a function of registered gross weight.

of their mileage in their home state (assumed to be apportioned). The average annual mileage of the nonapportioned vehicles is between 45 percent and 63 percent of the apportioned vehicles at corresponding weights. As a result, each of the apportioned vehicles pays taxes per mile that are between 67 percent and 80 percent of those paid by nonapportioned vehicles at corresponding weights. The higher tax payments for the nonapportioned vehicles occur despite the project team's decision to overstate property taxes paid by apportioned vehicles.

Body and Trailer Types

The analyses have focused entirely on vehicles with common body or trailer types—two-axle vans, dump trucks with three or more axles, and dry-van trailers for the tractor-trailer configurations. In states with ad valorem taxes, and particularly in states where these taxes are high, another factor affecting tax burden is the current value (and initial cost) of the vehicle. The initial cost for some specialized body and trailer types can be appreciably greater than the initial cost for vans and dump trucks. Refuse haulers typically cost about 25 percent more than dump trucks, a tractor-trailer combination using a gasoline tank trailer costs about 40 percent more than one using a dry van, and a combination using a pneumatic tank trailer or a pressurized tank trailer is appreciably more expensive.

Operators of vehicles with these high-cost body and trailer types pay higher ad valorem taxes than operators of vehicles with less expensive bodies and trailers; however, this extra burden is mitigated by the general practice of keeping expensive trailers in service for many more years than is done for less expensive trailers. Because ad valorem property taxes are paid on the depreciated value of the vehicles, the higher initial value of these specialized vehicles is partially compensated for by their greater average age.

TABLE 30 Effect of configuration on taxes per mile

Weight	Configuration	Average Miles Traveled	Taxes per Mile
30,000 lb	Single-Unit 2 Axle	13,163	8.4¢
	2-Axle Truck with Trailer	9,558	10.5
50,000 lb	Single-Unit 3+ Axle	15,656	10.9
	Combination 4 Axle	32,106	7.2
60,000 lb	Single-Unit 3+ Axle	20,342	11.1
	Combination 4 Axle	42,641	7.5
80,000 lb	Single-Unit 3+ Axle	23,628	12.5
	Combination 5 Axle	74,351	6.9

Sources: See Tables 25 and 27.

EFFECTS ON COMPETITIVENESS

Tables 26 and 27 indicate substantial variation among states in the level of taxes paid by motor carriers operating in different states. In this section, the project team considers the effects that these disparities may have on the ability of different carriers to compete for particular hauls, that is, is there a difference in the tax burden of different carriers that affects their marginal costs for providing a particular transport service?

To simplify the discussion, the focus is on the tax burden on carriers hauling freight between two points, A and B, in a single state, X. Initially, the team assumes that there is a specific vehicle configuration that is optimally designed for carrying the freight in question from A to B and that all carriers wish to use this configuration. Furthermore, it is assumed that all competing carriers can provide the service in question with equal efficiency, that is, empty mileage required at the beginning and the end of the trip is the same for all carriers.

With the above assumptions, if state X levies a weight-distance tax, weight-distance tax liabilities are the same for all carriers. Similarly, if it is assumed that all vehicles have the same fuel efficiency, because of fuel-use reporting, fuel tax liabilities are the same for all carriers.

The analysis of registration-fee liabilities is somewhat more complicated. For any carrier, the apportioned registration fee payable to state X as a result of the haul in question is a percentage of the state's annual fee, with the percentage obtained by dividing the miles traveled from A to B plus any associated empty mileage by the annual miles traveled by the vehicle in question. Accordingly, registration-fee liability is inversely proportional to the vehicle's annual mileage. However, this is merely one of several reasons why cost per mile is lower for high annual-mileage vehicles than for low annual-mileage vehicles. Because of these cost differences, the latter vehicles generally serve only relatively specialized markets, usually requiring relatively short hauls, that cannot be efficiently served by high annual-mileage vehicles. Accordingly, the difference in registration-fee liabilities is not a significant factor affecting competition between low and high annual-mileage vehicles.

Although the difference in registration-fee liabilities is not a significant factor in the competition between low and high annual-mileage vehicles, it can play a role in the competition for hauls that are priced at or near marginal cost. There are two types of such hauls: backhauls and hauls carried out-of-season by carriers whose principal markets are seasonal.

TABLE 31 Variation in taxes per mile between private and for-hire vehicles

Weight	Private/For-Hire	Average Miles Traveled	Taxes per Mile
30,000 lb	Private	12,254	8.8¢
	For-Hire	28,881	5.4
50,000 lb	Private	17,274	10.2
	For-Hire	30,674	7.4
60,000 lb	Private	25,193	9.7
	For-Hire	39,011	7.7
80,000 lb	Private	52,114	7.9
	For-Hire	87,421	6.6

Sources: See Table 25 and 27.

TABLE 32 Variation in taxes per mile between apportioned and nonapportioned vehicles

Weight	Nonapportioned/ Apportioned	Average Miles Traveled	Taxes per Mile
30,000 lb	Nonappportioned	12,412	8.7¢
	Apportioned	19,760	6.6
50,000 lb	Nonapportioned	15,747	10.8
	Apportioned	35,258	7.2
60,000 lb	Nonapportioned	22,711	10.4
	Apportioned	47,945	7.0
80,000 lb	Nonapportioned	53,085	8.0
	Apportioned	85,206	6.4

Sources: See Tables 25 and 27.

Backhauls are not likely to result in a significant change in annual mileage. (There is more extra mileage required for backhaul pickups and deliveries, but, because of time lost in making these pickups and deliveries, there is likely to be some reduction in the number of "fronthaul" trips made per year.) However, out-of-season hauls priced at or near marginal cost can produce a significant increase in annual mileage.

The marginal cost of a vehicle's out-of-season hauls is affected, to a small extent, by any difference between registration fees in the states where these hauls are made and the fees in the states where the in-season hauls are made. If the latter states have lower registration fees (using a mileage-weighted average) than the former states, then, as a result of registration-fee apportionment, increasing operations in the former states tends to raise total registration-fee liabilities. Similarly, if the latter states have higher registration fees than the former states, increasing operations in the former states tends to lower liabilities. Accordingly, carriers whose principal markets are seasonal markets in high registration-fee states have a marginal-cost advantage when competing for out-of-season hauls that would enable them to increase their annual mileage. Similarly, carriers whose principal markets are seasonal markets in low registration-fee states have a marginal-cost disadvantage when competing for out-of-season hauls that would enable them to increase their annual mileage.

The above discussion of liabilities that result from weight-distance taxes, fuel taxes, and registration fees, is readily generalized to hauls between any two points in different states.

Unlike the above taxes and fees, ad valorem taxes on the sale of vehicles are paid only to a vehicle's base state. Also, several states levy property taxes only on vehicles based in the state.[15] Accordingly, carriers whose vehicles are based in states without ad valorem sales taxes on vehicles and without property taxes that are levied only on in-state vehicles have a tax advantage relative to competing carriers whose vehicles are based in states with such taxes. Similarly, carriers that operate vehicles entirely in a state that has an ad valorem sales tax on fuel have a tax disadvantage relative to carriers operating vehicles that only operate partly in this state and that can purchase some or all of their fuel in states without such a tax.

Finally, there are the issues of compliance costs to the carriers and of evasion. Because purely intrastate carriers are not subject to apportionment of registration fees nor, in most states, to fuel-use reporting, these carriers have a paperwork advantage relative to their interstate competitors. Because of economies of scale in completing paperwork required by registration-fee apportionment, fuel-use reporting, and weight-distance tax reporting, this advantage is likely to be greatest in states that do not have a weight-distance tax and do not require fuel-use reports from intrastate carriers.

Among interstate carriers, larger carriers generally enjoy a significant efficiency advantage because they tend to be more automated and because some elements of compliance costs are relatively fixed costs that can be spread over their large fleets. On the other hand, there is good evidence that small carriers are more likely to underreport their tax liabilities (e.g., by overreporting mileage in low-tax states and underreporting mileage in high-tax states). Because small carriers usually are audited less frequently than large carriers, they are often more successful at tax evasion, and at least some carriers that are caught may simply go out of business or cease operation within the state (at least under their original corporate name)[16].

[15] States with such taxes are identified by Footnotes f, g, and i in the "Property Tax" column of Table 26. However, in the case of states identified by Footnote g, the tax is prorated to reflect only the portion of total mileage operated in state. These vehicles are placed at a disadvantage only when competing with out-of-state vehicles for hauls that require operation into, out of, or through their base state. Nonapportioned vehicles based in states identified by Footnote i and all vehicles based in states identified by Footnote f are placed at a disadvantage when competing with out-of-state vehicles for any haul.

[16] These and other similar relationships among types of carriers are documented in Cambridge Systematics and Sydec with Pacific Rim Resources, "Evasion and Enforcement of Oregon's Weight-Mile Tax," Technical Memorandum 6 of *Oregon Weight-Mile Tax Study*, prepared for Oregon Legislative Revenue Office, Public Utilities Commission, and Department Transportation, February 1996, pp. 6-27–6-40.

The previous discussion assumed that there is a specific vehicle configuration that is optimally designed for carrying freight from A to B and that this is the only configuration being considered for this haul. This is not always the case. For some hauls, more than one configuration may compete on roughly equal terms. The tax liabilities incurred by different configurations usually will be different, and, in the case of configurations with different GVWs, the differences in tax liabilities can be significant. If the tax liabilities of all configurations are proportional to their cost responsibilities, the differences in tax liabilities are fully justified. If not, some configurations are being provided a competitive advantage over other configurations. This situation demonstrates the importance of vertical equity in the design of the tax system.

The above discussion of effects on competitiveness is summarized in approximate order of significance:

- To the extent that taxes imposed on different configurations that compete with each other are not proportional to the cost responsibility of the configurations, the undertaxed configurations have a competitive advantage;
- Vehicles based in states that have neither an ad valorem tax on the sale of vehicles nor a property tax that is applied only to vehicles that are based in the state have a competitive advantage over vehicles based in states that have such taxes;
- Vehicles operating entirely in a state that has an ad valorem tax on fuel have a small competitive disadvantage relative to vehicles that are capable of operating in the state using fuel purchased elsewhere;
- Seasonal carriers operating primarily in high registration-fee states have a marginal-cost advantage when competing for out-of-season hauls with carriers that operate primarily in low registration-fee states, and carriers operating primarily in low registration-fee states have a marginal cost disadvantage when competing for such hauls;
- Some small carriers may find it easier than large carriers to reduce their tax burden by underreporting their liabilities;
- Because of efficiency advantages, the compliance burden on large carriers generally is smaller (per vehicle) than it is on similar small carriers;
- Purely intrastate carriers incur lower compliance costs than interstate carriers; and
- A reduced registration-fee liability per mile is one of several cost advantages enjoyed by high annual-mileage vehicles, but this advantage does not play a significant role in the limited degree of competition between high and low annual-mileage vehicles.

Most of the above effects apply only to relatively small numbers of carriers or vehicles and produce cost differences that are no more than a small fraction of a cent per vehicle-mile.

CHAPTER 5

TECHNOLOGY

This chapter presents a review of new technologies that are capable of reducing the administrative and compliance costs of existing or proposed heavy vehicle taxes and reducing evasion of these taxes. The first section of this chapter presents a summary of the recently introduced and very successful requirement that untaxed distillate fuel be dyed and chemically marked. The second section contains a review of various electronic and communications technologies that have potential for use in heavy vehicle taxation and monitoring systems. The third section describes functioning, experimental, and proposed applications of these technologies to weigh-station clearance, automated vehicle permitting, and systems for apportioning registration fees and fuel taxes among states. The final section of the chapter contains some preliminary conclusions about the potential roles for new and emerging technologies in the administration of highway tax systems.

DIESEL FUEL DYEING

Prior to 1991, estimated losses from combined Federal and state motor fuel tax evasion exceeded $2 billion annually.[1] In response to these revenue losses, Congress, in Section 1040 of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, authorized $35 million in fiscal years 1992–1997 for projects to counter highway use tax evasion schemes. In the 1992 DOT Appropriations Act, Congress earmarked $250,000 for studying the feasibility of using motor fuel coloring and marking as tools for stemming motor fuel tax evasion. To further enhance enforcement efforts, Section 13242 of the Omnibus Budget Reconciliation Act (OBRA-93) moved the point of Federal diesel fuel tax collection from the wholesale dealer level to the terminal rack level. Additionally, that act also mandated the dyeing of tax exempt fuel beginning January 1, 1994.

Since January 1, 1994, the Federal government has required that all tax-exempt distillate fuels be dyed red and chemically marked before being removed from a bulk storage terminal (a diesel or gasoline storage and distribution facility supplied by a pipeline or transporting vessel, from which fuel is distributed at a loading rack). The Internal Revenue Service administers the diesel fuel dyeing program. The goal of the program is to enhance Federal fuel tax enforcement efforts by making it easier for inspectors to determine if untaxed fuel is being used for taxable purposes.

The use of dyed diesel fuels is consistent with efforts underway in at least 42 nations around the world. A number of other industrialized nations, including Canada, France, Germany, Italy, Denmark, and Great Britain, use dyes to distinguish between taxable and nontaxable fuels.

In the United States, tax-exempt fuels are restricted to a few legislatively mandated purposes, such as home heating, use on a farm, or use by state and local governments. Dyed diesel fuel cannot be used to power vehicles traveling on the nation's highways, roads, and streets, except by the following exempt groups:

- Intercity buses,
- Local transit buses,
- Red Cross vehicles,
- School buses,
- State and local government vehicles,
- Vehicles owned by aircraft museums, and
- Vehicles used by nonprofit educational organizations.

The penalty for noncompliance is steep. The Internal Revenue Code provides for a penalty of $10 per gallon or $1,000, whichever is greater, plus payment of Federal diesel fuel taxes owed. Penalties increase with additional violations. States may impose fines in addition to any Federal penalties.

Enhanced enforcement efforts have augmented the impact of the Federal diesel fuel dyeing program. Additional enforcement activity has included motor vehicle fuel checks, random checks of end users, dyer enforcement at the terminal, and reviews of refund claims made by those using taxable fuel for tax-exempt purposes. To further enhance enforcement efforts, ISTEA established nine regional task forces, formally known as the Joint Project, to develop cooperative enforcement strategies.

During the program's first full year of operation (1994), diesel fuel on which Federal tax has been paid rose by 23 percent, while diesel fuel on which states taxes have been paid rose by a more modest 7 percent, about the same rate as it had

[1] Federal Highway Administration, *The Joint Federal/State Motor Fuel Tax Compliance Project: Fiscal Year 1994 Midyear Report*, Report No. FHWA-PL-95-040, November 2, 1994.

risen in the preceding year. In previous years, Federal tax had been collected on about 10 percent less fuel than state taxes had been collected on, but in 1994, fuel on which Federal taxes were collected slightly exceeded (by about 2 percent) fuel on which state taxes were collected.

FHWA estimates that, in 1994, total Federal Highway Trust Fund revenues rose by more than $1 billion from 1993. The growth in revenue is calculated net of the 1993 increase in the Federal fuel tax rate. Of these revenues, $600–700 million are directly attributable to compliance gains realized through increased motor fuel enforcement efforts, including the Federal diesel fuel dyeing program, the shift in the point of collection to the terminal rack, and the improvements made to the auditing and enforcement programs. Thus far, the investments made in these programs have yielded returns of $10 to $18 per dollar spent.[2]

ELECTRONICS AND RELATED TECHNOLOGY

There exists a wide variety of electronic and related technology with potential for application to fuel tax, registration fee, and weight-distance tax collection, auditing, and enforcement. This technology can be usefully classified according to whether it is in the vehicle, along the road, or part of computer systems for administration, operations, and management.

Vehicle Technology

Vehicle-based technologies useful for motor-carrier fuel and weight-distance taxation can identify a vehicle, determine the number of miles it travels within each jurisdiction, and communicate that information to a computer. In addition, the ability to monitor or measure fuel usage on board the vehicle can help corroborate or provide an independent record of fuel usage.

Automatic Vehicle Identification

AVI involves electronics and communications to uniquely identify a vehicle by using light, microwaves, or low-power radio waves to "read" an "electronic license plate" at highway speeds in order to associate a vehicle with a unique identification code. AVI technologies can include bar codes, transponders, radio-frequency identification (RFID) tags, and closed-circuit video cameras and vision technology coupled with optical character recognition.

The AVI technology of choice in the motor-carrier industry consists of transponders or electronic tags. A transponder/tag is mounted on either the side of a truck or trailer or the inside or outside of the windshield. Tags come in many shapes and sizes, but generally are no bigger than a wallet. Each tag stores a unique identification code and may contain additional information. There are three types of transponders/tags:

- **Type I:** Permits only one-way transmission of an identifier or other fixed data to a receiver.
- **Type II:** Permits two-way transmissions, usually with a variable message component. Thus it is possible to send a message to the transponder/tag and read the message later while assigning location and time stamps to each transmission.
- **Type III:** Permits two-way transmission of data and also provides electronic communication and interfaces to external devices including read-out displays and onboard computers.[3]

The technology currently is not standardized, and there are a large number of vendors of different types of transponders/tags even though there would be enormous advantages to standardization. It is desirable that transponders/tags work with different readers/writers in the United States, neighboring countries, and around the world. Currently in the United States there many incompatible systems offered by different vendors, and many vendors are vying to create de facto standards. At the same time, national efforts, including the National ITS Architecture and the CVISN project are attempting to establish standards for these transponders/tags.

Automatic Vehicle Location

There are a variety of different technologies that can be used to locate a commercial vehicle. This becomes important in determining the mileage a vehicle has traveled within a particular jurisdiction and may also be useful for auditing and enforcement purposes.

Satellite Global Positioning System Receivers. GPS receivers can be installed on trucks to determine their location. The Department of Defense has created a system of 24 satellites that forms the infrastructure of a worldwide navigation system. With an inexpensive stand-alone GPS receiver, one can receive transmissions from as few as three satellites to determine the latitude and longitude anywhere in the world. Currently, with a complementary base station and differential corrections (performed in post-processing or in real time) GPS receivers used in mobile civilian applications can determine location within 15 m most of the time.

[2] Federal Highway Administration, *Revenue Enhancement Through Increased Motor Fuel Enforcement,* May 21, 1996.

[3] Cambridge Systematics, Inc., *Systems Planning for Automated Commercial Vehicle Licensing and Permitting Systems,* Interim Report, prepared for Federal Highway Administration, October 5, 1993, pp. 3-2–3-3.

GPS receivers have very accurate internal clocks, and so it is possible to place time stamps on location readings. GPS allows easy calculation of speed, distance traveled, and bearing.

GPS data must be transferred to a computer or data logger to be useful. The data can be transferred through removable memory, cable, or other electronic or radio frequency connections.

Other Radio Determination Methods. GPS is one technique for using radio frequency signals to measure the distance between a truck and two or more known points by using triangulation or similar techniques. There are other methods of radio determination such as Loran C systems which transmit signals from a network of ground towers. Triangulation can also be used to determine the location of cellular transmission equipment over which people are talking or sending data.

Map Matching Algorithms. A map matching algorithm often accompanies other AVL technologies, especially for in-vehicle navigation systems. Many vendors of digital map databases and software developers have created algorithms that will correct the position of a vehicle represented on a digital map.

Border Crossing Determination Software. Software exists to determine border crossings by using a digital map database showing state or international borders and vehicle location determined through one or more AVL technologies. An example is software recently developed for a CVO operational test. The software uses probabilistic methods to determine when and where a border crossing is most likely to have occurred.[4]

Roadside Systems

Much of the technology that is potentially useful for motor-carrier fuel, registration, and weight-distance taxation is deployed by the roadside. This technology includes WIM, tag readers/interrogators, vision technology, automatic vehicle classification (AVC), axle sensors, and induction loops.

Weigh-in-Motion

Commercial vehicles can be weighed while traveling along a highway at normal speeds, but not as accurately as with a static scale. Thus, WIM can be used to screen vehicles for weight enforcement and can be combined with other technologies to automate clearances at weigh stations and ports of entry. Trucks passing the screening test can avoid the delay of leaving the highway or access road to be weighed on a static scale. Among the most commonly used WIM technologies are piezoelectric cable sensors, bending plates, capacitance weigh mats, and bridge strain transducers used in conjunction with road sensors.

Tag Readers/Interrogators

Tags/transponders on board trucks communicate with equipment installed in the pavement, beside the road, or over it. Because of a lack of standardization, different types of equipment for communicating with tags/transponders are found throughout the country.

Even though tags/transponders are not standardized, there is some potential to have roadside devices that can read and/or write to two or more different types of tags/transponders. There are two types of reader interoperability. The first is the parallel reader approach that involves the installation and operation of two or more sets of readers and antennas along the road. Each reader/antenna set would handle transmissions with only one type of tag/transponder. Time multiplexing or antenna separation might be needed to prevent interference. The second method is the multimodal reader approach, in which radio frequency and other electronics of two or more vehicle-to-roadside communication systems are packaged into a single box, allowing communication with two or more otherwise distinct systems.[5]

Vision Technology

The Oregon DOT has been working with a developer of a vision technology system that can photograph license plates at highway speeds day or night, optically scan the digits, identify the state, and record the data along with photographs of vehicles—in less than 1 second per vehicle—with a success rate of very close to 100 percent. As part of the recent Oregon Weight-Mile Tax Study, this system was used to determine with reasonable confidence that the nighttime evasion rate (operation without Oregon Public Utilities Commission plates) was not significantly different from the daytime evasion rate.

Vision technology has the potential for reducing evasion through "snoops" used in the audit process. Undetected observations of trucks are being used to identify operations of trucks that are not covered by weight-mile tax reports. Vision technology has the potential for automating the recording of thousands of such snoops (which were recorded manually and processed by computer into special audit files for more

[4] *AMASCOT: Automated Mileage and Stateline Crossing Operational Test*, Four Volumes, May 1, 1996.

[5] Robert F. Cunningham, "ETTM Equipment Interoperability," *Traffic Technology International '96*, pp. 268–270.

than 200 audits as part of the evasion analysis in the Weight-Mile Tax Study).

AVCs, Axle Sensors, and Inductive Loops

AVCs, axle sensors, and inductive loops do not have direct application to tax collection. However, they are often an integral part of automated clearance systems and other systems that produce information potentially useful for auditing and enforcement of tax collection.

Administrative, Operations, and Management Systems

Technology for truck tax collection and automated clearance involves roadside and off-site computer systems. These computer systems consist of supervisor computer systems for roadside operations, administrative and regulatory databases, EDI, and EFT.

Roadside Supervisor Computer Systems

Personnel responsible for operation of roadside CVO systems—whether for truck-size and weight enforcement, safety inspections, or commercial vehicle taxation—need access to computerized systems. Sensors may suggest a truck is not in compliance with applicable laws and regulations and may direct the truck, via a variable message sign, to pull out of the stream of traffic. Inspection and enforcement personnel need computers at their fingertips to query applicable databases or to enter information about the truck, driver, and motor carrier.

Furthermore, in quasi- or fully paperless credential systems, the transponder will communicate the identification code of the vehicle. Enforcement and inspector personnel need a computer with display to examine the status of all relevant credentials pertinent to driver, vehicle motor carrier, trip, and shipment.

Roadside computers will generally consist of either fixed-in-place PCs/workstations or portable computers (laptops or handheld computers that allow data entry with a pen-like stylus). The portable devices can have radio frequency (RF) links to a nearby computer.

Various computers in roadside inspection stations may be connected with a local area network (LAN) and these in turn to a wide area network or other communications networks and systems.

Administrative and Regulatory Databases and Computer Systems

Databases are a key part of the overall infrastructure for administration, operations, and management of commercial vehicle regulatory activities. Within a single state there are databases regarding fuel taxes, safety, registration, titles, drivers' licenses, and oversize/overweight permits. In addition, there are existing and emerging databases pertinent to fuel and weight-distance tax collection that contain information from more than one state. These multistate databases include clearinghouses for IRP, IFTA, and oversize/overweight permits.

Electronic Data Interchange

EDI consists of standardized computer transactions and formats to support the electronic exchange of business information. EDI can greatly reduce or eliminate paper transactions. EDI is widely used in business logistics management and to facilitate freight shipping and receiving. However, it is also used in many other applications. The American National Standards Institute (ANSI) Accredited Standards Committee (ASC) X12 works with private industry, and often government, to develop standards and computerized formats for EDI.[6]

EDI can play an important role in supporting apportionment of fuel tax collections among states under IRP, IFTA, and the base-state system for weight-distance taxes. EDI can also play an important role in data sharing and standardized transactions for other related state, regional, or national clearinghouses and databases. In addition, EDI can greatly speed and simplify transactions between government databases and private entities such as motor carriers or insurance companies.

Electronic Funds Transfer

The banking network provides the means to transfer funds electronically. Motor carriers must make tax payments, which can generally be handled much more efficiently and accurately through EFT than by manual methods. In addition, apportionment of fuel, registration, and weight-distance tax collections among states can potentially be handled more efficiently through EFT supplemented by electronic and manual auditing procedures of each state. To establish electronic procedures for tax payments, payers and receivers need to establish standards consistent with existing EFT arrangements of banks.

CURRENT AND EMERGING SYSTEMS

The technologies described in the preceding section have several actual and potential applications to the administration of heavy vehicle taxes. The first three subsections below describe systems that have been developed over the past several years for using these technologies for weigh station

[6] Johns Hopkins University, Applied Physics Laboratory, *Commercial Vehicle Information Systems and Networks (CVISN), Operational Concept*, prepared for the Federal Highway Administration, Preliminary Report, June 1996, pp. 3–33.

clearance, for automated permitting of heavy vehicles, and for electronic toll collection. The fourth subsection describes the recent Automated Mileage and Stateline Crossing Operational Test (AMASCOT) which evaluated the use of satellite communications and related technologies for automatically recording a vehicle's mileage in each state in which it operates as required by the IRP and IFTA. The final subsection describes current plans for designing integrated systems that could combine all of the capabilities described in the first three subsections.

Weigh Station Clearance

Many of the technologies described above have been incorporated into automated weigh station clearance systems. While clearance systems per se are not intended for motor-carrier tax collection, the information from such systems can be used for auditing. Trucks that pass automated clearance stations create events recorded in databases. Information associated with these events would normally include the time and location of the event, the vehicle identification number, the measured weight, truck classification and axle spacing, and possibly the number of vehicle-miles traveled so far on a mainline served by a weigh station clearance system. Auditors can use this type of information to check the accuracy of selected documents supporting tax submittals.

Weigh station clearance can be accomplished by a system involving WIM, AVI, and some method to signal drivers to bypass or pull into a weigh station. Differences exist between mainline bypass systems and systems involving low-speed WIM on the weigh station access road. Low-speed WIM results in fewer unnecessary diversions to the static weigh scale, while mainline WIM results in less delay for those trucks allowed to bypass the weigh station. Also, if the WIM cannot be installed on the main lanes at a location to allow sufficient processing time and safe exit from the highway, it may be better to require all trucks to leave the main lanes and screen their weight on the access road.

In either case, if WIM determines that a truck's weight exceeds an allowable threshold, a variable message sign or some other electronic communication directs the driver to pull onto the static scales. Otherwise, the truck is cleared to continue down or return to the highway.

If credential checking is integrated into the system, a tag reader obtains the vehicle identification code and checks it against a credential database. If the credentials are not in good order, the truck will be signaled to pull into the station for inspection.

A number of systems have been implemented that include these capabilities. The HELP (Heavy Vehicle Electronic License Plate) Program, begun in the early 1980s by several western states to develop, test, and demonstrate a wide range of heavy vehicle monitoring systems, has focused on use of WIM, AVC, AVI, and communications to a regional database.

HELP evolved into a demonstration program known as Crescent. The HELP/Crescent program grew to include 32 sites in 14 states and one Canadian province, forming an arc along Interstates 5 and 10 from British Columbia to Texas. Not all sites were equipped to allow fully automated bypass of weight and inspection stations. Nevertheless, the HELP/Crescent approach demonstrated the technical feasibility of automated mainline clearance of heavy trucks, but not without conflict. The motor-carrier industry voiced concern that the HELP/Crescent program was intended as a program to develop infrastructure for weight-distance taxes. As a result of this concern, participating states decided to limit the objectives of the program to reducing motor-carrier delays, improving the performance of the highway system, improving administrative efficiency, and protecting investment in state infrastructure.[7]

The HELP/Crescent program probably would have accomplished more in developing and testing technologies to aid in heavy vehicle tax administration and enforcement if it had followed its originally stated objectives; however, this would have been very difficult to accomplish with the active involvement of motor-carrier industry representatives as essentially equal partners.

The HELP/Crescent program has now become a public/private partnership called HELP Inc. HELP Inc. involves a third-party private provider of systems and information services, Lockheed Martin, and offers a menu of pay-per-use services to carriers and states. These services include PrePass, an automated clearance system based on the Crescent system. Approximately 4,000 trucks from 200 carriers are now involved.

One of the keys to the success of the HELP/Crescent program has been the decision to contract with a third party to operate the system with well-defined protections of the database. Neither the private sector nor the public sector has direct access to the database; but each has access to specific data items needed to serve the agreed upon program objectives. Data considered to be of proprietary interest are protected, and the states cannot obtain data for tax administration purposes.

HELP/Crescent also has led to a number of other systems. One is Advantage I-75, a program established to provide automated preclearance at 30 weigh stations along the 2,200-mi corridor of Interstate 75. The Advantage I-75 program is similar to the HELP approach in that a single centralized database of carrier credentials is used for the electronic clearance decision by all participating states. Each state is responsible for updating the credentials database in the centralized "gateway computer" for all carriers from which it receives credentials information. When a truck enters the first automated station, information about truck weight and credentials is written to an electronic tag on board the truck. Readers at

[7] Cambridge Systematics, Inc., *ITS/CVO Institutional Issues Study: Maine, New Hampshire, and Vermont,* October 1995, pp. 4-40–4-43.

each subsequent station retrieve these data from the tag. Each state or group of states has its own credentials database against which the information on the tag is checked. If truck weights and credentials are in conformance with a state's laws and regulations, the truck is allowed to bypass the weigh station. Otherwise it is pulled in.[8]

In another related effort, Oregon is pursuing Operation Greenlight to automate clearance at all the state's ports of entry and major weigh stations. Operation Greenlight, a $23 million program seeded with $8 million in Federal funds, evolved from a test of an automated preclearance system at the Ashland northbound port-of-entry on I-5 in 1992. The program employs mainline preclearance systems to weigh, classify, identify, verify, and direct commercial vehicles at highway speeds. The system enables commercial vehicles meeting necessary legal, safety, and tax requirements to bypass ports-of-entry and weigh stations. ODOT's preclearance system uses WIM scales, AVC, overheight detectors, axle sensors and loops, AVI systems (transponders), variable message signs (VMS), vision technology, and a supervisory system computer (SSC) to process vehicle information instantaneously.[9]

ODOT has proposed a discount of highway user taxes for firms investing in new technology by equipping their vehicles with AVI equipment (transponders) and using EDI to report and pay their highway use taxes electronically.[10] The proposal would reduce total tax liability of participating motor carriers by up to 3 percent.

Another automated clearance system has been implemented for longer combination vehicles using I-84 in Utah, Idaho, and Oregon. This system, called the Regional Automated Permit Processing Program (RAPPP) or IOU (for the three participating states), uses transponders to serve as annual trip permits and to provide activity data that will be used in an ongoing safety study.[11]

Credential Purchases and Verification

One-stop shopping programs are designed to allow motor carriers to obtain all their credentials and to submit filings under the IRP, IFTA, and other programs in a single communication or at a single site (usually a state agency, a service bureau, or a weigh station or port-of-entry). Automation can facilitate one-stop shopping, reduce the credential and tax report processing time for both states and motor carriers, and increase productivity of both state and motor-carrier employees.

Several states have established comprehensive one-stop shopping programs. California has recently completed a demonstration of a one-stop shopping program at a border site, in cooperation with Arizona and New Mexico, and is currently evaluating the results before proceeding with an implementation program. In addition, a number of states working under regional AASHTO committees have established multistate one-stop shopping for the issuance of permits for oversize/overweight loads.[12] Expanded one-stop shopping programs are envisioned under the CVO module of the ITS and the related CVISN. The ongoing development of these systems is discussed in the final subsection of this section.

Electronic Toll Collection Systems and Heavy Vehicle Pricing

Electronic toll collection systems have become operational on at least ten toll facilities over the last 10 years, with minimal assistance from national research and development programs and only limited state assistance. Recently, however, several congestion pricing projects have been initiated in California involving toll facilities (see page 31) and elsewhere as part of FHWA's congestion pricing demonstration program.

Although congestion pricing and toll collection systems are not commonly thought of as primary sources of heavy vehicle user revenues, they do deserve more attention for several reasons:

- Standardization of electronic toll collection systems will provide greater benefits to motor carriers who operate over long distances and use many toll roads. Benefits include reduced costs of acquiring and installing multiple transponders, time and vehicle operating cost savings, the availability of accurate cost accounting for toll charges, and avoidance of handling cash for drivers to pay tolls.
- Limited evidence obtained from toll schedules of several toll roads for the analysis reported in Chapter 2 indicates that heavy vehicles are significantly underpaying tolls on most toll roads in relation to the cost responsibility of heavy vehicles for the construction, maintenance, and operation of toll roads (as distinct from toll bridges and tunnels).[13]
- Marginal cost pricing for pavement wear on toll facilities is likely to lead to even more efficient pavement designs (toll road pavements probably already perform fairly well), thus reducing life-cycle pavement costs and

[8] Ibid., pp. 4-44 and 4-45.

[9] Kenneth R. Evert and Milan Krukar, "Greenlight for Oregon: A National CVO Project Prototype," *Traffic Technology International '96*, pp. 58–64.

[10] Oregon Department of Transportation, *Highway Use Tax Rate Reduction for Electronic Reporting: Legislative Concept for 1997 Session*, August 1996.

[11] Cambridge Systematics, Inc., *ITS/CVO Institutional Issues Study: Maine, New Hampshire, and Vermont*, op cit., pp. 4–44.

[12] Cambridge Systematics, Inc., *Systems Planning for Automated Commercial Licensing and Permitting Systems*, op. cit., pp. 2–6.

[13] California has initiated two efforts to improve electronic toll collections systems for heavy vehicles: improvements in the accuracy of automatic systems for classifying vehicles by axle configuration, and draft legislation to allow toll schedules that vary with axle configuration.

reducing the largest component of heavy vehicle cost responsibility. This could be a major gain in efficiency for trucking if pricing is extended to cover most heavy truck routes.
- The high technology scenario developed in NCHRP Project 20-24(7), the predecessor to this project, projected the potential for mileage-related taxes and tolls to increase to 34 percent of total national user revenues in 2020, compared with 5 percent for the base case scenario in 2020.[14] The proportional changes for heavy vehicle taxation would be even greater, as would the benefits to the motor-carrier industry and the national economy.

Despite the large potential national benefits that can be expected from congestion pricing, pricing of pavement wear, and other components of marginal cost pricing (several billions of dollars per year according to some estimates), progress has been quite slow, in large part because of widespread popular and political resistance.

One significant part of this resistance is that people view new toll collection systems as double taxation—rightfully so, to a significant extent. This problem could be addressed directly by (1) using revenue from other user charges to replace part or all of the tolls paid by those vehicle classes that meet much or all of their cost responsibility through these other user charges[15] and (2) using tolls primarily as a means of increasing revenue from vehicle classes that otherwise would not meet their cost responsibility.

Another significant part of the resistance to pricing is the perception that many users, particularly the "tolled off," would be negatively affected. Research is needed on this to identify the range of such negative impacts that can be expected and to evaluate options for mitigating these impacts (e.g., by providing alternative forms of mobility or some form of compensation).

Another reason for resistance to marginal cost pricing is that there is very little information available on the amount of potential benefits. Two types of analysis would be quite helpful:

- Analysis of user behavior to existing pricing systems to provide the basis for estimating elasticities for different classes of users so that benefits and costs to user groups and the economy can be estimated more reliably.
- Estimation of the amount of benefits to the economy that can be expected with partial and full implementation of marginal cost pricing and development of strategies for implementing the most promising parts of such systems, from the perspective of both estimated benefits and practical feasibility.

A final class of problem that has not been addressed in previous research, development, and demonstrations is the practical question of how to vary tolls by time of day (size and frequency of changes in toll rates), and how to communicate this information effectively to users without disrupting traffic flows (e.g., excessive speed or stopping and waiting).

Automated Mileage and Stateline Crossing Operational Test

Recently the Center for Transportation Research and Education at Iowa State University in partnership with government agencies in Iowa, Wisconsin, and Minnesota, a number of motor-carrier associations, several private partners, and the FHWA completed an operational test to evaluate the following:

- The feasibility of an in-vehicle system that determines when and where border crossings occur and measures the VMT within a state; and
- The feasibility of using EDI to transfer to base states VMT that accrue in each state for each participating vehicle.

The objectives of the field demonstration, AMASCOT,[16] included the following:

- Developing and testing the technology for an automated mileage and stateline data collection and reporting system that conforms with state auditing guidelines under IFTA and IRP;
- Developing and demonstrating procedures for electronic submission of fuel use and mileage reports to the base state; and
- Conducting an analysis of user acceptance and benefits and costs of the system.

AMASCOT represents the first test of a system that automatically generates the data on miles traveled by state that is required for apportionment of registration fees, fuel tax reporting, and determination of weight-distance tax liabilities.

Six motor carriers participated in the test: two for-hire operators of vans and flatbeds, two for-hire operators of food-grade tank trucks, one private carrier of agricultural chemicals, and one operator of leased used in truckload and less than truckload vehicles. For the test, five trucks operated by each of the six carriers were equipped with the following:

[14] Arlee T. Reno and Joseph R. Stowers, "Alternatives to Motor Fuel Taxes for Financing Surface Transportation Improvements," *NCHRP Report 377*, pp. 62–63 and Appendix E.

[15] In the case of bond-financed toll facilities, this reduction in toll revenue and its replacement by user charges might require bondholder approval.

[16] *AMASCOT: Automated Mileage and Stateline Crossing Operational Test*, Final Report, Four Volumes, May 1, 1996.

1. A GPS receiver,
2. An off-the-shelf computer board,
3. Gear for satellite communications linkage,
4. A border crossing detection algorithm applied to a digital map database, and
5. A mileage and route data collection/storage algorithm.

The onboard system recorded data on starts, stops, route samples, border crossings, and system exceptions such as loss of position, odometer, or power. These data—combined with a unique sequence number, driver ID, carrier ID, and vehicle ID—were compiled into a Driver Information Report. In the course of the test and pretest, the 30 trucks operated a total of 1.4 million miles in all 48 contiguous states and six Canadian provinces, crossing state and provincial borders 5,158 times.

The following are the key findings:

- Border crossings can be identified within 75 ft, making accurate, repeatable determination of border crossings feasible;
- System operation anomalies were minimal and were or could be corrected. These anomalies included power failure of a unit, a missing point in the jurisdictional database, a GPS data smoothing filter that resulted in the position error being too small, and, in rare instances, the failure to detect a border crossing because of the position error arising from the Department of Defense signal degradation for civilian GPS receivers.

The report estimates that motor carriers that already use satellite communications and vehicle-location tracking systems can add the electronic mileage-by-jurisdiction data collection capability for about $400 to $500 per vehicle. The cost to smaller carriers not already using satellite communications was estimated to be $1200 to $1500 per vehicle. These equipment costs were considered to be "affordable," though carrier responses suggested that the benefits of the tested system probably would not justify the costs to carriers not already using satellite communications.

As a part of AMASCOT, information from the onboard mileage and jurisdiction-line-crossing systems was used to prepare mock IFTA reports. Trip logs, expressed in terms of latitude and longitude, were combined with fuel usage reports obtained from the motor carriers participating in the operational test. Then reports able to meet IFTA requirements were prepared electronically and automatically transferred to one of the state DOTs. Widespread adoption of electronic transfer of combined mileage and fuel usage reports requires the establishment of EDI standards for this application.

Auditors from the states of Iowa, Minnesota, and Wisconsin evaluated the compliance of the data with IFTA and IRP reporting requirements. The auditors determined that the onboard equipment could accurately determine border crossings and record miles traveled cumulatively and by jurisdiction, and that the equipment would also record miles traveled on any routes designated as nontaxable. They concluded that the system could collect and process information that would comply fully with IFTA and IRP requirements.

Motor carriers also evaluated the operational test. They emphasized the importance of accuracy and reliability of the system. They generally found good correlation between the mileage data provided by the driver and the AMASCOT system, as well as between the IFTA-style reports produced by AMASCOT and the motor carriers' traditional IFTA filings. Motor carriers, however, did not regard EDI for transfer of IFTA and IRP as a high priority because the benefits of EDI would mainly accrue to the states. Motor carriers also expressed concern about whether the detailed information collected would compromise their privacy, and whether they might have to provide access to their computer systems during audits. Participating carriers indicated that an automated mileage and border crossing system had the potential to reduce the costs of IFTA and IRP compliance by 33 to 50 percent; however, widespread implementation is likely to occur only if automated procedures are part of a system offering additional functionality and benefits.

State concerns about automating truck mileage collection and tax reporting are a lack of EDI standards for transmitting IFTA and IRP reporting data between motor carriers and states, lack of EFT procedures, the current absence of software to accept electronic data from outside sources, and resistance of state personnel to electronic filing because of concern about job security.

In sum, AMASCOT was able to demonstrate that advanced onboard equipment, together with computer software, could replace a truck driver's duty to record odometer readings and related information. Also, AMASCOT showed that software could replace the procedures normally followed in the preparation of IRP and IFTA reports. Finally, AMASCOT demonstrated the feasibility of an electronic system that could be used to transfer mileage and fuel reports between motor carriers and base states.

Integrated Systems with Multiple Capabilities

The CVO component of ITS and CVISN are coordinated FHWA-funded efforts to develop and implement an integrated computer and telecommunications system that would function in the areas of safety assurance, roadside operations, credentialing, and tax administration. The development of the CVISN architecture, by Johns Hopkins University Applied Physics Laboratory,[17] is being closely coordinated with the development of the CVO component of the ITS National Architecture by Loral Federal Systems

[17] Johns Hopkins University, Applied Physics Laboratory, *Commercial Vehicle Information Systems and Networks (CVISN), Operational Concept,* prepared for the Federal Highway Administration, Preliminary Report, June 1996.

and Rockwell International.[18] Both architectures are open, modular, and adaptable; and both include mission and vision statements, a logical architecture, a physical architecture, analysis of communications bandwidth requirements, and identification and establishment of standards for data interchange and communications.

Under the CVISN concept, when a commercial vehicle starts a trip, the driver will use one of several input devices (smart card readers, bar code readers, numeric key pads) to enter unique identification codes for the carrier, driver power unit, and other trailers/containers into the tag on the power unit. Only tagged vehicles are allowed to participate in the preclearance system. Untagged vehicles are required to pull into the weigh/inspection station. The preclearance system must be initialized for each participating vehicle. The CVISN concept proposes that the state commercial vehicle administrator and Safety and Fitness Electronic Records (SAFER) system transmit electronic snapshots of interstate carrier, vehicle, and driver information to the roadside check station. When a tagged vehicle approaches a check station, a computerized screening system identifies the carrier, vehicle, and driver by reading the tag, and the vehicle is weighed (in motion) and classified. Credentials are checked against a database. If everything is in good order, the truck is signaled to bypass. Dedicated Short Range Communication (DSRC) (e.g., tag and reader/writer) sends clearance status to the tag and the driver is notified. If not, the truck is directed to a static scale or exit ramp, data are sent to the administrative computer system, DSRC sends the clearance status ("pull in") to the tag on the power unit, and a variable message sign directs the vehicle to proceed to an inspection area or to the parking area for a credential check. Later, if a truck is not taken out of service, as the truck leaves, a DSRC at the check station exit erases the "do not bypass" message from the tag/transponder and the truck is set to approach the next check station.

The ITS National Architecture and CVISN also provide for one-stop shopping for credentials. The procedure envisioned under the ITS National Architecture is as follows. A computerized Commercial Vehicle Administration Subsystem (CVAS) requests a tax/credential fee schedule and regulations for credential purchases/issuance from government administrators in local, regional, state, or national agencies. Each agency responds with its regulations and procedures for collection of fees and issuance of credentials which are stored in the CVAS. Then a motor-carrier issues an electronic credential and/or tax filing information request to the CVAS. This electronic message might include quarterly reports, vehicle logs, and fuel purchase data as prelude to tax payment, or it could include all the information needed to obtain credentials for a certain plan of operation such as regions of travel, border crossings, class of vehicle, cargo class, and weight. Additional enrollment request data would include credit card, debit card, or cash card numbers, as well as carrier, driver, and vehicle ID numbers needed for automated processing of tax payments and credential purchases. The CVAS then determines the total payment for credentials, taxes, and duties in its jurisdiction and makes a payment request to the financial institution the motor carrier has selected. The financial institution communicates electronically regarding whether the financial transaction is complete or rejected. Once all payments for credentials and taxes are successfully completed, the motor carrier is enrolled and electronic tax and credential receipts are issued.

CVISN also proposes full automation of IRP and IFTA as a complement to the one-stop shopping process. Once a base state receives payments for commercial vehicle registration or fuel taxes, the base state computes the portion due other states. National clearinghouses keep track of funds due each state. Periodically, accounts are reconciled and balances due other states are transferred electronically.

As part of FHWA's ITS Showcase projects, the Caltrans is involved in a priority corridor project whose goal is to provide more efficient use of limited infrastructure and to allow for the safe and efficient movement of goods. Major portions of this project include traffic and incident management, traveler information, freight and fleet management, automated roadside safety services, hazardous material management, CVO administrative processing, and standard AVI along with vehicle-to-roadside communications. A preliminary report for this project is expected soon.

PRELIMINARY CONCLUSIONS

The development and application of new and emerging technologies for tax administration and enforcement are at too early a stage to reach firm conclusions as to the types of systems that are most promising, likely relative costs and benefits, and the potential for widespread market penetration. The limited conclusions that can be drawn from this review include the following:

- Experience over the last 10 years demonstrates that quick breakthroughs in the application of new technologies and systems cannot be expected to occur very often.
- There is some possibility that electronic systems can be implemented for collecting and transmitting the mileage-by-jurisdiction data required for registration-fee apportionment and fuel-use reporting. Such systems have potential for reducing both evasion and public-sector administrative costs. However, they are likely to be financially attractive only to truck operators that already use GPS. Also, carriers may be reluctant to use these systems for tax-reporting purposes because of concerns about proprietary information and personal

[18] Loral Federal Systems and Rockwell International, *ITS Architecture, Theory of Operations*, prepared for the Federal Highway Administration, April 1996.

privacy (particularly as to whether carriers would be required to allow state auditors to access their computerized information systems) and concerns that implementation of these systems might lead to increased use of weight-distance taxes.

- National leadership is becoming increasingly important to give direction to research, development, testing, and demonstration programs. This leadership will probably be best achieved through cooperative efforts of several organizations including the Transportation Research Board, U.S. DOT, ITS America, and others. One short-term objective requiring national leadership is reaching agreement on ITS standards that will provide for efficient use of competing manufacturers' products for AVI and related communications systems.
- National and state R&D programs should encourage competition among all interested parties in the development of new technologies and improved tax systems, as a consensus develops on future directions. One of the difficult challenges at the national level is to institute a process that will lead to the adoption of national standards at the appropriate time during the development of new technologies and to do this in a manner that will achieve a proper balance between two somewhat conflicting objectives: (a) achieving compatibility of systems, such as cited above regarding transponders and related systems and (b) facilitating an open marketplace for multiple suppliers and improved technologies through competitive R & D efforts by adopting standards that do not stifle competition by favoring one or more suppliers over other potential suppliers.
- Research is needed on the development of a national base state system that would integrate all major heavy vehicle taxation systems, including registration, fuel, weight-distance and other types of taxes. Such a system should use available technology and computer systems to create simplified, common reporting systems, while preserving the prerogatives of the states to establish tax structures and rates.
- Economists are in agreement that marginal cost pricing promises to offer the greatest benefits to the economy of all forms of highway user tax structure. Much of this benefit would be realized in freight transportation in the form of congestion relief and more efficient heavy vehicle use. Because of this, more emphasis should be placed on research, development, and demonstrations in this area.

A pilot of the CVISN concept recently commenced in a joint effort of Virginia and Maryland with the cooperation of FHWA and the motor-carrier industry. In addition, seven model deployment contracts for implementing CVISN have been awarded in seven regions of the country.

CHAPTER 6

EVALUATION CRITERIA

There are six major criteria for analyzing heavy vehicle taxes and tax systems:

- Adequacy,
- Administrative efficiency,
- Equity,
- Economic efficiency,
- Evasion and avoidance, and
- Feasibility.

Each of these criteria incorporates several different considerations or issues as outlined in Table 33. These criteria are discussed in some detail below.

ADEQUACY

Adequacy is the criterion of most concern to transportation administrators. Adequacy is determined by revenue yields in relation to funding requirements, the stability of revenue streams over time, the responsiveness of revenue yields to inflation and increases in needs, and the ease of revising fees or tax rates when needs increase faster than revenue.

The obvious test for a revenue source is whether it provides enough revenue. Adequacy in the highway field has traditionally been defined to be the revenues required to satisfy "needs," which usually are defined to be the costs of improvement, operations, and maintenance programs driven by accepted engineering standards. Most highway standards are based on professional judgment rather than rational economic criteria. In a few of the more complex needs studies, engineering standards are varied to analyze the tradeoffs between the standards and total program costs.

The academic transportation economics literature, in contrast, would implicitly define adequacy as the amount necessary for an investment program that maximizes net benefits to the economy. The Highway Economic Requirements System (HERS)[1] has been applied to data for an extensive sample of highway sections to estimate national highway needs on this basis.[2] However, the project team knows of no application of this criterion for actual selection of highway projects or programming of agency budgets.

Most heavy vehicle taxes relate directly or (as in the case of registration fees) indirectly to usage of the road system. Hence, most of these taxes produce revenues that tend to grow with increasing real needs. However, except for ad valorem taxes and those fuel gallonage taxes that are automatically adjusted for inflation, these taxes generally produce revenues that do not grow with inflation. Accordingly, most heavy vehicle tax systems periodically require legislative increases in tax rates.

ADMINISTRATIVE EFFICIENCY

From a narrow public-sector perspective, administrative efficiency is measured by comparing public-sector administrative and enforcement costs to total revenue collected. From a broader perspective, administrative efficiency can be measured by also including the costs incurred by the private sector in complying with the administrative requirements of a tax.

All three types of administrative cost should be measured as incremental costs resulting from any tax or set of taxes that is being evaluated in the context of all existing taxes and related programs that are assumed to continue in effect. Thus, the enforcement and compliance costs of operating weigh stations should be attributed to a weight-distance tax only to the extent that imposition of such a tax results in increasing weigh station activity above the level adopted for enforcement of truck weight laws, safety regulations, and registration fees.

Similarly, in an evaluation of registration-fee apportionment and fuel tax reporting, the recordkeeping requirements imposed on the carriers may be viewed as a joint cost of the two programs. However, if one accepts registration-fee apportionment as a given, the incremental compliance burden of fuel tax reporting consists only of the costs of completing additional forms and maintaining any additional records not required by registration-fee apportionment.

For existing taxes to be administered using existing procedures, administrative and enforcement costs can usually be estimated by analyzing agency budgets (though these costs are unlikely to appear as separate line items). However, estimation of private-sector compliance costs will require a more

[1] Federal Highway Administration, *Highway Economic Requirements System*, Four Volumes, 1995–1996.

[2] U.S. Department of Transportation, *1995 Status of the Nation's Surface Transportation System: Conditions and Performance*, Report to Congress, 1995, pp. 298–305.

TABLE 33 Criteria for evaluating heavy vehicle tax systems

Adequacy
Yield
Stability and certainty
Responsiveness to changes in needs
Responsiveness to inflation
Potential for increases when needed
Administrative Efficiency
Administrative costs
Enforcement costs
Compliance costs
Implementation issues
Equity
Allocation of public agency costs
Among motor vehicles of the same class (horizontal equity)
Among classes of motor vehicles (vertical equity)
Relative to competing modes
Economic Efficiency
Charging based on full marginal costs
Public agency costs and other external costs
Spatial and temporal variation
Evasion and Avoidance
Illegal evasion
Legal avoidance
Feasibility
Availability of necessary data and technology
Political acceptability/opposition
Constitutional prohibitions

detailed analysis of the procedures used by various categories of taxpayers. In the case of new or proposed taxes, the estimation of all three types of costs requires specification of the procedures and technology to be used for administering the taxes and estimation of both the implementation and the annual costs of the proposed system. One-time implementation costs may be an important factor when deciding whether or not to change or modify the tax system, but they are likely to appear less significant when viewed from a long-run perspective.

The evaluation of administrative efficiency should give balanced attention to each tax or fee within an overall tax system alternative and should also consider the administrative efficiency of the system as a whole. Evaluation of each system as a whole may lead to the identification of ways in which overall costs can be reduced through integration of the elements of the system. It will also help to determine whether there is a potential for savings by combining fees or selecting a tax system composed of only one or two taxes instead of several (which tends to be selected to spread the pain around).

EQUITY

In the United States, the principle that highway users should pay the public agency costs of highways has been widely accepted at the state and Federal level for decades. The equity criterion usually is interpreted as measuring the extent to which the allocation of these costs among user groups (particularly vehicle classes) is in proportion to their estimated responsibility for these costs. The other, external costs of highway use, which shall be referred to simply as the external costs, have traditionally been excluded from consideration when evaluating equity. The project team shall adhere to this somewhat arbitrary convention in the definition of equity (but has included external costs in the economic efficiency criterion).

Considerable attention has also been paid in research studies to equity based on benefits derived by user classes, but no major studies have actually used this criterion. The types of user fees proposed for achieving equity may also result in greater administrative costs and more difficult enforceability than for more general taxes.

Since transportation taxes generally have been levied as user fees, there has been little concern with how impacts differ among industries. Because highway user taxes are a small percentage of costs, industry impacts have not often been an issue, except to the for-hire motor-carrier industry. States frequently give tax breaks to important local industries such as agriculture or forestry, but these tax breaks are seldom based on criteria that are subjected to any analysis.

The user-charge principle requires that each vehicle be charged in proportion to its estimated responsibility for public agency costs. Departures from this distribution of the tax burden result in inequities, and such inequities become a particular concern when they provide a competitive advantage to vehicles that pay lower shares of their cost responsibility than do other vehicles.

The use of the user-charge principle to evaluate the equity of heavy vehicle tax systems requires the use of estimates of cost responsibility for all significant groups of heavy vehicles. The development of these estimates has been the subject of extensive research[3] that lies outside the scope of the present study. For the purpose of these evaluation procedures the team assumed the use of an accepted set of such estimates.

The issue of equity also arises when considering how the tax system affects competition between motor carriers and other modes, particularly rail. If one of these modes pays its full cost responsibility and the other does not, the latter mode is, in effect, receiving a public subsidy that provides it with a competitive advantage. When focusing on the issue of heavy vehicle taxation, concern about such potential competitive advantages translates into a concern about whether or not rail-competitive motor carriers pay their full cost responsibility.

[3] E.g., see FHWA, *1997 Federal Highway Cost Allocation Study*, August 1997.

ECONOMIC EFFICIENCY

Related to equity, the goal of economic efficiency implies that vehicles should be charged a fee equal to their marginal cost responsibility both for public agency costs and for other externalities resulting from vehicle use. If one motor vehicle pays less than its full social cost responsibility while another vehicle or competing mode does not have such a subsidy, the underpaying vehicle will overuse the highway system, resulting in both an increase in real resource costs and in the implicit public subsidy of the first motor vehicle.

The economic efficiency goal differs from the most generally accepted version of the equity goal in four ways:

- In addition to public agency costs, the efficiency goal includes the other external costs of vehicle use;
- It is based on marginal costs rather than average costs;
- These costs are compared to the sum of *all* user charges (Federal, state, and local) rather than to charges imposed by a single level of government; and
- The marginal fee paid for vehicle use should, to the extent practical, match the marginal social costs attributable to that use.

Because of economies of scale in pavement and bridge costs for new facilities marginal public agency costs attributable to heavy vehicles are somewhat lower than average public agency costs—the costs that are most commonly used in operational definitions of the equity goal.

The external costs of vehicle use include the costs of the resulting congestion, noise, and emissions of air pollutants and greenhouse gases, as well as those crash costs that are not paid for by highway users or their insurers. For most heavy vehicle operations, the most important external costs are those relating to congestion and emissions, but marginal agency costs for pavement damage frequently are greater than any individual component of marginal external costs (and they can be greater than all marginal external costs combined).[4] As in the case of agency costs, there is substantial variation among vehicle classes in external costs per vehicle-mile, though this variation is not as great as it is for pavement costs. On the other hand, there is a substantially greater difference between the overall marginal external costs per vehicle-mile in urban areas and those in rural areas than is the case for agency costs; and marginal external costs exhibit significant time-of-day variation, particularly in the case of congestion costs. Furthermore, plausible high and low estimates of marginal external costs differ by an order of magnitude or more.[5]

Several issues have been raised about how best to charge for external costs. The substantial uncertainty that exists in estimates of these costs means that some care is required in determining the extent to which they should be reflected in highway user charges. Nonetheless, it is clear that the goal of economic efficiency is better served by setting charges to reflect external costs at the low end of the plausible range than by ignoring these costs entirely; and this goal probably would be even better served by setting charges to reflect consensus estimates of the extent of these costs.

Ideally, the economic efficiency criterion would require that user charges vary by route, time of day, and environmental factors, to match the marginal costs of congestion, emissions, pavement impacts from axle weights, ambient air quality conditions, and other factors. Such user charges would result in changes in highway use on the most congested routes at peak periods, particularly in areas with serious air-quality problems. Many of these changes would involve changes in travel patterns in terms of choice of route and time of day. However, the implementation of marginal cost pricing would not be expected to result in significant shifts of shipments from truck to other modes because truck is the most efficient mode for the vast majority of shipments moving by truck even if all external costs of truck use were to be covered by user charges.

Another issue is the effect of externality charges on modal competition. Ideally, such charges should be applied at appropriate levels to all competing modes. However, simultaneous introduction of such charges for all modes may be impractical. If these charges are applied to highway users but not to railroads, then, to avoid diverting more traffic to railroads than can be justified on the basis of economic efficiency, it would be desirable to reduce the level of charges applied to classes of trucks that include significant amounts of rail-competitive trucking operations.[6]

Other issues relating to charging highway users for the external costs of their use concern the administrative costs of such charges, evasion and avoidance problems, and applying the charges equitably across all user groups. For example, emissions fees charged only to vehicles registered in an area with air-quality problems would not result in charges against out-of-area vehicles operating in the area and would present opportunities for shifting in-area registrations to outside the area. Also, in the case of personal vehicles, there are significant issues of equity across income groups.

The introduction of externality charges is likely to be a slow process, both because of problems related to the design of such charges and because of the political difficulty and economic undesirability of introducing major increases in user charges in a single stroke. The gradual introduction of

[4] For five-axle combinations, marginal pavement costs are estimated to represent about 35 percent of total social costs when operating at 60,000 lb and about 65 percent of these costs when operating at 80,000 lb. (FHWA, *1997 Federal Highway Cost Allocation Study*, op. cit., Table ES6.)

[5] *1997 Federal Highway Cost Allocation Study*, op. cit., Tables V-22–V-24.

[6] In this situation, the appropriate set of user charges applied to rail-competitive trucking operations should, on a ton-mile basis, approximate the difference between the full marginal social costs of truck operation and the (unrecovered) marginal external costs of truck-competitive rail operations. This criterion can be restated as requiring that rail-competitive trucks be charged for their marginal public-sector infrastructure costs plus the estimated net difference (per ton-mile) between the external costs of rail-competitive truck operations and those of truck-competitive rail operations.

such charges would allow all highway users time to adapt to their effects and would allow for-hire carriers time to adjust their rates.

User charges designed to match full social cost responsibility would produce more tax revenue than required to cover public-sector highway costs. The resulting surplus could either be used for cost-effective measures to mitigate the externalities or be used as general revenue.

EVASION AND AVOIDANCE

Most major heavy vehicle taxes provide vehicle operators with some opportunity for underpaying their tax liabilities. Some of these taxes also provide operators with opportunities for legally avoiding the taxes, and some taxes, notably fuel taxes, provide third parties (not motor carriers) with substantial opportunities to profit from tax evasion.

Examples of potential evasion include use of untaxed fuel, registration of vehicles at declared maximum GVWs that are lower than the actual maximum GVWs, underreporting of mileage subject to weight-distance taxes, and misallocation of mileage operated among states so as to reduce total tax liabilities. This last type of evasion[7] has the effect of increasing tax payments to "low-tax" states while decreasing payments to "high-tax" states by a greater amount. Examples of legal avoidance include purchasing fuel in states that do not impose sales taxes on fuel, registering trailers in states that charge a low, one-time fee, and declaring vehicles to be based in states where they are not subject to property taxes or vehicle sales taxes or where the effect of these taxes is small.

Both illegal evasion and legal avoidance have important implications for tax adequacy and for equity. Evasion and avoidance reduce tax yields and, if the reduction is appreciable, they may result in a need to increase tax rates. Perhaps more important, evasion and avoidance reduce tax equity by interfering with governmental attempts to tax carriers on the basis of their estimated cost responsibility.

Trade-offs also exist between evasion and administrative efficiency. Evasion can be partially controlled with improved auditing and reporting procedures (e.g., through combined auditing of registration-fee apportionment and fuel-use reporting). On the other hand, increases in tax rates to achieve adequate revenue result in increased incentives for evasion, which, if not accompanied by increased enforcement, will increase evasion.

The relationship between evasion, administrative efficiency, and net revenue yield (adequacy) is shown schematically in Figure 8. The figure shows that, as enforcement effort increases, evasion drops while public-sector costs for administration and enforcement rise. The top curve in the figure is the sum of the other two curves and represents total costs to the public sector. The minimum point on the top curve corresponds to an enforcement effort of X and represents the point at which net revenue to the public sector is maximized for a given tax structure.

Political considerations generally make it difficult to obtain the funding necessary for a minimum cost enforcement program. The best existing programs for administering highway taxes have enforcement efforts, such as U in Figure 8, that are appreciably lower than the minimum cost effort and that result in slightly greater public-sector costs. Most programs entail even weaker enforcement efforts, such as V, that result in even greater costs to the public sector.

Although maximizing net public-sector revenue is one of the goals of tax administration, it is not the only goal. Figure 9 shows total public-sector costs (from Figure 8), private-sector compliance costs, and the sum of these two sets of costs, labeled total costs.[8] Total costs are minimized with an enforcement effort of Y, which is somewhat smaller than the effort (X) required to maximize net public-sector revenue.

Maximizing net public-sector revenue and minimizing total costs are two mildly conflicting goals of tax administration. A third goal is maximizing equity. Because evasion rates frequently vary among competing carriers, evasion tends to reduce a tax system's horizontal equity. Hence, some additional enforcement effort is justified to reduce evasion. Given these three goals, the "best" enforcement program probably lies in a region to the right of Y, labeled "Best" Program in Figure 9. Increasing enforcement effort from current levels (U or V in Figure 8) toward this "Best" Program level would have three desirable effects: increasing net public-sector revenue, decreasing total public- and private-sector costs, and decreasing inequity as a result of evasion.

FEASIBILITY

Feasibility, the final criterion for evaluating taxes, is primarily a concern in the evaluation of new taxes but may also be a concern in the evaluation of increases in the rates at which existing taxes are imposed, particularly if the proposed increases are large. Narrowly defined, feasibility addresses the following:

- Constitutionality of a tax that is new or significantly altered,
- Existence of the necessary technology and the availability of the necessary data to administer the tax, and

[7] Mileage can be misallocated differently for each type of tax reporting (a type of evasion that is relatively easily detected by comparing the separate tax-reporting forms) or it can be misallocated identically for each type of reporting (an alternative that is less readily detectable but that produces smaller savings to the vehicle operator). For the purpose of the latter type of misallocation, low-tax states are those whose combined effective tax rate per mile for apportioned registration fees, gallonage taxes on fuel, and weight-distance taxes is relatively low, and high-tax states are those for which this combined tax rate is relatively high.

[8] The project team has chosen to exclude from the total-cost curve the illegal private-sector benefits resulting from evasion, that is, evasion is treated as a pure cost rather than as a transfer payment (from the public sector to the private sector).

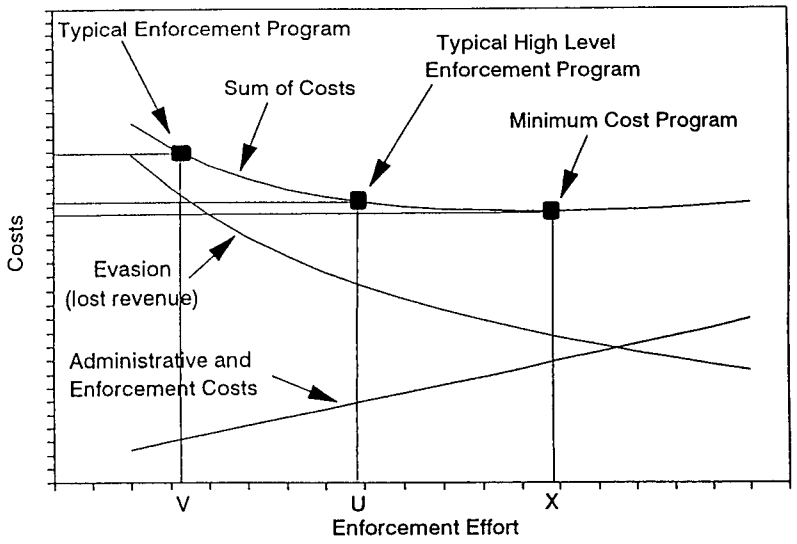

Figure 8. Conceptual relationships among all public-sector costs.

- Political acceptability of a new tax, of an increase in existing taxes, or of any new technology proposed for administering a new or existing tax.

More broadly, taxes or tax systems that fail any of the other criteria may also be classified as being infeasible.

In the short run, the feasibility criterion is absolute. If there is a fairly immediate need for additional revenue, only the most feasible options will be considered. Fortunately for highway administrators, the user-charge principle for highway finance enjoys wide support in this country. Accordingly, when additional revenue is needed, it is often possible to marshal support for rate increases for existing user fees and sometimes for the introduction of a new tax that does not encounter significant opposition.

In the longer run, feasibility remains important but is no longer absolute. A new tax or a radically revised tax system may meet with substantial opposition when first proposed. However, if the tax or tax system is deemed to be superior on the basis of the other criteria, political opposition is not a sufficient reason for automatic rejection. Instead, it is necessary to consider the educational effort that would be required to improve understanding of the new system and of its advantages. A decision as to whether or not to embark on such an

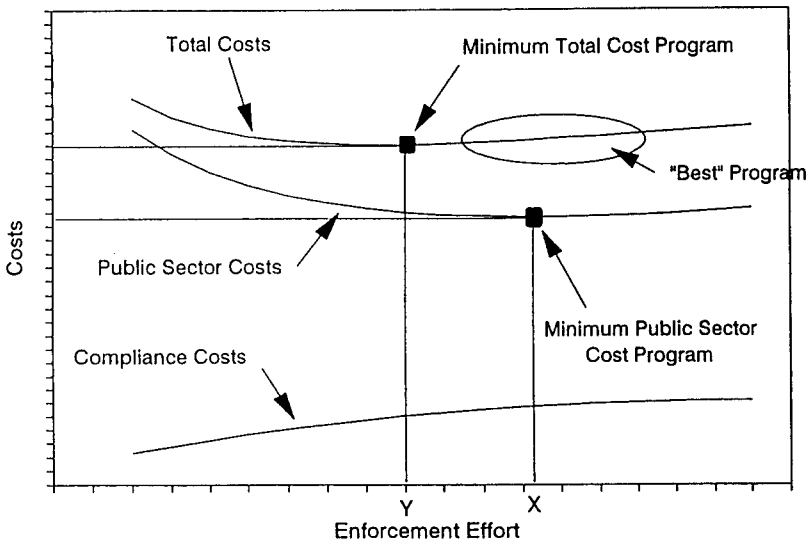

Figure 9. Conceptual relationships between public- and private-sector costs.

educational effort can then be based on an evaluation of the advantages of the new system relative to the expected effort that would be required and the likelihood of its ultimate success. In the case of major tax-structure changes that are designed to improve equity or economic efficiency, opposition may also be mitigated by phasing in any higher tax rates, allowing carriers time to adjust to the changes in their costs by instituting appropriate rate increases.

When evaluating long-run feasibility, constitutional prohibitions clearly present a higher hurdle than political opposition, but even this hurdle is not necessarily insurmountable. Factors to be considered in determining whether or not a constitutional amendment is worth pursuing include the requirements for such an amendment, the likely extent of support for and opposition to such an amendment (after an appropriate educational campaign), and the advantages of the tax.

CHAPTER 7

QUALITATIVE EVALUATIONS OF GENERIC TAXATION SYSTEMS

This chapter presents qualitative evaluations of four generic heavy vehicle taxation systems:

- A basic registration-fee/fuel tax system;
- The basic system plus fuel tax surcharges;
- The basic system plus a weight-distance tax; and
- The basic system plus tolls.

These four systems are described in more detail in the first section of this chapter. Each of the next six sections presents the evaluations of the potential of these systems for meeting one of the evaluation criteria. The final section of this chapter contains a summary of the evaluations of the four systems.

TAXATION SYSTEMS

The four generic taxation systems evaluated in this chapter are described below.

Basic System

The basic heavy vehicle tax system consists of a set of annual fees, monthly or quarterly fees for regular overweight operation, and a per-gallon fuel tax.

The annual fees include an annual registration fee that varies with maximum declared or registered GVW or, optionally, with axle configuration and maximum GVW. (A vehicle's *declared* GVW is the highest GVW at which a vehicle may operate on the basis of its registration and any overweight permit.) Annual "weight fees" are considered to be part of the registration fee, as well as annual permits for regular operation at weights above 80,000 lb. The registration fee may also vary with emissions class or with suspension system. This fee may be reduced for vehicles with low annual mileages (e.g., less than 10,000 or 30,000 mi per year). The annual fees may also include an ad valorem fee, frequently called a property tax or an in lieu of property tax. Annual fees do *not* include any fees that vary with annual mileage.

Monthly or quarterly permit fees are paid by vehicles that are operated at increased GVWs during part of the year (e.g., vehicles that are registered at 80,000 lb and operate at this weight during much of the year but which operate with two trailers at a higher weight during harvest season).

Excluded from consideration are issues related to the oversize and overweight permits required (frequently on a trip basis) by specialized haulers for transporting nondivisible loads such as cranes, electrical generators, mobile homes, and so forth. However, the project team recognizes that efficient administration and enforcement of these permits is an important aspect of heavy vehicle regulations, if not usually a major source of revenue. Much can be done to improve the administration and enforcement of trip permits through automation, one-stop shopping, and fee structures more closely related to actual highway costs.

The fuel tax is charged on fuel purchased or consumed at a per-gallon rate that may vary by type of fuel. The per-gallon rate may be set by statute or it may be adjusted quarterly or annually on the basis of changes in either fuel prices or a price index.

Fuel Tax Surcharge System

The fuel tax surcharge system consists of the basic system plus a fuel tax surcharge paid by most or all heavy vehicles. The surcharge is charged on fuel purchased or consumed at a per-gallon rate that is determined by the vehicle's declared GVW. The surcharge may take the form of a single (flat rate) increment applied to fuel consumed by all vehicles over a specified GVW, or it may be graduated, with the surcharge rate increasing with GVW in several steps. Graduated surcharges have been used in the past and they remain of interest to some observers; however, as discussed subsequently, they are not currently feasible.

Fuel tax surcharges increase fuel tax revenue from heavy vehicles. Accordingly, these vehicles are likely to be charged lower annual fees under a fuel tax surcharge system than under the basic system.

Weight-Distance Tax Systems

Two versions of a weight-distance tax system are considered: a conventional weight-distance tax system and an axle-configuration weight-distance tax system.

The weight-distance tax system consists of any variant of the basic system plus a weight-distance tax, that is, a tax on mileage that is imposed at a rate determined by a vehicle's

declared GVW. Most commonly, a single declared maximum GVW is used for each power unit during any reporting period (month or quarter). A more complex variant is to allow operators of power units that are used with varying numbers of trailers the option of declaring separate maximum GVWs for each trailer configuration. With this option, the tax is paid on the mileage of each configuration at a rate that is determined by the declared GVW for that configuration. Use of this option increases both the recordkeeping and reporting burden and the opportunities for evasion.

The axle-configuration weight-distance tax system consists of any variant of the basic system plus an axle-configuration weight-distance tax.

For single-unit trucks, the axle-configuration weight-distance tax is a tax on mileage that is imposed at a rate determined by the truck's axle configuration and its declared GVW.

For combinations, use of an axle-configuration weight-distance tax requires some increase in the registration information provided by a vehicle's owner. In particular, for each power unit, the owner is required to identify the axle configurations of the combinations in which the power-unit might be used during the reporting period plus the maximum GVW at which that configuration would be operated. For each configuration, there is a provisional tax rate determined by the maximum GVW specified for that axle configuration. The basic axle-configuration weight-distance tax then involves a tax on mileage imposed at the highest of the provisional tax rates for each of the vehicle's declared axle-configuration/GVW pairs. The owner may also have the option of specifying higher GVWs or additional configurations that are used during only part of the reporting period (e.g., during harvest season or on a single trip). A higher tax rate is then imposed on mileage accumulated during this period. Another variant allows separate reporting of mileage in each of several configurations and applies separate tax rates to reported mileage for each configuration.

In practice, the registration and tax-rate-determination process is simpler than the above generalized description makes it sound. For most tractors, there are one or sometimes two configurations in which the tractor is almost always used. For each of these configurations, the owner would specify the appropriate GVW (e.g., 80,000 lb) and determine the corresponding tax rate. For any configurations that are infrequently used, the owner would then specify a GVW that would not increase the tractor's axle-configuration weight-distance tax rate. For common configuration/GVW pairs, the process could be designed to handle this last step automatically (e.g., a 3S2 with a declared GVW of 80,000 lb could automatically be allowed to operate as a 3S1 at weights up to, say, 60,000 lb). Also, separate specification of GVW limits for bobtail operation would not be required.

The axle-configuration weight-distance tax allows a better match between tax rates and the cost responsibility of specific configurations than does a weight-distance tax. Because the variety of configurations operated increases with GVW, the capability of axle-configuration weight-distance taxes to match tax rates to configuration-specific cost responsibility is likely to be of greatest interest to states with GVW limits greater than 80,000 lb. (Indeed, the only current use of an axle-configuration weight-distance tax is in Oregon, where it is applied only to vehicles that operate at weights greater than 80,000 lb.)

Both types of weight-distance taxes are capable of obtaining substantial revenue from heavy vehicles. Accordingly, under either system, these vehicles are likely to be charged lower annual fees than under the basic system, and diesel-fuel tax rates may also be lower.

Systems That Include Tolls

Highway user-charge systems that include tolls generally consist of a non-toll component, which is applied to users of all roads, and tolls, which are paid only by users of the toll facilities. The latter facilities usually carry high traffic volumes. Most existing toll facilities were relatively expensive to build or have been built to and maintained at a higher standard than other "free" facilities.

Tolls are of particular interest because they can be much more readily assessed to highway users at rates that vary with the time and place of highway usage than any other type of user charge. Accordingly, tolls have potential as a means of charging for the external costs of highway use—costs that exhibit very strong variation by location[1] and, in the case of congestion costs, that also vary significantly by time of day.

The primary interest here is in tolls as a means of capturing the spatial and time-varying components of user cost responsibility. Hence, for the purpose of the evaluation, the focus is on toll systems that are designed with the goal of obtaining total revenue per mile from any vehicle class that, to the extent practical, matches its estimated full social cost responsibility per mile. Setting tolls on this basis requires the following:

- Estimates, by vehicle class, of the full social cost responsibility associated with the use of each toll facility, by segment and time-of-day; and
- Corresponding estimates of payments of fuel taxes and weight-distance taxes (if any) resulting from use of the facility, as well as an appropriate share of registration-fee payments (based on the per-mile cost of these fees).

Toll rates would then be set to approximate the difference between the above sets of estimates. Separate rates would be set for each of several vehicle classes and, where appropriate,

[1] One set of estimates indicates that the marginal external costs of vehicle operation in urban areas typically are four to seven times as high as they are in rural areas (FHWA, *1997 Federal Highway Cost Allocation Study*, August 1997, Table ES-6). These costs vary significantly among different urban areas and spatially within any single urban area.

the rates per mile would vary by facility segment. Rates set in this way are likely to yield relatively large amounts of revenue in highly congested corridors and in areas with severe air-quality problems. However, this type of toll is designed primarily as a device for charging for external costs and for infrastructure costs in those areas where the latter costs are particularly high. In areas where external costs and infrastructure costs are relatively moderate, revenue produced by these tolls would be correspondingly moderate.

The qualitative evaluations of the toll systems of interest consider both conventional toll-collection systems and electronic toll-collection (ETC) systems using vehicle-mounted transponders. The latter type of system allows much greater flexibility in the design of toll rates. In particular, rates can easily be varied on the basis of declared maximum weight or any other vehicle-registration characteristic that is encoded in the vehicle's transponder. Also, ETC systems can be used to vary toll rates by time of day seamlessly, while any attempt to implement such variation with conventional systems would be far less seamless.

Although the non-toll components of toll systems could correspond to any of the systems considered previously, for the purpose of these evaluations, the focus is on the case in which tolls are combined with the basic tax system.

ADEQUACY

As shown in Table 33, the adequacy criterion incorporates five related considerations:

- Yield,
- Stability and certainty,
- Responsiveness to changes in needs,
- Responsiveness to inflation, and
- Potential for increases when needed.

In the evaluation of actual or proposed tax systems, the first of these considerations, yield, is of overriding importance: Will the system, with its actual or proposed tax rates, produce the level of revenue required?

All the generic tax systems described here incorporate a registration fee and a fuel tax—two broad-based highway taxes that, in most states, have the *potential* to be raised as high as necessary to provide an adequate yield. However, in a few states and in all cities and counties that levy their own fuel taxes, many operators of vehicles not subject to fuel-use reporting can avoid high fuel taxes by purchasing fuel in other jurisdictions. Accordingly, in these states, cities, and counties, there is a practical limit on the revenue that can be obtained from a fuel tax. In these jurisdictions,[2] systems that incorporate a weight-distance tax or tolls have a somewhat greater potential than the basic system for producing adequate revenue. This increase in potential also appears to extend to a fuel tax surcharge system, because the point of fuel purchase does not affect the revenue obtained from the surcharges.

All the systems produce revenues that grow with VMT. Revenues from fuel taxes, weight-distance taxes, and tolls, vary directly with VMT, and secular growth in VMT is generally accompanied by a corresponding, though possibly slightly different, growth in registrations.

The secular growth in revenues means that the tax systems are at least partly responsive to changes in needs. However, to the extent that VMT increases generate significant requirements for capacity expansion, needs tend to grow faster than revenues.

On the other hand, because VMT varies with the economy, none of the tax systems provide a completely stable stream of revenues. Fluctuations in VMT, though generally small, are greater for trucks (particularly those used in cyclical industries such as construction) than for automobiles, so revenues from weight-distance and diesel-fuel taxes are likely to fluctuate somewhat more than those from gasoline taxes. On the other hand, as a result of secular increases in fuel efficiency, in the absence of rate increases, fuel tax revenue grows more slowly than VMT; and, when VMT declines, fuel tax revenue falls slightly more quickly. Furthermore, there is some concern that, in the future, fuel tax revenue may fall as a result of increased use of alternative fuels, such as gasohol, which receives tax breaks, and electricity, which currently is untaxed and may be difficult to tax. Registration fees are the most stable of the taxes considered, but even vehicle registrations (and particularly truck registrations) are influenced to some extent by changes in the economy.

The taxes and tax systems under consideration contain only two tax variants that provide any degree of responsiveness to inflation.[3] One of these is the use of an annual ad valorem tax on vehicle value, a charge that usually provides only a small fraction of highway revenues.

The second inflation-responsive tax variant involves indexing part or all of the per-gallon fuel tax rate to reflect changes in either the price of fuel or a more general price index (such as the consumer price index). For this purpose, a general price index probably works better than the price of fuel. Fuel prices do not always rise when other prices are rising, so use of the fuel price produces only imperfect inflation protection. Also, because fuel prices exhibit significant fluctuations, indexing the tax rate to the price of fuel can result in unanticipated declines in revenue (though these may be limited by establishing a minimum tax). On the other hand, indexing to the price of fuel protects against possible revenue declines that can occur if a particularly sharp rise in fuel prices results in a decline in fuel use and in VMT. Because

[2] These jurisdictions include the District of Columbia, New Jersey, and several other northeastern states that have significant amounts of cross-border traffic.

[3] Potential sources of revenues that increase with inflation but which are not in our generic systems include ad valorem taxes on the sale of fuel, vehicles, or vehicle parts.

indexed tax rates are adjusted quarterly, the inflation protection provided by any type of indexing incorporates an unavoidable lag.

Although indexing fuel tax rates can provide a degree of inflation protection, all the taxation systems contain potentially significant sources of revenue that do not respond to inflation. Accordingly, all the systems require periodic increases in tax rates to keep pace with inflation.

Fortunately, the direct and relatively visible relationship between highway tax revenue and highway conditions has made the public somewhat more willing to accept needed increases in highway user charges than increases in other taxes. When increases are needed in highway revenues, there may be some debate as to which taxes should be raised and how the schedules should be revised, but there is often acceptance of the need for the increases. Accordingly, in most jurisdictions, there currently is good potential for obtaining tax increases when needed. The exceptions are jurisdictions where substantial reliance is placed on the fuel tax and, for reasons discussed above, increases in this tax are limited by concerns about tax avoidance. Also, in the future, if significant percentages of vehicles produced use untaxed fuels (such as electricity), operators of vehicles using taxed fuels may be less accepting of fuel tax increases.

Adequacy would also be affected in several ways by any decision to use tolls or any other financing mechanism to charge highway users for their full marginal social costs (instead of just for public agency costs, as at present). Such a change would increase costs to highway users (particularly for using congested facilities) and would increase total revenue; however, it would also reduce revenue obtained from traditional user charges (as a result of reduced VMT and, perhaps, some reduction in tax rates). Reduced use of congested facilities, in turn, would reduce agency needs by an amount that could exceed the reduction in revenue from traditional sources. If so, all revenue from the new sources could be used for some other appropriate public purpose. On the other hand, if the reduction in revenue from traditional sources is greater than the reduction in agency needs (e.g., because of reduced tax rates), at least some of the revenue from the new source would be required for highway-related expenditures.

The above discussion suggests that all four tax systems have substantial potential to produce adequate revenue. The potential of the basic system, with its greater reliance on the fuel tax, is slightly more limited than that of the other systems.

ADMINISTRATIVE EFFICIENCY

From a narrow public-sector perspective, administrative efficiency is measured by comparing public-sector administrative and enforcement costs to total revenue collected. From a broader perspective, administrative efficiency can be measured by also including the costs incurred by the private sector in complying with the administrative requirements of a tax. All three types of administrative cost are best measured as incremental costs resulting from any tax or set of taxes that is being evaluated in the context of all existing taxes and related programs that are assumed to continue in effect.

As discussed in Chapter 6, there are important trade-offs between enforcement costs and level of evasion. There is also substantial variation in the enforcement effort made by various administrative agencies to reduce evasion. In evaluating a state's tax system, the actual enforcement costs and the corresponding private-sector compliance costs should be used. (Separate analyses may also be warranted of the effects of proposed changes in enforcement on administrative efficiency and on evasion). However, for the purpose of these comparative evaluations of prototypical tax systems, the focus is on how administrative efficiency is affected by inherent characteristics of the different tax systems. For this purpose, a level of enforcement is assumed that will keep evasion moderately low but that varies among the tax systems with perceived concerns about evasion. With this assumption, the qualitative estimates of enforcement and compliance costs vary with evasion potential, and so the estimates of administrative efficiency tend to correlate with the estimates of evasion and avoidance (which are presented on page 108).[4]

The following discussion addresses the potential for administrative efficiency achievable by practical versions of each of the tax systems. For this purpose, the project team focused primarily on the continuing costs of administering the systems. There is a description of the additional one-time costs that would be entailed for switching from an existing system to a new system. These costs, which are dependent on the specific characteristics of the existing system as well as the new system, are of particular significance to states considering such a change.

For presentational purposes, it is convenient to discuss the administrative efficiency of the four tax systems in a slightly different sequence than that used for most of the other criteria.

Basic System

The public-sector administrative costs of registration fees and fuel taxes are reasonably modest. One study[5] found that administrative and enforcement costs represented no more than 1.5 percent of gasoline and diesel-fuel tax revenue in three states for which appropriate data were available. Corresponding costs for registration-fee programs appeared to represent a comparable percentage of revenue. However, these estimates appreciably understate the relative costs of collecting fuel taxes and registration fees from heavy vehicles because of the extra cost of administering the fuel tax and registration-fee reporting systems and because taxing

[4] On the other hand, for any *single* tax system, there is an inverse relationship between evasion and the costs of enforcement and compliance.

[5] Jack Faucett Associates, *Revenue Derived from State Motor Carrier Taxes and Fees*, prepared for FHWA, November 1984, pp. 47–51.

diesel fuel supplies requires a much greater enforcement effort than taxing gasoline supplies. For reasons discussed in footnote 14 in the subsection after next, it appears that typical public-sector costs for administering the tax on diesel fuel are likely to represent 2 to 4 percent of revenue. Administrative costs for registration fees are also likely to be in the same range.

Compliance costs for the basic tax system are moderate for carriers subject to fuel-use reporting or registration-fee apportionment and very low (a small fraction of 1 percent) for carriers not subject to these requirements. Although these reporting requirements need not apply to intrastate carriers, several states now require fuel-use reporting for all heavy trucks as an aid in the states' enforcement efforts. Compliance costs for fuel-use reporting and fee apportionment are discussed further in a subsequent subsection.

Several of the variants of the basic tax system would tend to increase administrative costs. If registration fees are varied with both axle configuration and maximum GVW, the maximum weight at which a vehicle is allowed to operate becomes a function of both its registration-fee class and its axle configuration. In the case of power units that may be operated in more than one configuration, registration cards would probably have to specify the maximum GVW for each configuration, and manual checking of credentials at weigh stations would require some additional care.

Reducing annual fees for low annual-mileage vehicles requires a significant increase in auditing to prevent nonqualifying vehicles from taking advantage of the reduced fees. Similarly, if annual fees vary with axle suspension or engine-model emissions class, some additional auditing and vehicle inspection would be required to verify that vehicles actually have the suspension system or engine model that they are declared to have. Also, if annual fees vary with in-use emissions, an expensive system of annual or biannual emissions testing would be required. Governments adopting any of these variants would incur additional one-time costs for implementing the new system components.

Weight-Distance Taxes and Weight-Distance Tax Systems

The administrative and enforcement costs of weight-distance taxes have been a subject of much debate for many years, and several surveys of state costs have been made. By far the most detailed and comprehensive analysis of a state's costs was completed recently for Oregon,[6] resulting in an estimate of $18.7 million for the 1993–95 biennium, or 4.8 percent of the $391 million revenue.[7] About two-thirds of these costs are for administration and about one-third for enforcement. Another recent analysis estimated that public-sector costs for Idaho's weight-distance tax represented 4.0 percent of revenue in 1994.[8]

Administrative and enforcement costs for weight-distance taxes in other states vary widely. Some states have agency costs that are somewhat higher percentages of weight-distance tax revenue, but this is because of lower tax rates and lower revenue, rather than because of higher agency costs. Only New York has a weight-distance tax program with agency costs that are on the same scale as Oregon's. Some states have agency costs that are a small fraction of Oregon's; however, the evasion rates in these states are widely judged to be much higher than the 5 percent estimated for Oregon.[9]

The Oregon Public Utilities Commission has estimated that the administrative and enforcement costs of Oregon's entire heavy vehicle tax system are about 4 percent of revenue.[10] This system includes registration fees, the weight-distance tax, and a fuel tax paid by vehicles not covered by the weight-distance tax.

Industry compliance costs for weight-distance taxes vary widely depending on several factors:

- Size of fleet (some fixed costs are high per truck for small fleets),
- Extent of automation (which can reduce costs by an order of magnitude),
- Type of operation (costs increase for firms with short trips and a variety of configurations),
- Complexity of the weight-distance tax or axle-configuration weight-distance tax (e.g., carriers may select options for more complex reporting by configuration at varying GVWs), and
- Thoroughness of the documentation required by the auditors.

The Oregon study provides one of the very few estimates of compliance costs that are based on a survey of a sample of motor carriers. Estimated costs averaged 5.7 percent of tax payments, but varied from 2.6 percent for large firms to 7.8 percent for small and medium firms.[11] These estimates are likely to be much less accurate than estimates of government

[6] In this discussion, Oregon's weight-mile tax is referred to as a "weight-distance tax" to conform with common terminology. In Oregon, tax rates vary by axle configuration for vehicles with declared GVWs above 80,000 lb but not for vehicles with lower declared GVWs. Accordingly, using the distinction between weight-distance taxes and axle-configuration weight-distance taxes, the Oregon "weight-distance tax" is technically a hybrid weight-distance/axle-configuration weight-distance tax.

[7] Cambridge Systematics and Sydec with Pacific Rim Resources, *Oregon Weight-Mile Tax Study: Final Report,* prepared for the Oregon Legislative Revenue Office, Oregon Public Utilities Commission, and Oregon Department of Transportation, February 1996, Chapter 3.

[8] Idaho Transportation Department, Office of Economics and Research, unpublished table used to estimate the costs to administer Idaho's weight-distance tax, Summer 1994.

[9] Cambridge Systematics and Sydec with Pacific Rim Resources, op. cit., Chapter 5.

[10] Cambridge Systematics and Sydec, Technical Memorandum No. 5—Administrative Costs of Oregon's Weight-Mile Tax, January 1995, pp. 5–11.

[11] Cambridge Systematics and Sydec with Pacific Rim Resources, op. cit., Chapter 4.

agency costs because they are not based on the examination of any data on actual costs. They may be somewhat higher than actual costs because some respondents seemed anxious to impress interviewers with the burden caused by the tax. For a given level of auditing, the compliance costs for the weight-distance tax probably are not much higher than for an apportioned fuel tax and are probably about the same as for a graduated fuel tax surcharge. However, because many states audit much less aggressively than Oregon (and accept correspondingly higher levels of evasion), many carriers experience appreciably lower compliance costs than those estimated above.

An axle-configuration weight-distance tax presents vehicle owners with a somewhat more complex registration decision than does a conventional weight-distance tax; and it also requires some increased care in manual checking of credentials and, perhaps, in auditing and in issuing registration certificates. Accordingly, the administrative, enforcement, and compliance costs are all likely to be lower for a conventional weight-distance tax than for Oregon's tax.[12]

Adoption of a weight-distance tax by a government that does not already have such a tax would also entail one-time implementation costs for designing forms, developing administrative and auditing procedures, training personnel, and so forth.

Fuel Tax Surcharges

The administrative and enforcement costs of several alternatives to Oregon's weight-distance tax have also been studied.[13] Replacing the existing weight-distance tax with a flat-rate fuel tax surcharge was expected to result in slightly reduced agency costs because fuel tax reporting could be done on a fleet basis for all trucks over a specified GVW (e.g., 26,000 lb).[14] However, administrative and compliance costs for a system with fuel tax surcharges are appreciably greater than for the basic tax system, primarily because of the extension of fuel-use reporting requirements to intrastate vehicles.

Replacing the weight-distance tax with a graduated fuel tax surcharge raises several implementation issues. One reporting option would be to use a modified version of the weight-distance tax reporting form on which reports of fuel use and total VMT by vehicle class would be required in addition to the reports of in-state VMT by vehicle or vehicle class that currently are required. This option would increase both public-sector administrative and enforcement costs relative to those of a weight-distance tax.

Another option would be to implement a base-state reporting system that is capable of handling graduated fuel tax surcharges. Such a system could use expanded versions of either the IRP or IFTA reporting. One option would be to expand the IRP form to include total fuel use for the reporting period for each vehicle class (or for each vehicle). Combining this additional item with mileage reports on the form makes it possible to derive average miles per gallon by vehicle class (or vehicle) and thus to allocate fuel use among all jurisdictions in which the vehicles are operated. In concept, this option could be achieved with modifications to existing software and moderate increases in annual processing costs. Auditing and enforcement costs for this reporting system would be somewhat higher than required for the existing IRP system of registration-fee apportionment, but they would likely be lower than those for the administration of a weight-distance tax.

Unfortunately, the development of a base-state reporting system for graduated fuel tax surcharges is a realistic option only if such surcharges are adopted by a significant number of states and there is general acceptance of the desirability of developing such a system. In the absence of these preconditions, any state implementing a graduated fuel tax surcharge would have to develop and administer its own reporting system (similar to, but slightly more complicated than, a weight-distance tax reporting system) such as the one described two paragraphs above.

In addition to annual administrative costs, adoption of a fuel tax surcharge system would entail some implementation costs. The latter costs would be fairly modest for a flat-rate surcharge system but could be substantial for graduated surcharges. Graduated surcharges would require a major national effort to reorganize IRP and IFTA.

Compliance Costs for Registration-Fee Apportionment, Fuel-Use Reporting, and Weight-Distance Taxes

The project team knows of no study of the private-sector compliance costs of registration-fee apportionment and fuel tax reporting that is comparable to the previously discussed study of the compliance costs for the Oregon weight-distance tax. However, similarities in the data requirements of all three systems enabled the team to make some qualitative judgments about the compliance costs of apportionment and fuel-use reporting systems.

Registration-fee apportionment requires that, for each covered vehicle, summary information be submitted on declared GVW and miles traveled by state, and additional recordkeeping is required on individual trips made. If registration fees were to be based on axle configuration and declared GVW, information also would be required on each vehicle's axle-configuration/GVW class. The information

[12] See Footnote 6.

[13] Cambridge Systematics and Sydec with Pacific Rim Resources, op. cit., Chapter 3.

[14] A conventional diesel-fuel tax with fuel-use reporting is very marginally simpler than a fuel tax with a flat-rate surcharge. Accordingly, administrative and enforcement costs for a conventional diesel-fuel tax are likely to be slightly lower than those for Oregon's weight-distance tax if the level of auditing of fuel-use reports is comparable and appreciably lower if auditing is reduced. Because agency costs for Oregon's weight-distance tax are estimated to represent 4.8 percent of revenue, the project team concludes that corresponding costs for a diesel-fuel tax are likely to be 2 to 4 percent of revenue.

required for apportionment of these two types of fees is essentially the same as would be required by a base-state reporting system for a weight-distance tax or an axle-configuration weight-distance tax, respectively. Accordingly, compliance costs for a base-state system of registration-fee apportionment should be very similar to those for a corresponding base-state system for a weight-distance (or axle-configuration weight-distance) tax (but probably different from the compliance costs for a non-base-state reporting system for a weight-distance tax).

For vehicles covered by registration-fee apportionment, only a small increase in compliance costs would result from modifying the reporting requirements in order to provide for base-state administration of a weight-distance tax in which a single tax rate is applied to all miles. However, the increase would be larger for systems (such as those in Idaho, Oregon, and New York) that allow the tax rate to vary with the configuration operated or that allow a reduced rate for empty miles. Compliance costs would also be increased if separate weight-distance tax forms are required by each state administering such a tax.

Fuel-use reporting for a graduated fuel tax surcharge requires all the information required for administering a weight-distance tax and also fuel tax receipts and data on fuel consumed by each vehicle class or vehicle. Accordingly, compliance costs for a graduated surcharge would be moderately higher than those for a weight-distance tax. If such a reporting system were to be implemented, total compliance costs could be minimized by combining this system with the IRP. Such a combination would also reduce auditing costs for those states that currently have separate audit systems. As in the case of the weight-distance tax, compliance costs would be increased if separate tax reports are required by each state administering the tax.

For a conventional single-rate fuel tax, fuel-use reporting data can be submitted on a fleetwide basis rather than for individual vehicles. The same is true for a flat-rate surcharge in which the surcharge applies to all vehicles covered by fuel tax reporting. Fleetwide reporting results in a substantial reduction in compliance costs for most multi-vehicle fleets, and probably makes compliance costs for conventional fuel-use reporting lower than those for any of the other systems discussed. Nonetheless, if a single system were used for both fuel-use reporting and registration-fee apportionment, the number of reports and audits would be reduced, resulting in an additional reduction in compliance costs.

In addition to the annual compliance costs imposed by the various tax systems, any change from one system to another would impose several one-time costs. These would include the costs for changing procedures and purchasing or developing new software. These one-time costs are likely to be a substantially greater burden on small carriers than on large carriers.

The above discussion suggests that the private-sector costs of complying with IRP and IFTA represent a small percentage of revenue generated. These compliance costs are appreciably greater than the corresponding costs for vehicles not subject to registration-fee apportionment or to fuel tax reporting. However, these costs are widely accepted as necessary to a user-fee system that attempts to achieve equity both in the way costs are shared by highway users and in the way revenue is distributed among the states.

For carriers that use satellite communications and vehicle-location tracking systems, there is some potential to reduce compliance costs by adding an electronic mileage-by-jurisdiction data-collection capability. Carriers participating in a limited test of such a system[15] estimated that IFTA and IRP compliance costs could be reduced by 33 to 50 percent with an initial expenditure of $400 to $500 per vehicle.[16] However, for carriers that do not use vehicle-location tracking, the initial cost of installing electronic mileage-by-jurisdiction rises to $1200 to $1500 per vehicle, making such an option less attractive. Participating carriers also expressed privacy concerns about such a system, including concerns about the possibility that users of such systems would be required to provide auditors with access to their computer systems.

Tolls

The project team is primarily interested in using tolls as a means of capturing the spatial and time-varying components of the marginal social costs of highway use. For this purpose, tolls would be required on most or all principal arterials in areas where full social costs are above average. At a minimum, tolls would be used on many of the principal arterials in major urbanized areas as a means of charging for the high external costs of operating vehicles in these areas, including costs resulting from emissions and increases in congestion. For any major urbanized area, the number of roads covered by such a system would be substantially greater than the number covered by any existing toll systems.

Although the team knows of no studies of the potential use of tolls for recovering all types of external costs of highway use, several studies have been conducted of their potential use as a means of congestion pricing, particularly for the Los Angeles, San Francisco, and Washington, D.C., areas.[17]

[15] *AMASCOT: Automated Mileage and Stateline Crossing Operational Test,* Final Report, Four Volumes, May 1996. A slightly longer description of this test is presented on page 86.

[16] Combining such a data-collection system with electronic filing would also reduce public-sector administrative costs, though some financial incentives might be required to encourage carriers to use this option.

[17] Kiran Bhatt, "Potential of Congestion Pricing in the Metropolitan Washington Region," *Curbing Gridlock: Peak Period Fees to Relieve Traffic Congestion,* Transportation Research Board, Special Report 242, Washington, DC, 1994, Vol. 2, pp. 62–88; Patrick DeCorla-Souza, "Applying the Cashing Out Approach to Congestion Pricing," *Transportation Research Record 1450,* Transportation Research Board, Washington, DC, 1994; Greig Harvey, "Transportation Pricing and Travel Behavior," *Curbing Gridlock, Peak Period Fees to Relieve Traffic Congestion,* Transportation Research Board, Special Report 242, Washington, DC, 1994, pp. 89–114; Los Angeles County Metropolitan Transportation Authority (LACTMA), *TDM Phase II Program, Part III-A, Technical Appendix, Mobility,* Los Angeles, CA, February 1994; Michael Replogle, "Motor Vehicle Use and the Clean Air Act: Boosting Efficiency by Reducing Travel," Preliminary Draft, Environment Defense Fund, July 1993; and Urban Institute and K.T. Analytics, *Congestion Pricing Study,* prepared for the Southern California Association of Governments, April 1991.

These studies generally assumed the use of electronic toll collection; tolls of 10 to 20 cents per mile during peak periods, with lower tolls or no tolls during off-peak periods; and tolls imposed on part or all of an area's freeway system and, in some cases, on other arterials as well.

The administrative efficiency of this type of toll system will depend on the size of the system, the number of hours during which tolls are collected, the level of the tolls, and traffic volumes per roadway and per lane. Most of the cited studies do not estimate the costs of a toll system, and only one estimates the cost of a system that charges tolls throughout the day. This study[18] estimated costs for a system that would cover some or all of the freeways in the Los Angeles area. An average toll of 15 cents per mile was assumed. The resulting ranges of cost and revenue estimates for two alternative systems indicate that costs would be between 6 and 16 percent of revenue. Costs included private-sector costs for transponders and public-sector costs for enforcement and system operation and for amortizing the cost of installing the system. The amortization costs represent about one-third of the total,[19] though this component of total costs is falling as the technology is improving.

To obtain cost estimates that can be compared to those for the other tax systems analyzed, the above estimates were reduced by one-third to exclude the one-time costs for system installation. With this adjustment, the estimate of the continuing public- and private-sector costs for the above toll system becomes 4 to 11 percent of revenue.

The above estimates are for an extensive freeway-only system with an average toll of 15 cents per mile. However, in the most congested urban areas, a toll system designed to recover the marginal social costs of vehicle use might have average tolls that are somewhat higher than this value.[20] The administrative efficiency of such a system might be better than the indicated range of 4 to 11 percent. On the other hand, applying the system to a smaller set of roads or extending the system to include nonfreeway arterials would likely result in decreased efficiency (higher cost-to-revenue ratios). These rather speculative estimates indicate that the administrative efficiency of a toll system designed to capture the spatial and time-varying components of the marginal social costs of highway use could be better than that of any of the other tax systems considered, or it could be poorer than that of any of the other systems.

EQUITY

In applying the equity criterion, the potential of each of the generic tax systems is evaluated for equitably distributing the public agency costs of highways among user classes. The project team adheres to the somewhat arbitrary convention of excluding external costs from the equity criterion, but these costs are addressed as part of the application of the economic efficiency criterion discussed in the next section.

All states graduate highway user taxes to a greater or lesser degree with vehicle weight, because perceived highway cost responsibility generally increases with increases in weight. Some states periodically study highway cost responsibility in detail, while others rely on infrequent studies or the implications of studies in other jurisdictions, but all states to a greater or lesser degree try to match user fee rates with cost responsibility.

For heavy vehicles, public agency cost responsibility per VMT of travel varies significantly with a vehicle's axle loads (because of pavement costs) and, to a lesser extent, with GVW and axle spacings (for bridge costs), vehicle dimensions (for interference and certain geometric costs), vehicle weight-to-power ratios (for interference and capacity costs), vehicle emission characteristics (when external costs are considered), and time and place of travel (all costs).

While states cannot perfectly match highway user fees with a particular vehicle's precise cost responsibility, the generic tax systems result in wide variation in the degree of equity achievable. The evaluations of equity focus primarily on issues relating to weight and annual travel. Place of travel has a significant effect on public agency costs for expanding capacity and acquiring right of way; however, most past studies of equity have not considered place of travel. Because place of travel is also an important influence on external costs, this issue is addressed in the evaluation of the economic efficiency criterion in the next section.

Basic System

In the basic system (fuel tax plus periodic fees), the fuel tax varies directly with miles traveled and to some degree with GVW, while registration fees and other periodic fees vary with GVW, but, except for low-mileage discounts, not with miles traveled. Such a system can cover, at least to a degree, the variations in the highway cost responsibilities of various vehicles with GVW and VMT; however, a close match can occur only for a relatively small range of combinations of GVWs and annual mileages.

If annual fees are high and fuel taxes are low, the region where taxes tend to match weight-and-distance-related cost responsibility is near the median of annual mileages. Whereas, if annual fees are low and fuel taxes high, this region corresponds to the lower weight ranges (where fuel taxes are by themselves capable of providing a reasonable match to cost responsibilities). In the latter case, the region can be extended into the middle weight ranges if, instead of applying a single tax rate per gallon to all fuels, a higher tax rate is applied to diesel fuel (which is used primarily by medium and heavy vehicles). Similarly, the tax rate for liquefied petroleum gas (LPG) might best be set on the basis of

[18] The Urban Institute and K.T. Analytics, op. cit., pp. 10–12.

[19] Based on data from Metropolitan Washington Council of Governments, op. cit., pp. 62, 81 and 89.

[20] One set of estimates of the marginal social costs (excluding air-pollution costs) for operation on a typical urban Interstate yields 9 cents per mile for an automobile and 65 cents per mile for an 80,000 lb five-axle combination (including 41 cents per mile for pavement costs). (FHWA, *1997 Federal Highway Cost Allocation Study*, August 1997, Table V-26.) Costs in major urban areas are likely to be higher.

the relatively special use and cost responsibility characteristics of LPG-fueled vehicles.[21]

When the basic system is used with a reasonably well thought out set of tax rates, the greatest departures from equity occur (a) for vehicles that travel far more or far fewer than the average number of miles per year for a particular class and (b) for vehicles with high axle weights. An annual fee of $2,000, for example, yields 2 cents per mile from a vehicle traveling 100,000 mi per year, 4 cents per mile from a vehicle traveling 50,000 mi per year, and 20 cents per mi from a vehicle traveling 10,000 mi per year. Similarly, because pavement damage rises exponentially with axle weight but fuel consumption grows more slowly than GVW, fuel tax rates that produce appropriate revenue from low and moderate GVW vehicles produce revenue that fails to rise sufficiently as axle weights and GVWs rise.

Within the confines of the basic tax system, the second of the above problems can be imperfectly addressed by increasing reliance on annual fees to obtain revenue from the heaviest classes of vehicles. However, this strategy only exacerbates the first problem.

The first problem, in turn, can be partially addressed by charging lower annual fees on vehicles with low annual mileages. For example, charging vehicles traveling fewer than 30,000 mi per year one-third the rate of vehicles traveling more than 30,000 mi per year could reduce the fee-per-mile ratio of similar 10,000 and 100,000 mi-per-year trucks from 10 : 1 to just over 3 : 1. True, 10,000 mi-per-year trucks would continue to pay three times as much per mile as 29,999 mi-per-year trucks[22] and 30,000 mile-per-year trucks would overpay more than under a single-tier system, but this system would reduce the worst discrepancies, as illustrated in Figure 10.

A more complex set of equity issues relates to variations in the axle-loading characteristics of vehicles in a given GVW class and variations in the susceptibility of different road systems to pavement damage, which accounts for a significant share of Federal costs but a much smaller share of state costs. A five-axle vehicle with a declared weight of 80,000 lb might have a total cost responsibility, for example, of 10 cents per mile if it operates empty for 15 percent of its miles and loaded to its declared weight for the rest of its miles. However, if (as is more typical of for-hire carriers of general freight) its loaded weight varies in the 50,000- to 80,000-lb range, its cost responsibility would be appreciably lower; and if a similar vehicle using the same roads is empty for half its miles and loaded to 80,000 lb for the other half, its cost responsibility might only be about 7 cents per mile. This last type of operation is typical of vehicles that carry natural resources; however, these vehicles usually make disproportionate use of secondary roads that are relatively susceptible to pavement damage from heavy axle loads, so the relative cost responsibility of the last vehicle might not be as low as it appears. The lowest cost responsibility is for vehicles with declared weights of 80,000 lb that usually carry cube-limited loads that produce GVWs substantially lower than their declared weight.

Variations in axle-loading characteristics become more significant when vehicles with different axle configurations have the same declared weight. A four-axle vehicle with a given operating weight causes substantially more pavement damage than a five-axle vehicle with the same operating weight. The resulting variation in cost responsibility can be partially addressed by varying annual fees or special permit fees with axle configuration as well as weight, though inequities will exist for vehicles that travel far more or far fewer than the average number of miles for their axle-configuration and weight class. Varying fees with axle configuration becomes increasingly valuable as the maximum GVW allowed for routine operation rises and the number of axle configurations in use increases.

A less significant inequity results from variations in the pavement loads exerted by axles of the same weight but with different types of suspensions. This inequity can be substantially reduced by varying annual fees and permit fees with type of suspension.

Fuel Tax Surcharge System

Fuel tax surcharges that are graduated with GVW have the capability of simultaneously reflecting both the GVW and distance related variations in cost responsibility. Accordingly, the use of such surcharges in conjunction with very small registration fees has the potential to eliminate most of the GVW- and mileage-based inequities inherent in the basic system. Inequities stemming from differences in axle configuration would remain unless the fuel surcharges varied with both weight and axle configuration.

A fuel tax surcharge applied to all heavy vehicles at a single flat rate has a much more limited capability for reflecting GVW-related variations in cost responsibility. Nonetheless, such a surcharge can be used to produce an improvement in equity relative to that produced by the basic system.

The fuel tax surcharge would create a new class of inequity—it rewards vehicles that can operate at a given GVW with better-than-average fuel efficiency and penalizes fuel-inefficient users. On the other hand, since fuel use varies with operating weight rather than with declared weight, this system is somewhat better than the other systems in reflecting variations in the load characteristics of vehicles with a given declared weight.

[21] Another alternative, setting tax rates on the basis of Btu content is preferable to applying the same rate to all fuels but is less effective than tailoring the rates for different fuels to the cost responsibility of vehicles using those fuels.

[22] The excessive annual fees paid by vehicles with very low annual mileage can be further reduced by providing these vehicles with an option for paying an annual fee that varies with annual mileage—in effect providing a weight-distance tax option for these vehicles. Illinois currently provides this option for vehicles that operate exclusively in the state.

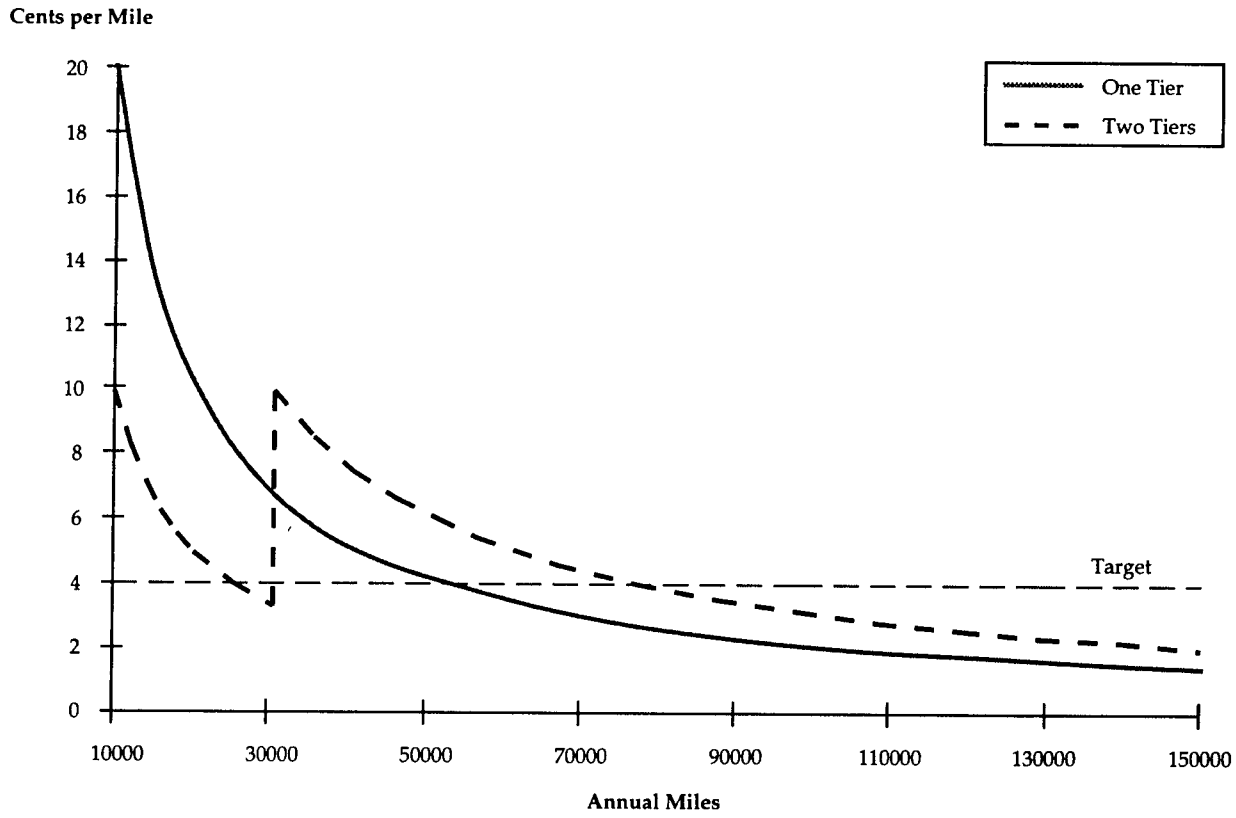

Figure 10. Rates per mile for two systems of annual fees.

Weight-Distance Tax Systems

A weight-distance tax is capable of producing a perfect match, by declared GVW class, between tax revenue and weight-and-distance-related cost responsibility. Referring to Figure 10, by setting the weight-distance tax rate to the target value, one eliminates all variation by annual miles of travel. This tax does not impose the fuel-efficiency inequities of the fuel tax surcharge system, but neither does it reflect variations in the load characteristics of vehicles with a given declared weight.

If tax rates are based only on declared GVW, inequities stemming from differences in axle configuration remain. However, these can be eliminated by using an axle-configuration weight-distance tax in which rates vary with both axle configuration and GVW.

Toll Systems

Toll systems have some unique characteristics that affect their potential for recovering highway infrastructure costs. One clear advantage is that tolls are charged for use of specific facilities, or even specific facility segments, so that they provide an attractive means of charging for use of facilities that are particularly expensive to build, expand, or maintain. Another potential advantage is that, at least in concept, tolls could be increased temporarily on hot days or during the spring thaw as a means of charging for the extra pavement damage that occurs during these times.

Despite these advantages, most existing uses of toll financing tend to decrease the relationship between overall user charges and cost responsibility. Use of toll facilities involves the payment of tolls, which are used mostly or entirely for financing the toll facilities, and the payment of other user charges, such as fuel taxes and registration fees, that are used mostly or entirely for financing other facilities. Accordingly, on an overall basis, users of toll facilities normally pay more than their share of cost responsibility. The extra costs borne by these users are considered inequitable by some observers, who believe that user charges should be directly related to cost responsibility; others argue that the value of time and these users' ability to pay generally are above average, so they receive above average benefits from the toll systems and their extra cost burden contributes to social equity.

The overcharging of toll facilities users could be reduced or reversed by (1) using revenue from other user charges to replace part or all of the tolls paid by those vehicle classes that meet much or all of their cost responsibility through these other user charges[23] and (2) using tolls primarily as a means of increasing revenue from vehicle classes that otherwise would not meet their cost responsibility. When the goal

[23] In the case of bond-financed toll facilities, this reduction in toll revenue and its replacement by user charges might require bondholder approval.

is only to recover public agency costs, this relatively restricted use of tolls would reduce their productivity unless administrative costs are also reduced (e.g., by collecting tolls only from heavy vehicles). The resulting effect on administrative efficiency could make tolls relatively unattractive. However, when the goal is also to recover a significant share of external costs (as discussed under the "efficiency" criterion in the next section), this restricted use of tolls is of greater interest.

Another limitation of tolls as a means of equitably recovering public agency costs from highway users is that the tolls paid by a given vehicle generally vary with the number of its axles rather than with its GVW or axle weights. Although there is a reasonable correlation between cost responsibility or weight and number of axles, the correlation is imperfect, and charging by number of axles produces a financial incentive to reduce the number of axles—a change that would substantially increase pavement costs. This limitation can be addressed by varying tolls with a vehicle's declared weight class—which is easy to do under ETC, and, under manual systems, might be possible with the aid of color-coded windshield stickers. Even greater equity might be achievable by varying tolls with actual vehicle weight (as determined on entry to a toll road), though administrative problems are likely to limit the attractiveness of this alternative.

For the purpose of recovering public agency costs, existing highway user-charge systems that include tolls are somewhat less equitable than corresponding systems without tolls. However, there is some potential to design toll systems that produce a modest improvement in equity relative to the basic system.

ECONOMIC EFFICIENCY

The economic efficiency criterion requires that, to the extent practical, user charges be formulated to provide incentives to use highways in a way that maximizes net social benefits, that is, highway transportation should be used when and only when the resulting benefits exceed the marginal social costs of such highway use. Thus, the economic efficiency criterion, like the equity criterion, specifies how user groups should be charged for highway use. However, the economic efficiency criterion differs from the equity criterion in several ways:

- The costs considered include external costs (which are somewhat arbitrarily excluded from consideration by the equity criterion);
- The criterion uses marginal costs rather than average costs;
- Social costs are compared with the sum of *all* user charges (Federal, state, and local) without distinction; and
- The criterion requires that, to the extent practical, the marginal charge for highway use matches the marginal social costs attributable to that use.

The first and last of these differences have very significant implications for tax systems designed to promote economic efficiency, and they also make this criterion substantially more difficult to satisfy than the equity criterion. In particular, the efficiency criterion requires that, to the extent practical, user charges vary with both the *amount* and the *type* of highway use. Annual fees do little to promote efficiency, because, once paid, they do not provide any incentive for limiting vehicle operation to uses for which social benefits exceed social costs. Charges that do not vary with location and time of day result in substantially overcharging for operation in rural areas and substantially undercharging for peak-period operation in urban areas,[24] thus discouraging economically efficient rural travel and underpricing economically inefficient peak-period urban travel. In addition, for any given type of highway use, the social costs of operating heavy vehicles increase more than linearly with weight (primarily because pavement costs, which increase nonlinearly with axle weight, account for a significant share of the costs of operating these vehicles[25]). Accordingly, heavy vehicle user charges should vary with weight, as well as with VMT and with time and location of use.

These observations have significant implications for evaluating the potential of the generic tax systems to contribute to economic efficiency.

Basic System

The basic tax system consists of a fuel tax and one or more types of annual, quarterly, or monthly fees.

From the standpoint of economic efficiency, the fuel tax has both advantages and limitations. Fuel consumption varies directly with highway use, and the rate of fuel consumption tends to vary with emissions. Also, the rate of fuel consumption increases with vehicle weight, though at a far slower rate than total social costs. Because fuel consumption rates are higher on congested roads, the fuel tax does tend to increase with congestion. It also is possible to apply slightly higher fuel tax rates in major urban areas than in rural areas. However, a significant difference in tax rates probably would cause many drivers in these areas to avoid much of the extra tax by purchasing fuel from out-of-area sources. Hence, the increase in fuel tax costs for operation in urban areas cannot come close to matching the extent to which congestion and emissions costs increase when vehicles are operated on congested urban roads. Accordingly, the fuel tax has only a lim-

[24] As previously observed, it has been estimated that the marginal social costs of vehicle operation in urban areas typically are 4 to 7 times as high as they are in rural areas. Furthermore, peak-period marginal social costs in congested parts of major metropolitan areas are likely to be several times as large as off-peak marginal social costs in less congested urban areas; so that, within any state, marginal social costs per vehicle-mile are likely to vary with location and time of day by at least an order of magnitude.

[25] For five-axle combinations, pavement costs represent about 35 percent of total social costs when operating at 60,000 lb and about 65 percent of these costs when operating at 80,000 lb. (FHWA, *1997 Federal Highway Cost Allocation Study*, August 1997, Table ES-6.)

ited ability to reflect the variations in marginal social costs with vehicle weight, location, and time of day.

Registration fees can be varied on the basis of vehicle characteristics, such as length, weight, and power-to-weight ratios, that affect the pavement and interference costs of vehicle use. An even more interesting option is to charge vehicles that are used during peak periods on certain roads or in certain congested areas a monthly or annual fee (e.g., enforced using windshield stickers). This form of congestion fee is currently in effect in the central areas of Bergen and Trondheim, Norway, (where the areas covered are referred to as "toll rings").

Both of the above fee options succeed in charging vehicles for at least some of their external costs, and the congestion fees also serve as a rationing device. However, there is no way to make monthly or annual fees vary directly with vehicle use, so they are not effective mechanisms for increasing economic efficiency. Congestion fees, for example, may cause some vehicle operators to choose to forego use of the areas or roads covered by these fees during the peak period, but they will do nothing to reduce the use of these roads by the many vehicle operators that choose to pay the fee.

The potential of the basic tax system for promoting economic efficiency is also limited by conflicts between the economic efficiency and equity criteria. Because of the latter criterion, relatively high annual fees usually are imposed on the heaviest classes of vehicles. These fees contribute a significant share of the user charges paid by these vehicle classes, but, because they do not vary with VMT, they do not provide the appropriate incentives for reducing usage.

The project team concludes that a tax system consisting only of annual fees and a conventional fuel tax has only limited potential for promoting efficient use of the highway system.

Fuel Tax Surcharge System

Fuel tax surcharges that are graduated with weight have substantially greater potential than a conventional fuel tax for reflecting the variation in social costs with weight. Also, because these surcharges make it possible to achieve a reasonable degree of equity across weight classes without the use of high registration fees, their addition to the basic tax system makes it possible to reduce reliance on annual fees significantly and to increase reliance on fuel taxes. Because fuel tax charges vary with highway use, this change increases the marginal costs of vehicle operation and so increases the resulting incentives for reducing inefficient uses of vehicles. Thus, a graduated fuel tax surcharge system has substantial potential for producing user charges that vary appropriately with VMT and weight. However, as in the case of the basic tax system, the graduated fuel tax surcharge system has only a limited capability for reflecting the spatial and temporal variation in marginal social costs.

Fuel tax surcharges that are not graduated with GVW are much less capable than graduated surcharges of reflecting weight-related variations in social costs. Also, because they contribute much less to equity among weight classes than do graduated surcharges, they permit a smaller reduction in registration fees and produce a correspondingly smaller increase in the incentive for reducing inefficient uses of vehicles. Accordingly, a flat-rate fuel tax surcharge system has appreciably less potential for encouraging economic efficiency than does a graduated fuel tax system, but it has more potential than the basic system.

Weight-Distance Tax Systems

As in the case of systems incorporating a graduated fuel tax surcharge, systems incorporating a conventional weight-distance tax have substantial potential for producing user charges that vary appropriately with VMT and weight but only limited capability for reflecting the spatial and temporal variation in marginal social costs (at least without an impractically large increase in the reporting burden). However, fuel taxes are more closely related to emissions (a moderately significant component of social costs) than are weight-distance taxes. Accordingly, the weight-distance tax system has slightly less potential for encouraging economic efficiency than does a graduated fuel tax surcharge system.

Systems incorporating an axle-configuration weight-distance tax have even greater potential for producing user charges that vary appropriately with weight than do systems incorporating a conventional weight-distance tax; however, in other respects relating to economic efficiency, the two types of tax systems are very similar. Accordingly, axle-configuration weight-distance tax systems have slightly more potential than conventional weight-distance systems for encouraging economic efficiency.

Toll Systems

Toll systems have unique capabilities for charging users of toll facilities on the basis of the full marginal social costs of their facility use. For each vehicle class and each facility segment, the toll can be set to approximate the difference between the estimated full social cost of a vehicle's use of the segment (agency costs plus external costs) and the fuel and weight-distance taxes paid as a result of that use. The price signals created by such a toll structure should produce social benefits in the form of reductions in congestion, emissions, and the other external costs of vehicle operation.

With ETC systems, it may be practical to charge tolls on all major arterials, so that marginal-cost pricing can be applied to a major share of highway use. Conventional toll-collection systems, however, are only feasible for a much smaller road system (generally only freeways, tunnels, and bridges), and so they would result in more limited use of

marginal-cost pricing. Furthermore, conventional systems require vehicles using toll facilities to stop, at least briefly, and then to accelerate, reducing the overall congestion and emissions benefits of the toll system.

ETC systems also have some other advantages over conventional systems. With ETC systems, tolls can be varied by time of day to approximate the temporal variations in social costs (particularly congestion costs), though such time-of-day variation may be at least partially feasible with conventional systems. Also, ETC systems can distinguish vehicle classes on the basis of declared weight and any other vehicle characteristics that significantly affect social costs, while conventional systems usually distinguish vehicle classes only on the basis of number of axles.

The project team concludes that ETC systems have substantially greater potential for promoting economic efficiency than any of the other tax systems evaluated, and that conventional toll-collection systems have more moderate potential for promoting economic efficiency.

EVASION AND AVOIDANCE

The evasion and avoidance criterion includes two elements: illegal evasion and legal avoidance. In principal, both can be measured in terms of annual dollars of revenue lost; however, both are inherently difficult to estimate. Normally, qualitative evaluations or order-of-magnitude estimates of evasion and avoidance are sufficient.

As described in Chapter 6, there are trade-offs between the level of effort in enforcement activities and the amount of evasion that occurs. That description suggested that the optimum level of enforcement effort probably lies somewhat above the level that minimizes public- and private-sector costs. Such a level of enforcement would lead to appreciably less evasion than most current programs. However, this level of enforcement may be greater than can be supported given the realities of the legislative budget-making process. Given this limitation, tax administrators are faced with the twin tasks of attempting to expand their budgets for enforcement activities and designing procedures that will use available enforcement funds in the most effective way possible.

The process of performing an assessment of evasion and avoidance should be viewed as an opportunity to make use of what is learned to significantly reduce revenue losses for whatever tax system is selected and to find ways to effectively monitor and reduce revenue losses.

To the extent possible, the following comparative evaluation of the likely extent of evasion and avoidance under the prototypical tax systems presumes comparable levels of enforcement for all four systems. In practice, enforcement effort is likely to be correlated with concerns about evasion; so that for the more evasion-prone systems, enforcement effort is increased to limit evasion to acceptable levels.

Basic System

Annual Fees

The following are some of the common ways in which registration fees are evaded:

- Not registering a vehicle in the state as soon as required by law after it is brought into the state;
- Using partial-year registration (which most states allow), but operating vehicles for a longer period of the year;
- Registering at a lower GVW than the maximum weight at which the vehicle is operated;
- Registering as a publicly owned vehicle or other exempt type of use and using the vehicle for private purposes;
- Misrepresenting some tax-related characteristics of the vehicle, such as a resale price, or purpose for which the vehicle is used, such as private versus for hire; and
- Underreporting mileage in high-fee states and over-reporting mileage in low-fee states.

Surveys and interviews with state officials indicate that registration and related fees are perceived as having relatively low evasion and avoidance rates compared with most other user taxes and fees. However, the team knows of no significant analysis of this type of revenue loss. The highest evasion rates in percentage terms probably occur in areas where enforcement activity is very low, such as registering at lower GVW than actual operating weight and misrepresenting characteristics or use of vehicles.

The more complex annual fee structures generally provide some increased opportunity for evasion. Making annual fees vary with suspension system or emissions class provides additional tax-related characteristics that can be misrepresented. Similarly, varying registration fees or permit fees on the basis of combinations of axle configurations and declared GVWs increases the complexity of the registration fee and may result in some intentional or unintentional understatement of the appropriate registration fee. Rules for the last type of system would also have to be structured to prevent vehicle operators from legally reducing their registration fee liability by adding non-load-bearing axles to their vehicles.

Fuel Taxes

These are some common ways of evading fuel taxes:

- Purchasing untaxed fuel and selling it as taxed fuel,
- Selling fuel taxed in one state in another, higher tax state (bootlegging),
- Blending untaxed fuel (e.g., kerosene) with taxed fuel and treating the blend as taxed fuel,
- Purchasing and using untaxed fuel without reporting it,

- Misrepresenting the ownership or purpose for which the vehicle is used (such as farm, off-road, public transportation, or school bus),
- Understating fuel use and overstating fuel economy in fuel-use reports, and
- Underreporting mileage in high-tax states (possibly combined with overreporting mileage in low-tax states).

In addition, operators of vehicles not subject to fuel tax reporting can legally reduce fuel taxes paid by purchasing disproportionate amounts of fuel in low-tax jurisdictions and using the fuel in high-tax jurisdictions.

As a result of the fuel dyeing program and various other efforts, fuel tax evasion at the Federal level has been reduced, and evasion of the Federal tax now appears to be the same as or lower than evasion of state fuel taxes. Some states have also been able to reduce fuel tax evasion through changes in the point of taxation (although frequently the reduction has proven temporary) and by increased enforcement efforts in close working relationships with the Federal initiatives. However, state fuel tax evasion has not been reduced across the board, and there is some reason for concern that state fuel tax evasion could actually increase despite recent efforts.[26]

Additional Considerations

Misallocation of mileage among states results in decreasing fuel tax and registration-fee receipts in some states while increasing receipts in other states. Such misallocation may be performed consistently on both IRP and fuel-use reports or, at least in concept, separate misallocations can be used. The latter strategy can result in greater evasion of taxes and fees; however, because it may be easy to detect in joint audits of the two taxes (which are performed by some states), it is probably the less common strategy. When misallocations on the two sets of reports are consistent, they may be quite difficult to detect. There is some potential for a state to use ITS technologies to verify that carrier mileage records are consistent with the state's records of when and where the carrier's vehicles have been observed. There is also a similar potential for carriers to use these technologies to limit any misallocations of mileage to those that are consistent with the state's records.

As a result of the promotional efforts of the National Governors' Association and various other groups and because of the requirements of ISTEA, administration of registration fees and fuel taxes has been largely converted to a base-state system. This has substantially reduced compliance costs for industry, and it has reduced or eliminated one form of auditing abuse—the arbitrary assignment of any unreported miles that are found to the auditor's state (an abuse that can result in double taxation when the same unreported miles are found by different auditors and assigned to different states).

The adoption of base-state systems has frequently been cited as being promising for reducing evasion; however, evasion could actually increase as a result of the low standards of these programs. Auditing of carriers based out of state has been substantially reduced by many states and auditing requirements for the base-state systems are an order of magnitude below the standards of the best state programs. Moreover, both base-state systems have a low level of enforcement of standards for auditing and other enforcement-related requirements. Also, because states with relatively low per-mile combined charges for fuel taxes and registration fees are likely to be beneficiaries of any misallocation of mileage, there is little incentive for their auditors to look for such misallocations. Thus, each state's program should be evaluated based on that state's standards, not on the basis of requirements of IRP or IFTA.

Unfortunately, many states have not taken advantage of opportunities to integrate the administration of the two base-state systems that result from the new requirements of ISTEA. Under the existing IRP and IFTA agreements, individual states cannot fully integrate the administration and enforcement of the two programs because of differences in their reporting and payment requirements. The reductions in administrative costs and evasion that can be produced by full integration of the two programs can probably only be achieved through a national effort. The National Governors' Association has indicated interest in conducting a study of the feasibility of doing this in the near future.

Fuel Tax Surcharge System

The most significant and obvious difference between fuel tax surcharge systems and the basic system used here is the surcharge. The surcharge permits increased reliance on the fuel tax for obtaining revenue from heavy vehicles and decreased reliance on registration fees. Accordingly, heavy vehicles are likely to pay lower registration fees under a fuel tax surcharge system.

The introduction of a fuel tax surcharge also makes it possible to set the basic gasoline and diesel-fuel tax rates entirely on the basis of the level of user charges to be obtained from light vehicles, without consideration of the effects on heavy vehicle user charges. Thus, there is some possibility that the basic fuel tax rates will be lower when they are supplemented by a surcharge (though this does not appear to be the case for most current fuel tax surcharge systems).

The differences in tax rates between a fuel tax surcharge system and the basic system affect the incentives for evasion and thus the likely amount of evasion. In particular, the increased tax rate applied to fuel used by heavy vehicles

[26] R. D. Mingo and Associates et al., *Diesel Fuel Fee Non-Compliance,* Final Report, prepared for Oregon DOT, March 1996, pp. 25–34.

increases the incentive for underreporting total fuel use and overestimating fuel efficiency.[27]

Similarly, if surcharges are used in some states but not others, the incentive for misallocating mileage among states is increased. If fuel-use and IRP mileage reports are consistent, this incentive depends on the extent to which the sum of the per-mile charges for fuel taxes and registration fees varies across states. Any misallocation then results in evading taxes in states where this sum is high and overpaying taxes (by a lesser amount) in states where the sum is low. Since this sum is likely to be highest where fuel tax surcharges are in effect, states with such surcharges are most likely to be adversely affected by misallocation of mileage.

Furthermore, the use of multiple fuel tax rates (two in the case of a flat-rate surcharge, several in the case of a graduated surcharge) makes it possible to misallocate total fuel use among vehicle classes, overreporting fuel used by the lighter classes and underreporting fuel used by the heavier classes. Opportunities for this type of evasion are very limited in the case of a flat-rate surcharge and in the case of fleets that consist entirely or nearly entirely of vehicles in a single surcharge class (e.g., 80,000-lb vehicles). However, under a graduated surcharge, fleets that operate vehicles in several different weight classes might be able to misallocate a moderate amount of fuel use from the higher weight classes to the lower weight classes. Such fleets are likely to be more common in states that allow routine operation at GVWs above 80,000 lb than in states that do not allow such operation.

If the introduction of a fuel tax surcharge is accompanied by a reduction in the basic fuel tax rate, the above types of evasion may be balanced to some extent by a reduction in the incentive for selling untaxed fuel as taxed fuel.

In addition to creating a new opportunity for evasion and changing the incentives for evasion in many states, the introduction of a fuel tax surcharge creates a new class of potential evaders—intrastate carriers for which fuel-use reports are required under a surcharge system but not under the current tax system. These carriers will have a substantial incentive (varying with the size of the surcharge) to underreport fuel use, and they may find it easier to do so than larger interstate carriers. Thus, increased evasion by these carriers may be significant.

The team observes that all the increases in the incentives for evasion vary with the size of the surcharge. Accordingly, these incentive increases generally will be smaller for flat-rate surcharges than for graduated surcharges (which, for the heaviest vehicle classes, are likely to be appreciably larger than flat-rate surcharges). Furthermore, misallocation of reported fuel use among vehicle classes is a potentially significant type of evasion in the case of graduated surcharges.

[27] In the case of fuel purchased at truck stops, the increased incentive to underreport fuel use may represent the creation of an incentive where none existed. For retail fuel purchases, tax is paid at the pump (at the local rate). Hence, in the absence of a surcharge, there usually is no incentive to underreport purchases. However, the introduction of a significant surcharge could create such an incentive.

The project team concludes that, for a given enforcement effort, fuel tax surcharge systems generally can be expected to have somewhat higher evasion rates than the basic system, especially when the surcharge is graduated. From a public management perspective, this conclusion implies that, if evasion is to be limited to a given level, fuel tax surcharge systems require a greater enforcement effort than does the basic system.

Weight-Distance Tax Systems

Some of the ways of evading a simple weight-distance tax are as follows:

- Operating a vehicle at a weight that is higher than the maximum GVW declared for the vehicle,
- Misrepresenting the use of a vehicle (farm, off-road, etc.),
- Underreporting total mileage, and
- Underreporting mileage in high-tax/fee states and overreporting mileage in low-tax/fee states.

Some of the weight-distance tax variants allow additional types of evasion. For example, allowing operators to pay weight-distance taxes at rates per mile that vary with a vehicle's configuration makes it possible for operators to misallocate a power unit's total miles among the configurations in which it is operated. Use of an axle-configuration weight-distance tax does not actually introduce a new type of evasion, but it complicates the first of the above types of evasion[28] and it probably results in some increase in the occurrence of this type of evasion.

There is some similarity between fuel tax evasion resulting from underreporting total fuel use (or overstating fuel efficiency) and weight-distance tax evasion resulting from underreporting total mileage. However, enforcement procedures to limit these two types of evasion are different. In particular, auditing of the weight-distance tax generally involves a detailed review of mileage reports and vehicle logs, while fuel use can probably be checked most efficiently by checking for consistency with a carrier's fuel purchase records and its financial records and income-tax returns.[29]

The most significant difference between evasion of the two taxes, however, is that all diesel-fuel taxes present an

[28] For an axle-configuration weight-distance tax, the first type of evasion becomes operation of a power unit in a configuration at a weight that is higher than the maximum GVW declared for that configuration.

[29] Other differences between the two taxes are in the agencies that administer them and in the way auditing is conducted. Many revenue departments that usually administer fuel taxes view these taxes as minor ones that do not warrant a significant enforcement effort. On the other hand, weight-distance taxes usually are administered by transportation agencies that have a stronger commitment to enforcement of highway user taxes and thus are able to achieve lower evasion rates. Also, weight-distance tax auditors are concerned only with evasion of their own state's taxes, so they may be more effective at fulfilling this narrow responsibility than fuel tax auditors, who are concerned with evasion of taxes in all states in which a carrier operates.

The resulting differences in evasion rates, however, result primarily from differences in enforcement effort and not from differences in the potential for evasion.

evasion opportunity for use of untaxed or blended fuel while weight-distance taxes do not. Because use of untaxed blending agents is considered to be a significant type of fuel tax evasion, it is likely that, assuming similar levels of enforcement and corresponding per-mile tax burdens, overall evasion of a weight-distance tax would be lower than overall evasion of a diesel-fuel tax without a surcharge. This conclusion appears to be consistent with a recent estimate of a 5 percent evasion rate for the weight-distance tax in Oregon,[30] which has a well-managed tax enforcement program, and limited evidence from other studies that indicate higher evasion rates when enforcement efforts are less extensive.

The above discussion indicates that, for a given enforcement effort, when designed to produce comparable amounts of revenue, evasion rates for weight-distance taxes are likely to be somewhat lower than those for conventional diesel-fuel taxes. However, this advantage for weight-distance taxes is at least partly balanced by an increased incentive for evasion resulting from the higher marginal tax rate per mile (for all taxes combined) that usually is applied to the heaviest vehicle classes under a weight-distance tax system. The project team concludes that, for a given enforcement effort, it is not clear that overall evasion rates for weight-distance tax systems would be significantly higher or lower than those for the basic system. However, because of the somewhat greater complexity of the axle-configuration weight-distance tax, for a given enforcement effort, evasion rates for axle-configuration weight-distance tax systems are likely to be slightly greater than for conventional weight-distance systems.

Toll Systems

For facilities with conventional toll-collection systems, evasion can take the form of nonpayment, partial payment, or the use of slugs. The use of slugs is directly measurable, while other forms of evasion are potentially measurable. Actual citations for failure to pay are an evasion indicator, but they represent just a fraction of actual nonpayment.

In addition to illegal evasion, barrier toll-collection systems may lose revenue as a result of the use of local bypass routes. Rough estimates of the extent of this form of legal avoidance can be developed from traffic data.

Potential means of evading ETC systems include the following:

- Use of ETC-only lanes by vehicles without transponders (potentially measurable),
- Delinquent accounts (measurable), and
- Illegitimate transponders (potentially measurable).

ETC systems can also lose revenue as a result of equipment malfunctions and malfunctions of payment clearance between different toll authorities. Both these forms of revenue loss are measurable.

In addition to the above forms of revenue loss, to the extent that parallel "free" roads are available, externality charges collected through the use of toll systems (regardless of the collection mechanism used) can be legally avoided by avoiding the use of toll roads altogether. This is a somewhat different type of toll avoidance than the bypassing of barrier tolls on toll-financed roads. In the earlier instance, drivers are avoiding payment for their use of facilities that are financed by tolls. In the case of externality charges, no use is being made of these facilities, but drivers that use alternate routes are avoiding payment for the emissions and other external costs of their vehicle operation. This type of avoidance transfers congestion problems from the toll facilities to alternate routes and the net effect on emissions in the area is unclear. Thus, this type of avoidance may reduce the benefits of the externality charges.

Externality charge avoidance may be significant if tolls are charged only on a few freeways but is likely to be much less significant if tolls (using an ETC system) are extended to all arterials serving an area. However, in both cases, various traffic-related problems are likely to result on alternates to the toll roads as a result of diversion. Moreover, extending tolls to nonfreeways may produce a substantial decline in the administrative efficiency of toll systems.

Toll systems have completely different types of evasion and avoidance problems from other types of tax systems, and there probably has been no comparative analysis of evasion of toll systems versus other types of tax systems. However, a few tentative statements can be made:

- Evasion and avoidance for conventional toll collection systems is a subject that many toll authorities have had long experience with, so that it should not be difficult to make quantitative assessments.
- Evasion at conventional toll-collection booths which have visible means of enforcement (cameras or police vehicles) is likely to be very low.
- Evasion at toll barriers that have attendants in some or all lanes but no other visible means of enforcement is likely to be somewhat higher.
- Evasion at unattended toll booths (usually low-volume ramps at night or weekends) may be high, especially in the absence of lift arms.
- Evasion of ETC systems is probably quite low where visible means of enforcement are present.
- A significant portion of revenue loss for current ETC systems are correctable (confusion over conventional versus ETC versus mixed lanes, confusion over signing at approaches, malfunctions of equipment, etc.).
- For all toll systems, visible enforcement efforts probably are very cost-effective.

[30] Cambridge Systematics and Sydec with Pacific Rim Resources, *Oregon Weight-Mile Tax Study: Final Report*, prepared for the Oregon Legislative Revenue Office, Oregon Public Utilities Commission, and Oregon Department of Transportation, February 1996, p. 5–8.

The project team concludes that, with a relatively modest enforcement effort, toll facilities probably experience evasion rates that are appreciably lower than those for other highway taxes and fees. Accordingly, user-charge systems that derive a significant share of total revenue from tolls are likely to experience lower overall evasion rates than any of the other systems evaluated. However, as discussed above, avoidance of toll systems designed to charge for external costs can be significant, especially if tolls are charged only on limited-access facilities. Such avoidance could significantly reduce the benefits of externality charges.

FEASIBILITY

Feasibility can be affected by constitutional prohibitions, legislative restrictions, political constraints, and technical problems. Feasibility issues must be evaluated differently for the short term and the long term because absolute constraints in the short term can sometimes be changed through education and negotiation, and sometimes the probability of implementing a tax option is greater today than in the future because of foreseeable trends.

The project team knows of no constitutional prohibitions on any of the components of any of the generic tax systems. However, other factors do affect the feasibility of some of the components. Legislative restrictions exist for many tax options and for many changes in taxes; however, in the long term, these restrictions are of little importance beyond whatever constraints are likely to be caused by political opposition. Many of the limits on current feasibility are either (a) political constraints that can be changed because they are based largely on incomplete public understanding of the facts or (b) technical problems that may have a good prognosis for being solved in the foreseeable future.

Basic System

The most clearly feasible components of any of the generic tax systems are the registration fee, fuel tax, and overweight permit fees. All three of these taxes are used in every state (although heavy vehicles that pay the weight-distance tax are exempt from diesel-fuel taxes in Oregon). Annual ad valorem taxes (which are used by a somewhat smaller number of states) and reduced fees for low-annual-mileage vehicles (as is done in two states) also do not appear to pose any feasibility issues. Similarly, although not in current use, there do not appear to be any feasibility issues raised by varying registration fees with axle configuration or with suspension systems.

Varying annual fees by amount of emissions, however, does raise some feasibility issues. This option has been widely discussed and debated in Southern California without resolution, implying that there are serious political and technical feasibility problems. Public and political resistance to such a proposal is likely to be highly correlated with the amount of increase in fees that would be required for the vehicles with the highest emission rates (generally older and larger vehicles). Such variations could result in a reduction in the total tax burden on owners of lower emission vehicles (generally newer and smaller vehicles) via a relatively small annual emissions fee coupled with a somewhat larger reduction in other highway fees and taxes. If so, some support for this option might come from owners of these vehicles. However, opposition can also be expected based on the regressive nature of having higher fees for the older autos, which tend to be owned by lower income persons.

Fuel Tax Surcharges and Weight-Distance Taxes

Feasibility issues are of somewhat greater concern in the case of fuel tax surcharges and the two types of weight-distance taxes, and they are very significant in the case of graduated fuel tax surcharges.

Fuel tax surcharges and weight-distance taxes are designed primarily to allow taxes on high-VMT heavy trucks to be increased to a level that better matches their cost responsibility without simultaneously overtaxing lighter high-VMT diesel vehicles or low-VMT heavy trucks. For this reason, these taxes are strongly opposed by most operators of for-hire interstate trucks, though other reasons usually are given for their opposition. These include concerns about administrative and compliance costs and levels of evasion. Owner-operators and motor carriers have also expressed privacy concerns about the installation of monitoring systems that could be used in the administration of weight-distance and other taxes, though these concerns have not prevented many carriers from installing various types of electronic systems for other purposes, such as for clearance at weigh stations, ETC, tracking of trucks and shipments, and identifying the location of hijacked vehicles. Privacy concerns have also been expressed about possible requirements that tax auditors be allowed access to company computer systems. Although these evaluations suggest that the stated concerns about costs and evasion are frequently exaggerated, the opposition of the for-hire motor-carrier industry has resulted in reducing the number of states that impose weight-distance taxes and limiting the introduction of vehicle-monitoring and auditing technology.

Institutional issues may also affect the feasibility of setting up the most efficient multistate systems for administering weight-distance taxes. For these taxes, interstate administration and auditing could be handled by expanding the scope of IRP or of IFTA. However, to eliminate duplication of effort and exclude the possibility of evasion through the filing of inconsistent reports to multiple organizations, it would be preferable to combine these two agreements, a change that would require a major national effort with the involvement of representatives of many or all states.

Flat-rate fuel tax surcharges are appreciably less effective than weight-distance taxes in increasing the taxes paid by high-VMT heavy trucks, and so there is less opposition to these surcharges than to weight-distance taxes. Graduated fuel tax surcharges, however, can be as effective as weight-distance taxes, and so they encounter significant opposition. More important, at the present time, the implementation of graduated surcharges by any state is effectively prohibited by Federal law proscribing "fuel-use tax reporting requirements (including tax reporting forms) which are not in conformity with the International Fuel Tax Agreement."[31] Because IFTA reporting forms require fuel-use and VMT data by fleet, but not by vehicle or vehicle class, these forms do not provide the information necessary to administer graduated fuel tax surcharges. Implementation of graduated surcharges thus would require one of the following: a change in federal law, a significant increase in IFTA reporting requirements, or a merger of IRP and IFTA and the adoption of a unified mileage and fuel-use reporting form that would provide all the needed information.

Because of the strong opposition to weight-distance taxes from most of the for-hire motor-carrier industry, new taxes of this type, in whatever form, can probably not be implemented without a sustained, well-organized effort. This effort would have to include the development of a sound plan for effective administration and enforcement, as well as an educational effort to explain the benefits in terms of equity and economic efficiency and the ways in which the problems that have been associated with these types of taxes can be minimized.

Toll Systems

Feasibility issues relating to the use of tolls are relatively complex. The complexities involved are evaluated by defining four principles based on general U.S. experience, and then several specific types of toll systems are considered.

One general principle is that opposition to tolls will be strong if the proposals are perceived as double taxation or as a tax increase. Thus, the addition of tolls on any existing free route or set of routes in an area, without a corresponding decrease in other forms of tax, will probably meet strong opposition.

A second general principle is that it is feasible to charge tolls on a new facility or for a new opportunity to use a route such as an HOV lane, if that new facility or HOV lane is perceived as not being available to users without the imposition of tolls.

A third general principle is that reductions in existing off-peak tolls are attractive to users. If off-peak reductions in tolls are as large or larger than peak-period increases in tolls, a congestion pricing system may be politically feasible.

The fourth and final general principle is that it will probably be difficult to implement toll schedules that cover external costs other than congestion costs until there is widespread support for congestion pricing based on the perceived net benefits of reduction in congestion.

Tolls are often accepted as a mechanism to pay part or all of the public agency costs of facilities that are particularly expensive or are designed to provide premium quality service in congested corridors that are also served by facilities without tolls. In some areas, portions of revenue produced by toll facilities are used for other purposes, including support of untolled highway facilities and transit subsidies. However, political opposition has limited the use of revenue from toll facilities as a funding source for other highway facilities.

Although use of tolls as a means of charging for infrastructure costs is well established, their use as a means of charging for externality costs is not and attempts to use tolls for this purpose are likely to encounter political opposition. A survey performed for the Southern California Association of Governments found that, while 60 percent of respondents thought that congestion and air pollution were serious problems, less than 20 percent were willing to see these problems addressed by raising the cost of driving.[32] In part because of this, the only attempt the project team knows of to obtain approval by a state legislature to use tolls on an existing toll facility to charge for externality costs was unsuccessful.[33] A Federal program for subsidizing experiments with congestion pricing has resulted in only two relatively limited experiments that involve instituting or increasing tolls. The first pricing project that has been implemented is a new four-lane toll facility (the SR 91 Express Lanes) in the median of the Riverside Freeway in Orange County, California. Transponder-equipped vehicles are charged a toll that varies by time of day and is eliminated for HOVs. A second, similar experiment, which was recently inaugurated on a limited basis, allows SOVs to pay to use an existing HOV lane on I-15 in North San Diego.

Modifying toll structures on existing toll facilities might also require approval of the bondholders, particularly if any of the revenue from externality charges is to be used for purposes other than the operation of the facility and repayment of the bondholders.

ETC systems are also affected by the requirement that vehicles using such systems be equipped with transponders. In the near term, this form of toll collection probably is practical only on facilities that also provide conventional toll collection as an alternative or have pricing through the use of

[31] *Intermodal Surface Transportation Efficiency Act of 1991*, PL 102–240, December 18, 1991, Section 4008 (g) (1).

[32] Fairbank, Bregman and Maullin, *Transportation Planning and Management: Public Opinion Survey*, prepared for the Southern California Association of Governments, Santa Monica, April 1990.

[33] Stephen Shmanske, The Bay Bridge Blunder, *CATO Regulation*, The Cato Institute, Washington, D.C., Vol. 19, No. 4, 1996.

both toll lanes and free lanes (as in the two California experiments). Widespread use of ETC probably will not be feasible until most vehicles are equipped with transponders.

The development of an extensive toll system for collecting externality charges has also been inhibited by restrictions on the addition of tolls to Federally funded portions of the Interstate System other than bridges and tunnels.[34] Except for designated congestion-valve pilot programs (of which no more than three can be on the Interstate System and no more than one in any state), such use of Federal funds on the Interstate System is prohibited.[35]

SUMMARY

Table 34 presents a simplified summary of the evaluations of three of the heavy vehicle taxation systems studied. The fourth system, the toll system, is very different from the other systems[36] and the evaluation of it is less readily summarized in a table; instead a summary of this system is presented below.

Table 34 shows a rating of each system's *potential* for satisfying each of the six evaluation criteria. The ratings are on a scale of one (poor) to five (excellent). The footnotes to the table identify several instances in which the rating in the table does not apply to all variants of the system. It should be emphasized that the ratings reflect the evaluations of the *potential* for each of the prototypical systems to satisfy the various criteria; they do *not* measure how well actual tax systems meet these criteria.

Additional information relating to all ratings is provided in the discussions of the previous six sections. These discussions should be reviewed to understand both the reasons for the ratings and the conditions under which they apply. (These discussions also present a number of other observations about the design and administration of the various taxation systems. Of particular note is the discussion of the advantages of integrating administration of the separate taxes to the greatest extent practical.)

Table 34 indicates that the ratings differ slightly for the two principal variants of the fuel tax surcharge system (using flat-rate or graduated surcharges) and also for the two principal variants of the weight-distance tax system (using a conventional weight-distance tax or an axle-configuration weight-distance tax). Each of the five tax system variants distinguished in the table does relatively well under some criteria and less well under others. However, the advantages of the graduated fuel tax surcharge system do not appear to balance its very low feasibility rating. With this one exception, each of the principal system variants shown in the table has something to offer. The choice rests primarily on the relative importance placed on the various criteria.

The fourth major taxation system evaluated in this chapter would use tolls as a means of charging for the full social costs of highway use. This system has unique capabilities for reflecting the significant spatial and temporal variations in the full social costs of highway use. As such, it does far better than any of the other systems in meeting the economic efficiency criterion, at least when ETC is used. Furthermore, if tolls are set to reflect the difference between cost responsibility for use of toll facilities and the fuel taxes and other user charges paid as a result of that use, toll systems can also meet the equity criterion quite well. However, the potential for toll avoidance makes it very difficult to design toll systems that achieve their economic efficiency objective in an administratively efficient manner. Also, there is substantial popular opposition to introducing tolls on facilities that currently are free and to charging motorists for the external costs of emissions, as well as more moderate opposition to charging for the external costs of a user's impact on congestion.

The assessment of the several generic tax systems with regard to the six criteria can be related to the states' responses to the survey question regarding their relative ranking of a somewhat different list of potential criteria, as shown in Figure 3. The average ranking of several of the criteria was fairly close, particularly the rankings of equity among vehicle classes, evasion, responsiveness to inflation, administrative costs, and compliance costs. In contrast, "stability and predictability" (elements of adequacy) were ranked much higher than these four criteria and economic efficiency was ranked much lower.

The project team does not believe it would be appropriate or useful to link the results of the survey of the states to the ranking of the tax systems for each of these criteria to find a winning tax system. The set of criteria used in this evaluation process has evolved over the course of the study and is quite different from the set used in the survey at the start of the study. Also, states were asked to rank the early set of criteria without reference to any specific list of tax alternatives, and most important, the average of the states' ranking may not reflect any individual state's evaluation. The rankings provided by the states might be quite different, in many cases, depending on which agency, or which unit within an agency prepared the responses. Also, the responses of individual states to this question frequently were far different from the average responses. It is also expected that states' relative assessment of the tradeoffs among the various criteria for *actual* tax options would be quite different from the qualitative assessment of *generic* tax options.

On the other hand, the project team does not advise that the overall assessment of the results of an evaluation of the alternatives be reduced to a simple ranking (such as the type shown in Table 34) and an unweighted sum of the rankings

[34] *Intermodal Surface Transportation Efficiency Act of 1991*, op. cit., Section 1012.

[35] However, Federal funds can be used for non-Interstate System toll facilities and also apparently for improvements to existing Interstate System toll facilities.

[36] The project team has focused on the use of tolls for charging for the full social costs of highway use. As such, tolls are principally of interest for use in highly congested urban areas rather than as a major component of a statewide or national heavy vehicle taxation system. Furthermore, this interest primarily reflects the ability of tolls to capture the significant spatial and temporal variations in social costs and only secondarily their ability to vary with vehicle size and weight.

TABLE 34 Evaluation summary
Scale of 1 to 5 (poor to excellent)

Tax System[a]	Adequacy	Administrative Efficiency	Equity	Economic Efficiency	Evasion and Avoidance	Feasibility
1. Basic System	4 to 5	4[b, c]	2	1.5	3[b]	5[d]
2. Fuel Tax Surcharge System						
Flat rate	5	4	3	2	2.5	4
Graduated	5	3	4	2.5	2	1
3. Weight-Distance Tax System						
Weight-distance tax	5	3.5	4	2.5	3	3
Axle-configuration weight-distance tax	5	3	4.5	3	2.5	2.5

[a] Toll system is evaluated in text.
[b] Slightly lower with more complex annual fee structures.
[c] Much lower if fees vary with in-use emissions.
[d] With emissions classes, feasibility = 3.

then be used to select the "best" tax system. Most states will probably want to give greater weight to some criteria than to others, and these weightings should be given considerable attention if an overall weighted ranking is desired.

It is also recommended that states give serious consideration to trade-offs among the criteria. This can be done by addressing questions such as how can the ranking of a tax alternative for evasion and avoidance be improved and at what cost? Can administrative efficiency costs be reduced for an alternative without substantially increasing evasion? Can the feasibility of an otherwise good alternative be improved through an education effort or further study of specific problems raised by interested groups? Figures 5 and 6 are graphic evaluations of tradeoffs among enforcement effort, administrative costs, compliance costs, and evasion.

Finally, the relative assessment of alternative tax options may change over time as technology improves and as future research provides additional information to aid in implementing more equitable and more efficient tax systems.

CHAPTER 8

CONCLUSIONS AND SUGGESTED RESEARCH

In the course of this study, the project team reviewed the heavy vehicle taxation systems currently in use in this country and in several European and Asian countries, and six criteria for evaluating these systems were developed:

- Adequacy,
- Administrative efficiency,
- Equity,
- Economic efficiency,
- Evasion and avoidance, and
- Feasibility.

The team used these criteria to perform qualitative evaluations of several prototypical tax systems and prepared an *Applications Manual* (available on the NCHRP World Wide Web site at http://www2.nas.edu/trbcrp) to guide others in performing detailed evaluations of existing and proposed taxes and tax systems. These criteria should be helpful in assessing the strengths and weaknesses of various systems of taxes and tax administration. Unfortunately, the better systems all have some weaknesses. Choosing among these systems involves making trade-offs among the criteria that affect both the choice of taxes and the systems used for administering them.

One of the most important trade-offs is between administrative efficiency and evasion. Effective enforcement efforts can reduce tax evasion, but they increase costs for both public-sector administration and private-sector compliance. Political pressures to reduce administrative costs usually result in enforcement efforts that fall well short of optimal. In most if not all states, net tax revenue (after subtracting administrative costs) can be increased by increasing enforcement expenditures. Improved enforcement also would contribute to increasing equity, because there are substantial differences in evasion rates among carriers.

A more complex set of trade-offs relates to the equity criterion and the extent to which various classes of carriers pay their fair share of the public agency costs of highways. Although there are several factors that affect the cost responsibility of an individual heavy vehicle, the most significant ones that are usually addressed by equity analyses are annual miles of travel and weight.

In most states, the most important heavy vehicle tax is the fuel tax. Revenue from this tax tends to be proportional to miles traveled, but it increases more slowly than vehicle weight and much more slowly than weight-related cost responsibility.

Annual fees, such as registration fees, that increase sharply with weight can be used to obtain additional revenue from heavy vehicles. However, reliance on these fees results in overtaxing vehicles with low annual miles or undertaxing those with high annual miles. High annual fees and variations in annual miles among vehicle and carrier types result in taxes per mile for vehicles of a given weight being higher, on average, for private carriers than for for-hire carriers, higher for intrastate carriers than for interstate carriers, and higher for heavy single-unit trucks than for combinations. Also, the increase in annual fees with declared weight generally is not as sharp as the increase in average annual miles. For this reason, there are only three states in which the average of total taxes per mile is not lower for 80,000-lb vehicles than for 60,000-lb vehicles.

Weight-distance taxes are capable of being matched to both the weight- and mileage-related components of cost responsibility. However, relative to fuel taxes, weight-distance taxes entail somewhat higher compliance costs (particularly for intrastate carriers) and they may be somewhat more expensive to administer. More importantly, because weight-distance taxes make it practical to increase taxes paid by high-mileage heavy trucks, these taxes are strongly opposed by most operators of for-hire interstate trucks.

Varying highway taxes by area of operation is a related and difficult issue that arises when considering the economic efficiency criterion. This issue probably should also be considered when considering the equity criterion, since area of operation has significant effects on public agency costs for expanding capacity and acquiring right of way. Of the charging mechanisms considered in this study, tolls in general, and ETC systems in particular, have the greatest potential for reflecting locational factors. ETC systems also can be used to vary toll charges with time of day and with selected vehicle registration information, such as maximum declared weight. However, toll systems appear to be an imperfect mechanism for varying highway charges by area of operation, because limiting tolls in any area to a small set of roads makes avoidance relatively easy, while extending tolls to a larger set of roads increases administrative costs.

There is some possibility that, in the next several years, electronic systems can be implemented for collecting and transmitting the mileage-by-jurisdiction data required for registration-fee apportionment and fuel-use reporting. Such systems have potential for reducing evasion and reducing

public-sector administrative costs. However, they are likely to be financially attractive only to truck operators that already use GPS. Also, carriers may be reluctant to use these systems for tax-reporting purposes because of concerns about proprietary information and personal privacy (particularly as to whether carriers would be required to allow state auditors to access their computerized information systems) and concerns that implementation of these systems might lead to increased use of weight-distance taxes.

Arguments are sometimes made against charging user fees to cover full cost responsibility for heavier trucks because of the negative effects this may have on competition within the for-hire motor-carrier industry. However, the analysis of state tax structures conducted in this study shows that most of the effects on competitiveness that can be identified apply only to relatively small numbers of carriers or vehicles, and produce cost differences that are no more than a small fraction of 1 cent per vehicle-mile. The most significant exception occurs in the case of taxes (such as ad valorem taxes on vehicle sales and some property taxes on vehicles) that are applied on vehicles based in state but not on competing vehicles based in other states.

The above discussion presumes that each of the six criteria is readily applied to any heavy vehicle taxation system. However, a lack of available information affects the application of some of the criteria.

The most significant limitations affect the economic efficiency criterion, which requires that highway users be charged for the full marginal social costs of their use. Difficulties in developing tax systems that address this criterion are political (significant opposition by highway users to paying for the external costs of their use), analytic (plausible high and low estimates of marginal external costs differ by an order of magnitude or more), and practical (most proposed externality charges present administrative or evasion and avoidance problems, and the charges do not always vary with responsibility for external costs in an appropriate manner). However, it is worth observing that all taxes that relate to vehicle usage (fuel taxes, distance taxes, and tolls) tend to contribute to economic efficiency while annual fees do not. Furthermore, if political opposition can be overcome, current understanding of external costs is sufficient to justify introducing emissions and congestion charges at modest levels.

Good estimates of evasion are also difficult to obtain. These difficulties are partly due to the relatively limited understanding of many administrators of the methods and extent of evasion. Though in-depth studies of the extent of evasion are relatively expensive to perform, the information they produce can be useful in improving enforcement procedures and in reducing evasion.

A more readily surmounted limitation affects the equity criterion. This criterion presumes the availability of information on the responsibility of various vehicle classes for state highway costs. However, relatively few states have performed recent cost-responsibility studies that can be used as the basis for such an evaluation of equity.

Finally, a component of administrative costs affects the estimation of private-sector compliance costs. The primary source of information on these costs is the private firms that incur these costs; however, cost estimates provided by many of these firms may be intentionally exaggerated.

SUGGESTED RESEARCH

There are a number of issues relating to the taxation of heavy vehicles that require additional research:

- A study should be conducted of the effectiveness of base-state auditing in uncovering evasion of fees and taxes owed other states. There is a possibility that base-state auditing procedures are not effective for uncovering misallocation of mileage among states.
- An evaluation should be conducted of the advantages and disadvantages of replacing the IRP and IFTA with a single base-state system for handling both registration-fee apportionment and fuel-use reporting and perhaps for handling weight-distance taxes as well. The possibility of enhancing such a system to allow it to handle registration fees that vary with annual-mileage bracket might also be considered.
- Software and a users' manual should be developed to be used by the states for performing cost-allocation studies and for evaluating tax systems.
- A study should be conducted to determine the conditions under which closely spaced vehicles are misclassified as larger vehicles and to develop procedures for avoiding and correcting for the resulting overcounts of large vehicles. The resulting improvements in VMT estimates of large vehicles will be useful in studies of tax evasion by heavy vehicles and in other analyses of heavy-truck operations.
- Substantial additional research is required to produce improved estimates of the external costs of vehicle operation. Current high and low estimates of these costs differ by an order of magnitude or more.
- Research is required into the overall effects of marginal cost pricing on economic efficiency as well as the effects on different user classes, the benefits and costs to these classes, and options for mitigating adverse effects on low-income persons.
- ETC systems and other potential systems for charging for marginal costs on a localized basis require further evaluation and refinement.

OTHER RECOMMENDATIONS

The following are some additional recommendations:

- All states should perform in-depth reviews of their tax administration and enforcement programs to identify

opportunities for reducing evasion and increasing net revenue. To the extent that such opportunities are identified, the results should be used to generate support for the funding needed to take advantage of these opportunities.

- Auditing of carrier records relating to payment of both registration fees and fuel taxes should be performed jointly, even in states in which other functions related to the administration of the two programs are performed by separate offices. Joint auditing avoids duplication of effort and makes it easy to identify any inconsistencies in mileage reports filed for these fees and taxes.
- All states should perform cost responsibility studies periodically to produce better evaluations of the equity of their highway tax systems.
- All states should adopt improved procedures for estimating the VMT of heavy trucks and for counting six-tire trucks. (Such procedures are discussed in Section 3.1 of the *Applications Manual.*) The resulting improvements in VMT estimates will improve the quality of estimates of tax evasion by heavy vehicles as well as the quality of various other analyses of heavy-truck operations.
- The EU's evolving heavy vehicle taxation system should continue to be monitored, particularly in the effectiveness of existing and proposed fees relating to emissions classes and to congested and environmentally sensitive routes. Other aspects of this system that are of potential interest are discounts for air suspensions and Germany's exploration of ETC technology for implementing distance-based motorway permit fees.

APPENDIX A

SURVEY RESPONSES

Question No. 1. Studies Relevant to Heavy Vehicle Taxation

State	Replied (x = yes)	Cost Allocation[1]	Equity/ Efficiency (1A)	Admin. Resources (1B)	Motor Carrier Resources (1C)	User Tax Evasion (1D)	Economic Impacts (1E)	Alternatives (1F)	Other Studies (1G)
Alabama									
Alaska									
Arizona	x	Y	Y			Y	Y		Y
Arkansas	x	Y	Y			Y			
California	x	Y		Y		Y			
Colorado	x	Y							
Connecticut	x	Y	Y	Y	Y			Y	Y
Delaware		Y							
Florida	x	Y							
Georgia		Y							
Hawaii									
Idaho	x	Y		Y			Y		
Illinois	x					Y			
Indiana		Y							
Iowa	x	Y							
Kansas	x	Y				Y	Y	Y	
Kentucky	x	Y				Y		Y	
Lousiana	x								
Maine	x	Y				Y	Y		Y
Maryland		Y							
Massachusetts	x								
Michigan	x								
Minnesota	x	Y	Y						
Mississippi	x	Y							
Missouri		Y							
Montana	x	Y	Y			Y			
Nebraska	x					Y	Y	Y	
Nevada	x	Y		Y	Y	Y		Y	Y
New Hampshire									
New Jersey	x								
New Mexico	x		Y	Y				Y	
New York									
North Carolina		Y							
North Dakota	x								
Ohio		Y							
Oklahoma									
Oregon	x	Y	Y	Y	Y	Y	Y	Y	Y
Pennsylvania	x	Y	Y	Y		Y		Y	Y
Rhode Island	x								
South Carolina	x		Y						Y
South Dakota	x								
Tennessee									
Texas	x	Y	Y						
Utah	x	Y				Y			
Vermont	x	Y							
Virginia	x	Y				Y			Y
Washington	x	Y		Y	Y	Y		Y	Y
West Virginia	x								
Wisconsin	x	Y							
Wyoming	x	Y							
D. of Columbia									
	36	31	10	8	4	15	6	9	9

[1]Responses in this column are based on information from 1996 Federal Highway Cost Allocation Study.

Question No. 2A. Impacts of Multi-State Agreements (IRP/IFTA, etc.)

State	Equity (a)	Economic Efficiency (b)	Rev. Stability Predictability (c)	Flexibility to Adjust Rates (d)	Administrative Cost (e)	Compliance Cost (f)	Potential for Tax Evasion (g)	Econ. Impacts on Carriers (h)
Alabama								
Alaska								
Arizona	O	O	O	O	N	O	N	P
Arkansas	Z	Z	P	N	O	O	O	P
California	P	P	O	O	O	P	P	P
Colorado	O	P	P	O	P	P	P	P
Connecticut	P	P	P	O	P	P	N	P
Delaware								
Florida	P	P	P	O	Z	P	P	P
Georgia								
Hawaii								
Idaho	P	O	O	P	P	P	O	P
Illinois	P	O	O	O	N	P	P	Z
Indiana								
Iowa	P	O	O	O	P	P	P	P
Kansas	P	P	O	O	P	Z	P	Z
Kentucky	N	O	O	O	P	P	N	P
Lousiana	P	P	P	O	P	O	N	O
Maine	P	P	Z	P	N	Z	P	P
Maryland								
Massachusetts	Z	Z	P	O	N	N	N	P
Michigan	O	O	P	O	N	P	P	P
Minnesota	P	P	P	O	P	P	P	P-IRP; N-IFTA
Mississippi	P	P	Z	O	P	P	P	P
Missouri								
Montana	P	P	P	P	P	P	P	P
Nebraska	O	Z	Z	O	P	P	P	P
Nevada	O	P	O	O	O	P	N	P
New Hampshire								
New Jersey	(no experience with IRP/IFTA)							
New Mexico	O	O	N	O	N	P	N	P
New York								
North Carolina								
North Dakota	P	P	P	O	N	P	Z	P
Ohio								
Oklahoma								
Oregon	O	P	P	O	P	P	O	O
Pennsylvania	P	P	P	O	N	P	P	P
Rhode Island	(reluctantly participating in the IRP)							
South Carolina								
South Dakota	O	O	O	N	N	P	Z	P
Tennessee								
Texas	P	Z	P	Z	P	Z	Z	P
Utah	P	P	P	P	P	P	P	P
Vermont	O	P	N	O	N	P	N	P
Virginia	P	P	P	O	P	P	O	P
Washington	P	P	O	N	P	P	P	P
West Virginia	O	O	O	P	P	P	P	P
Wisconsin	P	P	P	O	P	P	P	P
Wyoming	P	P	P	Z	P	P	P	P
D. of Columbia								

P = Positive Impact; N = Negative Impact; O = No Impact; Z = No Opinion

Question No. 2B. Impacts of Multi-State Agreements

Alabama	
Alaska	
Arizona	Interactions among jurisdictions, information and idea sharing, ease of reporting
Arkansas	Single State Reg. - streamlined operations, less overhead/paperwork, IFTA - reduced accounts, IRP - low-rate out-of-state license
California	Reduced administrative effort, simplified interstate carrier licensing and tax reporting.
Colorado	Eliminated many evasion concerns such as distance-percentage calculations, which can now be assessed to states
Connecticut	IFTA - Greater tax compliance, fewer accounts; IRP - lower admin. costs, carriers may register in other states with incentives.
Delaware	
Florida	Reduced no. of carriers state has to deal with, IFTA - increased fuel tax revenue, increased sharing of information and technologies
Georgia	
Hawaii	
Idaho	
Illinois	Revenues increased and continued to grow as more states join
Indiana	
Iowa	Beneficial and working well. Base state audits the reports for all jurisdictions
Kansas	
Kentucky	Insurance Reg. - Positive impact on collection and sharing of info., IRP -beneficial to industry and agency, IFTA - limited exposure
Lousiana	Positive impacts for states and taxpayers, excellent communications among states, more accurate audit info. and leads.
Maine	IRP - min. inconvenience for regist.; increased admin. costs but higher gains, enhanced tax compliance, efficient program admin.
Maryland	
Massachusetts	IFTA - Limited experience to reach any conclusion. IRP - Allowed motor carriers to conduct business easier; interjurisdictional contact.
Michigan	Makes it easier for taxpayers to comply with the laws.
Minnesota	Created extra work for state agencies, but has been beneficial to the motor carrier industry.
Mississippi	IRP - Consistency, sharing of ideas, problems & solutions; IFTA - Reduced regulatory requirements, fewer accounts, increased auditing
Missouri	
Montana	Minimized administration cost
Nebraska	IFTA - improved enforcement. However it is difficult for other states to follow all rules and regulations.
Nevada	Less out-of-state auditing. Common procedures. Increased communication; Complacency, loss of info. on indiv. carriers, training.
New Hampshire	
New Jersey	No experience to deduce impacts.
New Mexico	Resulted in revenue losses
New York	
North Carolina	
North Dakota	Simplifies the process for motor carriers. Increases administrative costs.
Ohio	
Oklahoma	
Oregon	Facilitates uniform fees and fee structure among IRP jurisdictions. Some states not adequately enforcing and auditing charges.
Pennsylvania	Reduced # of accounts. Better service to carriers. IFTA caused revenue loss but offset by increased compliance.
Rhode Island	Believes registration system based on mileage is unfavorable to small states.
South Carolina	IRP - positive impact; IFTA - just recently began participation
South Dakota	Must change tax rates on a quarterly basis, cannot change rates in middle of reporting period. High administration costs.
Tennessee	
Texas	Single registration plan concept encourages full use of highway system for growth of member jurisdictions
Utah	Agreements are necessary due to growth of Interstate Motor Carriers.
Vermont	Will join IFTA in 1997. Projects revenue loss of $2.2 M annually, but will provide better service to industry.
Virginia	
Washington	Provided positive impacts in most areas, but are becoming increasingly complex and may clash with state laws.
West Virginia	
Wisconsin	Requires more work, but promotes uniformity in tax collection, eliminates duplication, and serves carriers better.
Wyoming	Reduced red tape. Promoted trust and unity between carriers and the state.
D. of Columbia	

Question No. 2C. Suggestion for Modifying IRP, IFTA

Alabama	
Alaska	
Arizona	Automate interstate information exchange, combine IFTA and IRP requirements
Arkansas	Suggestions included in previous modification of IFTA
California	IRP - coordinate the application process and criteria
Colorado	Plan has sufficient procedures in place to address concerns
Connecticut	None
Delaware	
Florida	
Georgia	
Hawaii	
Idaho	
Illinois	IFTA - reduce number of paper reports, shorten ballot process, reduce number of needed votes.
Indiana	
Iowa	Combine audit of IRP and IFTA. Include safety verification with IRP registration.
Kansas	
Kentucky	Ambiguous IRP requirements regarding charter bus registration (state plate)
Lousiana	
Maine	Continue pursuing netting of fees and the electronic capture/transmittal of data.
Maryland	
Massachusetts	IRP - Revisit issues of "base state" shopping by motor carriers in order to avoid taxes.
Michigan	Uniform licensing, audit requirements, dispute resolution, and revenue transmittals for on-time registration/electronic reporting.
Minnesota	Firmer stance on basing points for carriers, better definitions of vehicles
Mississippi	
Missouri	
Montana	Streamline the process.
Nebraska	
Nevada	Common vehicle and carrier identifiers and reporting formats. Ease access to electronic information.
New Hampshire	
New Jersey	Remove rental of passenger cars from IRP requirements.
New Mexico	
New York	
North Carolina	
North Dakota	None
Ohio	
Oklahoma	
Oregon	IFTA - Permit staggered registration. Change member balloting provisions.
Pennsylvania	Reduce paperwork. Electronic transmission of data among states. Clearer interpretation of restricted plates.
Rhode Island	
South Carolina	
South Dakota	None.
Tennessee	
Texas	Anything to further federal/state cooperation. IRP - more uniformity and fewer exceptions.
Utah	
Vermont	
Virginia	Automated exchange of data among jurisdictions.
Washington	IFTA- ballot process is far too complex and time consuming. IRP - needs to reevaluate the dispute resolution process.
West Virginia	
Wisconsin	Establish registration fee based on weight only. Merge IRP and IFTA into one.
Wyoming	None
D. of Columbia	

Question No. 3. Criteria for Evaluating Tax Alternative (Continued on next page)

State	Stability and Predictability (a)	Responsiveness to Inflation (b)	Responsiveness to Road Usage (c)	Appropriateness for Dedication (d)	Flexibility for Adjustment (e)	Equity by Vehicle Class (f)	Equity by Income Group (g)
Alabama							
Alaska							
Arizona	1	3	4	9	7	10	12
Arkansas	1	1	2	2	1	2	9
California	3	6	2	1	6	3	6
Colorado	1	1	3	1	1	3	3
Connecticut	1	1	1	1		1	1
Delaware							
Florida	1	8	9	10	5	11	12
Georgia							
Hawaii							
Idaho			1			1	
Illinois	2	7	5	1	11	5	12
Indiana							
Iowa	6		7	10	8	1	11
Kansas	3	2	2	1	10	3	10
Kentucky	3	3	1	1	9	6	9
Lousiana	1	3	3	3	5	3	5
Maine	1	3	3	2	2	2	8
Maryland							
Massachusetts							
Michigan	1	1	1	1	6	1	7
Minnesota	Evaluated several options using their own criteria (See Exhibit 2.10)						
Mississippi	1	5	5	1	3	4	4
Missouri							
Montana	7	9	12	13	8	1	10
Nebraska	1	3	2	1	2	1	8
Nevada	1	5	1	1	3	4	5
New Hampshire							
New Jersey	1	6	6	1	7	12	12
New Mexico	5	1	1	3	6	6	12
New York							
North Carolina							
North Dakota	3	6	4	9	8	5	10
Ohio							
Oklahoma							
Oregon	4	10	1	1	4	1	8
Pennsylvania	1	2	2	4	5	3	6
Rhode Island	3	8	2	1	10	4	11
South Carolina	5	8	9	1	7	12	11
South Dakota	1	1	1	1	6	3	6
Tennessee							
Texas	2	2	1	2	5	3	3
Utah	1	1	1	3	6	3	2
Vermont	1	1	6	2	6	2	6
Virginia	1	12	3	2	11	4	12
Washington	1	1	1	1	6	6	6
West Virginia	1	1	2	2	6	2	3
Wisconsin	1	1	5	4	3	5	7
Wyoming	1	3	2	4	6	5	7
D. of Columbia							
	2	3.9	3.3	3.1	5.9	4.1	7.7

Question No. 3. Criteria for Evaluating Tax Alternative (Continued)

State	Equity by Geog. Group (h)	Administrative Costs (i)	Compliance Costs (j)	Potential for Tax Evasion (k)	Economic Efficiency (l)	No. of Accounts Generated (m)
Alabama						
Alaska						
Arizona	11	6	5	2	8	12
Arkansas	9	5	5	3	6	5
California	4	4	5	5	4	11
Colorado	3	1	1	1	2	3
Connecticut	2	1	1	1		
Delaware						
Florida	13	2	3	4	6	7
Georgia						
Hawaii						
Idaho	1					
Illinois	12	3	3	3	10	3
Indiana						
Iowa	12	2	9	3	4	5
Kansas	10	5	4	4	4	9
Kentucky	9	6	6	3	3	12
Lousiana	6	3	3	5	5	5
Maine	8	4	4	4	4	5
Maryland						
Massachusetts						
Michigan	10	5	5	1	11	11
Minnesota						
Mississippi	4	6	10	2		11
Missouri						
Montana	11	3	4	5	2	6
Nebraska	5	3	1	1	4	9
Nevada	5	3	3	3	4	7
New Hampshire						
New Jersey	12	7	8	4	9	10
New Mexico	12	6	6	6	6	12
New York						
North Carolina						
North Dakota	12	2	1	7	12	11
Ohio						
Oklahoma						
Oregon	6	3	3	2	3	10
Pennsylvania	6	3	3	2	5	5
Rhode Island	12	6	7	5	9	13
South Carolina	13	2	3	4	10	6
South Dakota	6	3	4	1	3	3
Tennessee						
Texas	3	4	4	4	4	4
Utah	2	4	4	3	2	4
Vermont	6	2	2	2	4	2
Virginia	12	1	1	1	12	12
Washington	10	1	1	1	1	10
West Virginia	3	6	6	9	8	12
Wisconsin	6	2	2	2	3	4
Wyoming	10	11	12	8	9	12
D. of Columbia						
	8.3	3.8	4.2	3.4	5.7	8.1

Question No. 4. Programs to Facilitate Implementation of Alternative Taxation Methods

Alabama	
Alaska	
Arizona	Prepass Program.
Arkansas	None
California	Weigh station by-pass. One-stop shop demo. Congestion pricing (HOV, Toll Bridges, HOT Lane)
Colorado	None
Connecticut	I-95 Corridor Coalition. CVISN Project
Delaware	
Florida	
Georgia	
Hawaii	
Idaho	None
Illinois	None
Indiana	
Iowa	
Kansas	Alternative funding sources for corridor expansion
Kentucky	ADVANTAGE I-75: dynamic weigh-in-motion and carrier checking
Lousiana	COVE program
Maine	ITS/CVO Study with VT and NH
Maryland	
Massachusetts	No statewide CVO program, but state has 53-foot trailer permit process.
Michigan	ADVANTAGE I-75, Automated Border Crossing, OS/OW permit issuance computerization
Minnesota	Advanced transp. systems. Alt. transp. financing. Public/private partnership for toll-financed freeway. New logistics office.
Mississippi	
Missouri	
Montana	Automated weigh station analysis. CanaMex corridor (I-15) allows an LCV to operate betw. Canada & Mexico on one permit
Nebraska	None
Nevada	None
New Hampshire	
New Jersey	Coordinate compatibility of CVO operations among highway facilities
New Mexico	None
New York	
North Carolina	
North Dakota	None
Ohio	
Oklahoma	
Oregon	"Green Light" will reduce tax evasion and provide Electronic Data Interchange payments and national database access (for CVO).
Pennsylvania	Studying electronic registration for future state/federal tax consolidation (i.e. Safety Net)
Rhode Island	New England Consortium for uniform issuance of Oversized/Overweight permits
South Carolina	None
South Dakota	None
Tennessee	
Texas	None
Utah	Vehicle tolls are talked about but no proposals have been made so far. Utah has no significant tolls.
Vermont	I-95 Corridor Study (Overweight/Oversized permit), New England Consortium (same as Rhode Island)
Virginia	Commercial Vehicle Info. System and Networks (CVISN)
Washington	Public/private partnerships. Toll/congestion pricing programs. May participate in CVISN projects. Info exchange on CVO.
West Virginia	None
Wisconsin	Alternative financing/funding sources
Wyoming	None
D. of Columbia	

Question No. 5. Measures to Reduce Evasion

Alabama	
Alaska	
Arizona	Changed point of taxation. Reduced motor carrier rates.
Arkansas	Audits and suggestions for updating the law.
California	Changed point of taxation (from pump to rack). Increased border enforcement. Created unit to investigate evasion cases.
Colorado	Removed 3rd structure taxes. Tax evasion staff training. Increased tax audits. Participated in federal/state compliance projects.
Connecticut	Joint federal/state motor fuel tax compliance project (identify and convict individuals engaged in tax evasion schemes)
Delaware	
Florida	Expanded audit program
Georgia	
Hawaii	
Idaho	Focused Audits by Tax Commission (Fuel Tax) and ITD (Weight-Distance Tax)
Illinois	Wholesalers have to report all movements of diesel fuel, creating paper trail
Indiana	
Iowa	Changed point of tax collection. Dyed fuel. Increased recordkeeping penalty.
Kansas	Changed point of tax collection. Coordinate enforcement and data sharing with other states. Computerized revenue records.
Kentucky	Tax audit trail at weigh stations using computer records.
Lousiana	Diesel dyeing. Test supply tanks of motor vehicles.
Maine	Fuel dyeing program with IRS. Additional audit staff
Maryland	
Massachusetts	Enhance staff, technology and interstate networking for auditing. State Police questions/surveys drivers at truck stops.
Michigan	IRS Fuel Tax Evasion program
Minnesota	Federal/state evasion program. Dyed fuel. Special fuels: now at wholesaler, before at dealer levels. Removed farmer tax exemption.
Mississippi	Adopted federal rules for dyeing with penalties. Contracted with IRS for dyed fuel testing.
Missouri	
Montana	Created tax management unit to track fuel shipments, initiated info. sharing among states, placed 2 covert officers to track fuel.
Nebraska	Rewrote tax laws on reporting requirements, point of taxation, penalty provisions. Created unit dedicated to fuel tax collection.
Nevada	Changed point of taxation from pump to terminal level.
New Hampshire	
New Jersey	Requires all highway users to complete tax reporting forms.
New Mexico	Collect diesel taxes at pump (previously sold exclusive of tax)
New York	
North Carolina	
North Dakota	None
Ohio	
Oklahoma	
Oregon	"Green Light" project and Integrated Tactical Enforcement Network will reduce port-of-entry dues and weigh station evasion.
Pennsylvania	Pre-licensing investigations. Use of Grand Jury system for tax evasion.
Rhode Island	Police work with IRS to detect red-dyed, untaxed fuel use.
South Carolina	None
South Dakota	Changed point of taxation from distributor to rack. Implemented Dyed Diesel Program.
Tennessee	
Texas	
Utah	Tax evasion programs conducted by FHWA and IRS. Utah took fuel samples, checked for dyed fuel at port of entries.
Vermont	Consolidated audit staff for greater efficiency.
Virginia	Legislation strengthening fuel tax laws.
Washington	Tax evasion became felony charge. Increased penalty. Extended statute of lim. from 2 to 5 yrs. Better DOT/State Patrol coord.
West Virginia	None
Wisconsin	Moved from wholesale to terminal level for gas tax. Retail to terminal level for diesel tax. More efficient tax collections.
Wyoming	Changed reporting requirements.
D. of Columbia	

Question No. 6. Assessment of Reliability of Fuel Tax as Revenue Source

Alabama	
Alaska	
Arizona	None
Arkansas	None
California	DMV examined "pay at the pump" for registration fees several years ago
Colorado	None
Connecticut	None formally, there is effort to reduce fuel tax. Many HVs pass State without refueling hence no immediate revenue contribution
Delaware	
Florida	
Georgia	
Hawaii	
Idaho	No formal studies.
Illinois	None
Indiana	
Iowa	None
Kansas	Only monitoring, no formal study
Kentucky	None
Lousiana	None
Maine	None
Maryland	
Massachusetts	Nothing formal
Michigan	Nothing formal
Minnesota	Nothing formal
Mississippi	
Missouri	
Montana	
Nebraska	Variable motor fuel tax has provided stability in highway funding. May be reaching upper limit on variable tax.
Nevada	Yes, informally. Fuel tax is reliable but not equitable (passenger cars absorb disproportionate share of highway costs).
New Hampshire	
New Jersey	None
New Mexico	Fuel taxes lag inflation.
New York	
North Carolina	
North Dakota	None
Ohio	
Oklahoma	
Oregon	Consultant study predicted a high level of diesel fuel tax evasion. Internal study assessed long-range finance.
Pennsylvania	None
Rhode Island	Future reliance on state fuel tax because other sources are earmarked for General Funds
South Carolina	None
South Dakota	None
Tennessee	
Texas	Reliable in terms of dollar amount, but increased fuel efficiency contributed to revenue reduction.
Utah	Motor fuel tax increase is planned for the next Legislative Session (Jan/Feb. 1997) to finance the I-15 Corridor Improvements
Vermont	None
Virginia	
Washington	$15 mil/yr. evasion loss. Considered inflation index, excise tax reallocation, raising pt. of taxation & implement dyeing program.
West Virginia	None
Wisconsin	Tolls - negative reaction. Congestion Pricing -difficult to implement. Infrastructure Banks - on hold pending results of pilot program.
Wyoming	1995 fuel tax increase failed legislative approval - would have generated $20 M additional revenue.
D. of Columbia	

APPENDIX B

QUESTIONNAIRE USED FOR SURVEY OF THE STATES

Survey for NCHRP Study 20-24(7)A
Alternative Approaches to the Taxation of Heavy Vehicles

1. In the last 10 years, has your State completed studies, investigations, or analysis of any of the topics listed below? Please list the name of the most appropriate contact person, including his or her agency affiliation and telephone number. Please also include a copy of the reports or products from any of these efforts, if possible.

A. The equity and/or economic efficiency of existing and/or alternative state highway user taxes (including evaluations of tax options, but not including highway cost allocation studies):
Studied? (Yes/No)___ Contact person_____ Telephone_____

Agency_____ Report available/enclosed___

B. The resources required of your State in administration of existing and/or alternative state highway user taxes (e.g., staffing and/or budgets for collecting, enforcing, auditing, etc.):
Studied? (Yes/No)___ Contact person_____ Telephone_____

Agency_____ Report available/enclosed___

C. The resources required of motor carriers in complying with existing and/or alternative state highway user tax laws and regulations:
Studied? (Yes/No)___ Contact person_____ Telephone_____

Agency_____ Report available/enclosed___

D. The evasion of existing and/or alternative highway user taxes or ways of reducing evasion:
Studied? (Yes/No)___ Contact person_____ Telephone_____

Agency_____ Report available/enclosed___

E. Economic impacts to motor carriers and other industries, including other shipping modes, of existing and/or alternative highway user taxes:
Studied? (Yes/No)___ Contact person_____ Telephone_____

Agency_____ Report available/enclosed___

F. Alternatives to current or previous state or federal motor carrier taxes or alternative methods for collecting taxes:
Studied? (Yes/No)___ Contact person_____ Telephone_____

Agency_____ Report available/enclosed___

G. Other studies which may be relevant to the NCHRP study on alternatives for heavy vehicle taxation:
_____

Studied? (Yes/No)___ Contact person_____ Telephone_____

Agency_____ Report available/enclosed___

2a. From your State's experience, how has the joining and/or participating in multi-state agreements such as IRP, IFTA, etc. affected your State in terms of the following subjects?

Subject	Positive Impact	Negative Impact	No Impact	No Opinion
The Equity of Highway User Taxes				
The Economic Efficiency of Highway User Taxes				
Stability and Predictability of Revenue				
Flexibility to Adjust Tax Rates				
Administrative Costs to the State				
Compliance Costs to Taxpayers				
Potential for Tax Evasion				
Economic Impacts to Motor Carriers and Other Industries				

2b. Please provide any general comments about the impacts of joining and/or participating in multi-state agreements such as IRP, IFTA, etc.

_____

_____

_____

2c. Does your State have any specific suggestions for modifying any IFTA or IRP requirements or procedures? What would these suggestions accomplish?

_____

_____

3. Please rank the following criteria that your State would consider in evaluating an alternative highway user tax, from very important (1) to unimportant (12). (Note – you may rank two or more criteria equally important, and you may cluster several of them at the most appropriate level of importance.)

___ Stability and Predictability of Revenue
___ Responsiveness of Revenue to Inflation
___ Responsiveness of Revenues to Road Usage
___ Appropriateness to Dedication of Revenue (i.e., does revenue from this tax pay for costs imposed by its payers?)
___ Flexibility to Adjust Tax Rates
___ Equity by Vehicle Class
___ Equity by Income Group
___ Equity by Geographic Group (e.g., urban vs. rural)
___ Administrative Costs
___ Compliance Costs
___ Potential for Tax Evasion
___ Relationship to Economic Efficiency
___ Number of Accounts Generated by the Tax

4. Is your State currently studying or implementing any statewide/regional/corridor commercial vehicle operations program, commercial vehicle tolls or permit fees, congestion pricing/toll program, or other program that might facilitate the implementation of alternative highway user taxation methods (e.g., encouragement or provision of on-board computers, mileage and/or fuel consumption meters)? If so, please briefly describe the project and give the name of a contact person.

5. In the last several years, has your State taken any new measures to reduce evasion of any types of highway user taxes? If so, what have been the measures?

6. Has your State performed an assessment on the probability of fuel taxation or alternatives being a reliable source of revenue in the future? If so, what was the assessment?