Technical Report Documentation Page

1. Report No. FHWA/TX-03-1810-3	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle HIGHWAY COST ALLOCATION IN TEXAS: EXECUTIVE SUMMARY		5. Report Date November 2002 6. Performing Organization Code
7. Author(s) David M. Luskin, Alberto Garcia-Diaz, C. Michael Walton, Zhanmin Zhang		8. Performing Organization Report No. 1810-3
9. Performing Organization Name and Address Center for Transportation Research The University of Texas at Austin 3208 Red River, Suite 200 Austin, TX 78705-2650		10. Work Unit No. (TRAIS) 11. Contract or Grant No. 0-1810
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Implementation Office P.O. Box 5080 Austin, TX 78763-5080		13. Type of Report and Period Covered Research Report 14. Sponsoring Agency Code
15. Supplementary Notes Project conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration, and the Texas Department of Transportation.		

16. Abstract

Vehicle travel on Texas highways generates revenue from state and federal taxes on highway users, such as fuel taxes, and it also creates costs in highway construction and maintenance. This study estimates the 1998 revenue contribution and cost responsibility by class of motor vehicle. If fairness requires that each class pay a share of tax revenue that equals its share of highway system costs, then the findings of the study suggest that passenger cars and pickup trucks are paying more than their fair share, and combination trucks less. The study concludes with recommendations for future research that would complement and enhance the framework developed for this study.

17. Key Words Highway cost allocation, Texas highways, Highway user taxes, Highway finance		18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.	
19. Security Classif. (of report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of pages 30	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Center for Transportation Research
The University of Texas at Austin

Highway Cost Allocation in Texas: Executive Summary

David M Luskin
Alberto Garcia-Diaz
C. Michael Walton
Zhanmin Zhang

CTR Research Report:	1810-3
Report Date:	November 2002
Research Project:	0-1810
Research Project Title:	*Highway Cost Allocation in Texas*

This research was conducted for the Texas Department of Transportation in cooperation with the U.S. Department of Transportation, Federal Highway Administration by the Center for Transportation Research, Bureau of Engineering Research, The University of Texas at Austin.

Center for Transportation Research
The University of Texas at Austin
3208 Red River
Austin, TX 78705

www.utexas.edu/research/ctr

Disclaimers

Author's Disclaimer: The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Federal Highway Administration or the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation.

Patent Disclaimer: There was no invention or discovery conceived or first actually reduced to practice in the course of or under this contract, including any art, method, process, machine manufacture, design or composition of matter, or any new useful improvement thereof, or any variety of plant, which is or may be patentable under the patent laws of the United States of America or any foreign country.

Engineering Disclaimer:
NOT INTENDED FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES.

Project Engineer: C. Michael Walton, P. E.
Certification Number: Texas No. 046293
P. E. Designation: Research Supervisor

Acknowledgments

The authors acknowledge the assistance provided by the TxDOT project directors for this research, A. Luedecke (TPP) and subsequently Wayne Dennis (TPP). Other TxDOT staff who helped out are too many to mention individually. In the revenue allocation analysis, we received valuable assistance from Doug Freer and Bob Mattheisen of the Texas Comptroller's office, from Kevin Rohlwing of the International Tire and Rubber Association. Others who helped us include Jim March and other staff of the FHWA, and the team that developed the State Highway Cost Allocation software for the FHWA, in particular Joe Stowers of Sydec, Inc. and Roger Mingo of R. D. Mingo and Associates. We also thank several current and former graduate students for their sterling contributions to the research for and drafting of this report. Dr. Chiung-Yu Chiu and Mr. Alberto Miron assisted with the revenue allocation analysis while graduate students in Civil Engineering at the University of Texas at Austin. At Texas A&M University, several doctoral candidates in Industrial Engineering worked on the cost allocation analysis: Dr. DongJu Lee, Mr. Jeffrey Warren, and Mr. Jaewook Yoo.

Table of Contents

List of Figures

List of Tables

Executive Summary

Highway users pay substantial revenues to governments through fuel taxes, vehicle registration fees, and other taxes. A highway cost allocation (HCA) study attempts to throw light on the fairness of these revenue contributions by comparing different classes of highway users. One notion of fairness is that each class should pay a share of revenue that equals its share of highway system costs. This has led various HCA studies to compare the revenue and cost shares among the classes of highway users.

Research Project 1810, "Highway Cost Allocation in Texas," used the vehicle classes defined in Table 1 and depicted in Figure 1. The "pickup" class included sport utility vehicles, vans, and minivans, in keeping with the Federal Highway Administration's classification system, which counts these vehicles as trucks rather than automobiles.

The focus of the project was the road network maintained by the Texas Department of Transportation (TxDOT). Funding for this network comes from state and federal collections from highway users. To keep the scope of the project manageable, the focus excluded local government road expenditures, which, in 1998, amounted to about two-fifths of all expenditures on Texas public roads. Also excluded were the minor tax revenues that local governments collect from road users, mainly in the form of registration fees. In 1998, these revenues accounted for only about 2 percent of all government tax revenues from Texas road users (see Figure 2).

The reference year for the analysis was 1998, the most recent year for which comprehensive data were available when the project commenced. Since the reference year, changes to the rates or coverage of taxes on Texas highway users have been minimal. To make our analysis more current, however, we have conducted it as though the tax provisions in effect in 2001 had been in effect in 1998. All other conditions in 1998, such as the volumes of fuel consumed, have been taken as given.

Revenue Allocation Analysis

The revenue allocation analysis entailed the estimation of each vehicle class's contribution to revenues from taxes on Texas highway users. Table 2 shows the taxes considered in the analysis and their shares of revenues; Table 3 describes the principal data sources used in the analysis.

Federal and state fuel taxes generate about 80 percent of the revenues collected from Texas highway users, so accurate estimation of fuel economy was a high priority for this project. The *Highway Statistics* series provides estimates of fuel economy for autos, buses, and for broad classes of trucks. To obtain estimates for the narrower truck classes used in this project, the researchers combined the estimates from *Highway Statistics* with other sources of data. In the project's early stages, the other source of data was the Highway Revenue Forecasting Model (HRFM). Later, alternative estimates of truck fuel economy became available from the State HCA software developed for the Federal Highway Administration (FHWA) Each of these sets of estimates of truck fuel economy has its advantages: those from the HRFM incorporate engineering evidence, while those from the State HCA software are somewhat specific to Texas and based on more recent data.

Table 1 Vehicle classes

Auto	**Automobiles (or, "passenger cars")**
Pickup	Single-unit trucks with 2 axles and 4 tires
Other 2 Ax SU	Single-unit trucks with 2 axles and 6 tires
3 Ax SU	Single-unit trucks with 3 axles
4 Ax+ SU	Single-unit trucks with 4 or more axles
4 Ax– STT	Combination trucks with single trailer and 4 or fewer axles
5 Ax STT	Combination trucks with single trailer and 5 axles
6 Ax+ STT	Combination trucks with single trailer and 6 or more axles
5 Ax– MTT	Combination trucks with multiple trailers and 5 or fewer axles
6 Ax MTT	Combination trucks with multiple trailers and 6 axles
7 Ax+ MTT	Combination trucks with multiple trailers and 7 or more axles

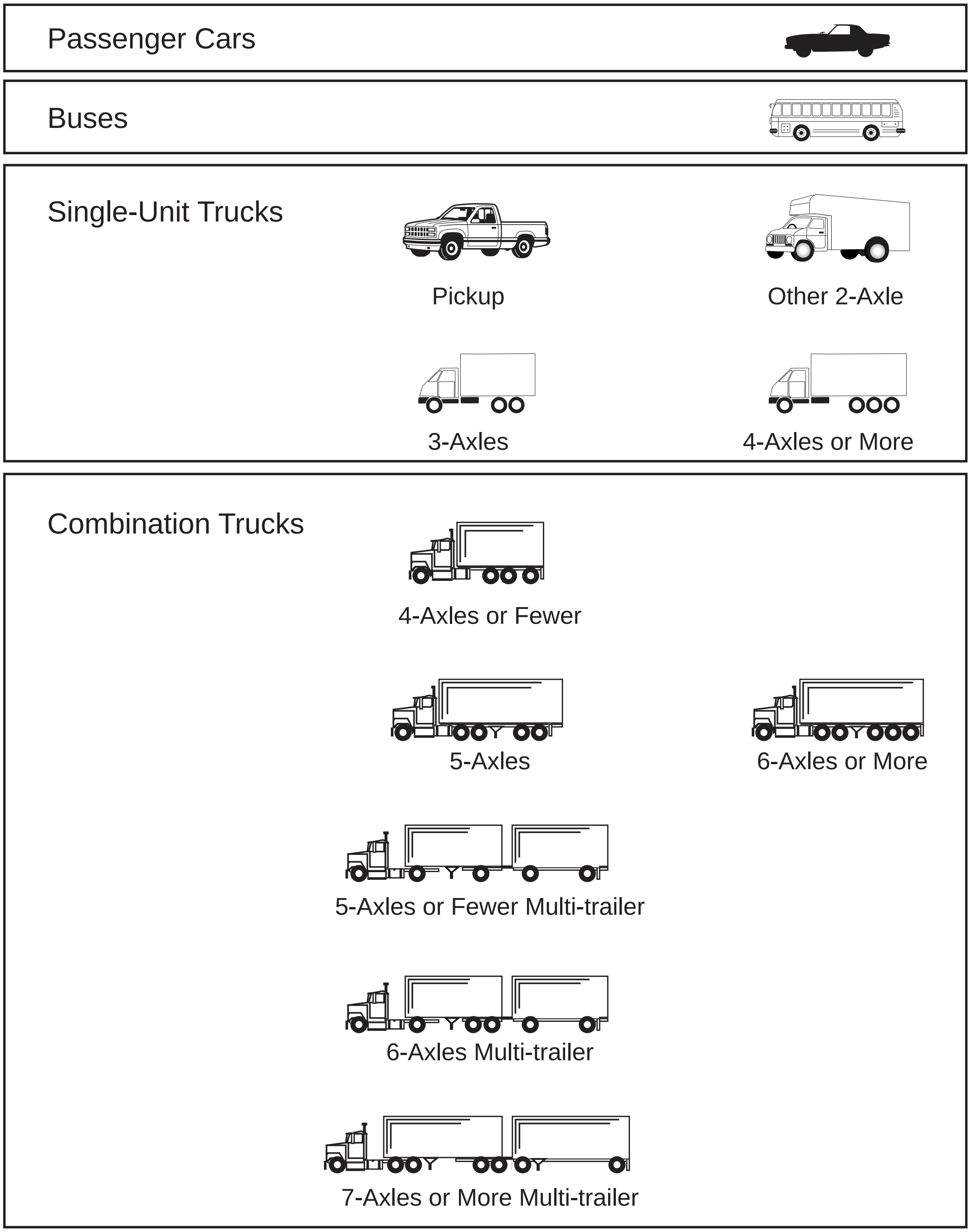

Figure 1 Vehicle types

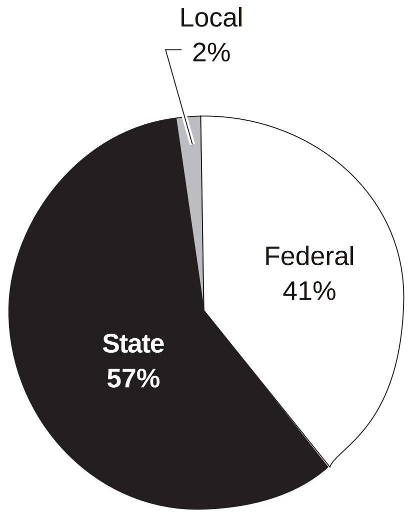

Figure 2 Revenues from taxes on Texas highway users, 1998:
Percent distribution by level of government to which revenue accrues

Source: *Highway Statistics*, Tables FE-9, MF-1, MV-2 and LDF.
Note: State revenues do not include those from sales tax on motor vehicles.

Table 2 Taxes analyzed and their revenue contributions, Texas, 1998

Category of tax/charge	**Additional description of coverage**	**% of revenue**
State taxes:		
Fuel taxes	Motor fuels consumed for on-road travel	41.4
Vehicle registration fees		13.7
Sales tax on motor vehicle lubricants		0.4
Federal taxes:		
Fuel taxes	Motor fuels consumed for on-road travel	40.1
Heavy vehicle use tax	Vehicles with gross weight ≥ 55,000 lbs (including the weights of any semitrailers and trailers that the vehicle customarily pulls).	2.7
Sales tax on trucks and trailers	Trucks with gross weights > 33,000 lbs Trailers with gross weights > 26,000 lbs	1.1
Sales tax on tires	Tires with weights > 40 lbs.	0.5

Table 3 Principal sources of data for revenue allocation analysis

Data Source	**Provider**	**Vehicle Classes Covered by Data**	**Highways Covered by Data**	**Data obtained**	**Additional Description**
Highway Revenue Forecasting Model (HRFM)	Federal Highway Administration	All	National	Fuel economy Vehicle weights Vehicle sales	Projections
Weigh-in-Motion Data (WIM)	TxDOT	Except: Auto Pickup 4 Ax+ SU 7 Ax + MTT	Texas Interstate Highways, (Data from 18 collection stations)	Gross vehicle weight (sum of all axle weights)	WIM is a technology for weighing vehicles as they move over a scale embedded in the road
1997 Vehicle Inventory and Use Survey	U.S. Census Bureau	Trucks	National, Texas	Average annual mileage per vehicle Commodities carried	
State HCA software	Federal Highway Administration	Trucks	Texas	Fuel economy Annual mileage per vehicle Vehicle Prices	Estimates derived from 1997 Vehicle Inventory and Use Survey
Highway Performance Monitoring System	Federal Highway Administration	All	Texas	Annual vehicle miles of travel by vehicle class	
Texas Vehicle Registration Database	TxDOT	All	Texas	Vehicle gross weight Vehicle age Other variables	
Highway Statistics series	FHWA	All	Texas, National	Numbers of Vehicles (Texas) Fuel Economy (National)	

1.1.1 Revenue Allocation Results

The results of the revenue allocation analysis proved largely insensitive to the choice of data source for the detailed estimates of truck fuel economy. The differences were confined to the allocations of fuel and motor oil taxes and were generally small. As one switches from the HRFM to the State HCA software, the most significant differences were the increases in the revenue contributions of 3- and 4-axle single-unit trucks. In view of the overall similarity of the results, only those based on the HRFM are considered in this section (Tables 4–6).

For combination trucks, the estimated share of revenue is greater for federal taxes than for state taxes. The predominant combination class—five-axle combinations with a single trailer—generated an estimated 22.2 percent of the federal revenues, compared with 13.5 percent of state revenues. For the light vehicle classes—automobiles and pickups—the summed estimates displayed the opposite pattern: these classes account for a larger share of state taxes (76.9 percent) than of federal taxes (67.5 percent). The differences stem partly from federal taxes that fall only on the heavier vehicle classes—the sales taxes on tires and on heavy trucks and trailers, and the heavy vehicle use tax. The differences also reflect that the Texas government taxes diesel fuel and gasoline at the same per gallon rate, whereas the federal government applies a higher rate to diesel fuel.

A common practice in HCA studies is to exclude revenues that are not allocated for highway spending. The previous Texas HCA study (Euritt et al. 1994) excluded the 25 percent of net revenues from state fuel taxes that is dedicated to education rather than to highways. It also excluded the portion of federal fuel taxes that is dedicated to mass transit. In the present study, the estimates obtained with this approach differed only slightly from those in Tables 4-6, which are based on the researchers' preferred approach of counting all revenues from highway-related taxes, regardless of whether they were earmarked for highways.

A related issue was whether to count all revenues that Texas highway users pay into the federal highway trust fund. Although the preponderance of these revenues returns to Texas for highway spending, Texas has been traditionally one of the "net donor states" that pays somewhat more into the fund than it gets back. Because we were uncertain as to the appropriate adjustment factor, no adjustment for this overpayment was made in our research.

Cost Allocation Analysis

The researchers statistically allocated highway system costs among the five broad components in Table 7, each of which has its distinctive material, technical, or labor requirements. The load-related components of pavement costs are functions of traffic—of the numbers and weights of vehicles that use the highways. The costs that are in the common, or "residual", component are, in contrast, not related to traffic, and they account for about half of all Texas highway system costs. Common costs include, for example, the costs for right-of-way acquisition, landscaping, excavation, grading and drainage, and traffic control and protection.

Table 4 Revenues from state highway-related taxes, Texas, 1998: Distribution by type of tax and vehicle class

	Fuel Tax						
	($ thousand)						
	Gasoline*	**Special Fuels****	**Total**	**Registration Fees**	**Oil Tax**	**Total Revenue**	**%**
Auto	1,390,454	19,309	1,409,763	403,076	11,796	1,824,635	54.03
Pickup	532,987	16,646	549,633	216,363	5,431	771,426	22.84
Other2Ax SU	73,640	54,509	128,149	41,164	1,720	171,034	5.06
3 Ax SU	2,674	26,766	29,440	35,414	402	65,256	1.93
4 Ax+ SU	36	1,042	1,078	1,454	12	2,544	0.08
4 Ax– STT	3,456	25,794	29,251	12,579	535	42,365	1.25
5 Ax STT	4,023	331,352	335,374	114,088	4,860	454,322	13.45
6 Ax+ STT	31	7,150	7,180	3,178	106	10,464	0.31
5 Ax– MTT	23	11,736	11,758	3,956	184	15,899	0.47
6 Ax MTT	0	2,044	2,044	633	31	2,707	0.08
7 Ax+ MTT	0	306	306	119	4	430	0.01
Bus	5,698	8,111	13,809	1,974	97	15,879	0.47
All Vehicles	2,013,022	504,763	2,517,785	833,998	25,178	3,376,961	100.00

* “Gasoline” includes gasoline and gasohol.
** “Special fuels” include diesel and other fuels.

Table 5 Revenues from federal highway trust fund taxes, Texas, 1998: Distribution by type of tax and vehicle class

	Fuel Tax							
	($ thousand)							
	Gasoline*	**Special Fuels****	**Total**	**Truck & Trailer Tax**	**Use Tax**	**Tire Tax**	**Total Revenue**	**%**
Auto	1,292,887	21,542	1,314,429	0	0	0	1,314,429	48.63%
Pickup	490,470	18,164	508,634	0	0	423	509,057	18.83%
Other2Ax SU	67,942	62,512	130,454	143	0	400	130,997	4.85%
3 Ax SU	2,467	30,719	33,186	10,250	2,408	1,353	47,197	1.75%
4 Ax+ SU	33	1,196	1,229	715	764	43	2,751	0.10%
4 Ax– STT	3,307	29,606	32,913	16,075	511	1,427	50,926	1.88%
5 Ax STT	3,849	380,308	384,156	127,893	61,089	26,225	599,363	22.17%
6 Ax+ STT	30	8,206	8,236	3,570	1,853	543	14,201	0.53%
5 Ax– MTT	22	13,470	13,492	4,539	2,306	970	21,306	0.79%
6 Ax MTT	0	2,346	2,346	699	375	153	3,573	0.13%
7 Ax+ MTT	0	351	352	141	59	25	576	0.02%
Bus	5,662	2,614	8,275	0	0	535	8,811	0.33%
All Vehicles	1,866,667	571,033	2,437,700	164,024	69,365	32,097	2,703,186	100.00%

* "Gasoline" includes gasoline and gasohol.
** "Special fuels" include diesel and other fuels.

Table 6 Revenues from highway-related taxes, Texas, 1998: Distribution by vehicle class and level of government imposing the tax

	State Revenues	Federal Revenues	Total Revenues	%
	($ thousand)			
Auto	1,824,635	1,314,429	3,139,064	51.63
Pickup	771,426	509,057	1,280,483	21.06
Other 2 Ax SU	171,034	130,997	302,030	4.97
3 Ax SU	65,256	47,197	112,453	1.85
4 Ax+ SU	2,544	2,751	5,294	0.09
4 Ax– STT	42,365	50,926	93,291	1.53
5 Ax STT	454,322	599,363	1,053,685	17.33
6 Ax+ STT	10,464	14,201	24,665	0.41
5 Ax– MTT	15,899	21,306	37,205	0.61
6 Ax MTT	2,707	3,573	6,280	0.10
7 Ax+ MTT	430	576	1,005	0.02
Bus	15,879	8,811	24,690	0.41
All Vehicles	3,376,961	2,703,186	6,080,147	100.00

Table 7 Highway system costs by component, Texas, 1998

	$ (thousand)	%
Load-related pavement construction costs	804,651	25.36
Load-related flexible pavement rehabilitation and maintenance costs	560,510	17.67
Load-related rigid pavement rehabilitation and maintenance costs	34,327	1.08
Bridge costs (construction & maintenance)	171,866	5.42
Common costs	1,601,575	50.48
Total Cost	**3,172,929**	**100.00**

1.1.2 Cost Allocation Methods

The method selected for cost allocation varied among the components of cost, based on data availability and theoretical considerations. The aim was an allocation that reflects each vehicle class's responsibility for highway system costs.

The proportional method assigns cost responsibilities to the vehicle classes in proportion to a specified measure that varies among these classes. For common costs, the researchers followed the standard practice in HCA studies of assigning cost responsibilities in proportion to vehicle miles of travel (VMT).

For the other cost components, alternative methods exist that are theoretically superior to proportional allocation but also more data intensive. The researchers obtained detailed data to apply these alternative methods, including data on the costs of individual TxDOT projects. For load-related rigid pavement rehabilitation and maintenance costs—a minor component of TxDOT highway expenditures—unavoidable gaps in the database forced researchers to fall back on proportional allocation, with the factor of proportionality being the number of equivalent single-axle loads (ESALs).

For the other load-related components of pavement costs, the researchers used the variety of methods indicated in Table 8. The variable lanes approach recognizes that the vehicle classes differ in the number of lanes they require, with automobiles requiring more than truck-trailer combinations. For descriptions of this, the generalized, and modified incremental methods, see TxDOT Research Report 1810-1 and 1810-2. For description of the FHWA software for State HCA, see that agency's web site.

1.1.3 Cost Allocation Results

Relative to the other methods, proportional allocation by ESALs attributes a much larger share of costs to the heavy truck classes, and smaller shares to automobiles and pickup trucks (Tables 8 and 9). Although none of the methods is unambiguously superior, the researchers judged the Generalized Method to be the best for the cost components to which these tables relate.

Table 10 reports for each cost component the researchers' recommended method of allocation and the results from its application. Because common costs account for a full half of total costs, changes in the allocation method used for the other components do not greatly affect the overall allocation. This emerges from Table 11, which incorporates the variation in method that featured in Tables 8 and 9.

Table 8 Load-related pavement construction costs, Texas, 1998: Percent distribution by vehicle class according to method of cost allocation

	Generalized Method	Modified Incremental Approach	Proportional by ESALs	Variable Lanes Approach	FHWA Software
Auto	29.60	29.22	5.36	30.11	23.25
Pickup	10.56	11.15	2.36	11.93	11.27
Other 2 Ax SU	4.03	6.10	7.22	5.08	7.63
3 Ax SU	3.19	3.94	7.41	4.36	5.31
4 Ax+ SU	0.21	0.15	0.49	0.81	0.84
4 Ax– STT	1.85	2.18	3.93	2.95	2.58
5 Ax STT	47.07	43.82	64.88	38.02	44.37
6 Ax+ STT	0.61	0.57	1.49	1.51	1.27
5 Ax– MTT	1.32	1.37	2.44	2.19	0.95
6 Ax MTT	0.19	0.13	0.28	0.64	0.08
7 Ax+ MTT	0.08	0.01	0.03	0.11	0.04
Bus	1.29	1.37	4.11	2.29	2.42
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 9 Load-related flexible pavement rehabilitation and maintenance costs, Texas, 1998: Percent distribution by vehicle class according to method of allocation costs

	Generalized Method	Modified Incremental Approach	Proportional by ESALs	Variable Lanes Approach	FHWA Software[a]
Auto	1.97	1.97	0.71	7.76	12.37
Pickup	0.95	0.95	0.37	2.69	6.22
Other 2 Ax SU	4.96	4.96	5.07	4.81	6.60
3 Ax SU	6.70	6.70	6.90	6.06	6.84
4 Ax+ SU	0.36	0.36	0.37	0.66	1.88
4 Ax– STT	3.66	3.66	3.75	3.66	2.28
5 Ax STT	73.75	73.75	74.98	65.97	58.52
6 Ax+ STT	1.38	1.38	1.42	1.67	1.85
5 Ax– MTT	3.41	3.41	3.45	3.43	0.71
6 Ax MTT	0.32	0.32	0.33	0.61	0.06
7 Ax+ MTT	0.03	0.03	0.03	0.08	0.07
Bus	2.52	2.52	2.63	2.58	2.61
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

[a] The result considering both rigid and flexible pavement rehabilitation and maintenance.

Table 10 Texas highway system costs by component, 1998: Recommended allocation method and percent distribution among vehicle classes

Cost Category	Pavement Construction	Flexible Pavement Rehab and Maintenance	Rigid Pavement Rehab and Maintenance	Bridge	Common	Total Costs
	Generalized Method	Generalized Method	Proportional by ESALs	Modified Incremental Approach	Proportional by VMTs	
Auto	29.60	1.97	0.22	51.47	67.79	44.86
Pickup	10.56	0.95	0.13	16.08	21.06	14.35
Other 2 Ax SU	4.03	4.96	2.89	3.28	3.65	3.95
3 Ax SU	3.19	6.70	4.76	1.23	0.86	2.54
4 Ax+ SU	0.21	0.36	0.31	0.14	0.03	0.14
4 Ax– STT	1.85	3.66	2.02	1.12	0.61	1.51
5 Ax STT	47.07	73.75	83.76	21.56	5.28	29.71
6 Ax+ STT	0.61	1.38	1.55	2.79	0.12	0.62
5 Ax– MTT	1.32	3.41	2.37	0.82	0.20	1.11
6 Ax MTT	0.19	0.32	0.29	0.35	0.03	0.14
7 Ax+ MTT	0.08	0.03	0.08	0.62	0.01	0.06
Bus	1.29	2.52	1.63	0.54	0.36	1.00
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 11 Percent distribution highway system costs by vehicle class, Texas, 1998: Sensitivity to method of allocating certain load-related pavement costs[a]

	Generalized Method	Modified Incremental Approach	Proportional by ESALs	Variable Lanes Approach	FHWA Software
Auto	44.86	44.77	38.49	46.02	45.22
Pickup	14.35	14.50	12.17	15.00	15.53
Other 2 Ax SU	3.95	4.47	4.78	4.19	5.19
3 Ax SU	2.54	2.73	3.65	2.73	3.13
4 Ax+ SU	0.14	0.12	0.21	0.35	0.58
4 Ax– STT	1.51	1.59	2.05	1.79	1.45
5 Ax STT	29.71	28.88	34.44	26.04	26.06
6 Ax+ STT	0.62	0.61	0.85	0.90	0.88
5 Ax– MTT	1.11	1.12	1.40	1.33	0.52
6 Ax MTT	0.14	0.13	0.17	0.31	0.07
7 Ax+ MTT	0.06	0.05	0.05	0.08	0.06
Bus	1.00	1.02	1.74	1.27	1.31
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

[a] Costs for pavement construction and for flexible pavement rehabilitation and maintenance

Equity Analysis

The equity ratios in Table 12 combine the revenue allocation results with the cost allocation results in Table 11. For each class, the equity ratio is its share of highway-user tax revenues, divided by its share of highway-related costs. The revenue shares that enter this calculation are taken from Table 6, except in the last column, which is based on an analysis that draws certain information from the FHWA software rather than from the HRFM.

When equity ratios fall below unity for some classes, then, of algebraic necessity, they must exceed unity for some other classes. Table 13 shows the derivation of equity ratios from the revenue shares in Table 6 and from the cost shares based on our recommended methods of cost allocation. Table 14 presents the equity ratios for an aggregation of our 12 vehicle classes.

If an equity ratio of unity is the benchmark of fairness, classes with equity ratios greater than unity are paying more than their fair share of the costs of the Texas highway system. These classes are cross-subsidizing the other vehicle classes, which, with equity ratios less than unity, are paying less than their fair share. Applied to our aggregated results, this criterion of fairness would lead to the conclusion that light vehicles—autos and particularly pickup trucks—are cross-subsidizing combination trucks and buses (Table 14). Although the results vary somewhat among the allocation methods, each produces this same pattern. The only disagreement pertains to heavier single-unit trucks (i.e. excluding pickups), for which the equity ratios straddle unity.

The sensitivity of the results to the allocation method is more pronounced at the 12-vehicle class level (Table 12). A caveat to these results is that they are likely to be less reliable for the relatively uncommon vehicle classes. The least common classes are multi-trailer trucks with seven or more axles and single-unit trucks with four or more axles: they each account for fewer than 4 out of every 10,000 miles traveled on Texas roads. For such classes, the sample sizes in transportation data collections will often be smaller, and hence the estimates less reliable, than those for the more common vehicle classes.

The low equity ratios for buses stem in part from the many tax exemptions and preferences they receive. School buses are exempt from federal taxes and, if they serve public schools, from state taxes. The vast majority of transit buses are government-owned vehicles, which are exempt from federal taxes and from Texas vehicle registration fees. Moreover, both Texas and the federal government tax the diesel fuel consumed by many commercial intercity bus services at a concessionary rate.

Table 12 Equity ratios using alternative allocation methods, Texas, 1998

	Generalized Method	Modified Incremental Approach	Proportional by ESALs	Variable Lanes Approach	FHWA Software
Auto	1.15	1.15	1.34	1.12	1.16
Pickup	1.47	1.45	1.73	1.40	1.35
Other 2 Ax SU	1.26	1.11	1.04	1.19	0.94
3 Ax SU	0.73	0.68	0.51	0.68	0.75
4 Ax+ SU	0.62	0.71	0.41	0.25	0.18
4 Ax– STT	1.02	0.96	0.75	0.86	1.13
5 Ax STT	0.58	0.60	0.50	0.67	0.62
6 Ax+ STT	0.65	0.66	0.48	0.45	0.44
5 Ax– MTT	0.55	0.55	0.44	0.46	1.18
6 Ax MTT	0.72	0.81	0.61	0.33	1.51
7 Ax+ MTT	0.26	0.36	0.33	0.21	0.26
Bus	0.41	0.40	0.23	0.32	0.30

Table 13 Derivation of equity ratios based on recommended cost allocation methods

	% of Total Revenues	% of Total Costs	Equity Ratio
Auto	51.63	44.86	1.15
Pickup	21.06	14.35	1.47
Other 2 Ax SU	4.97	3.95	1.26
3 Ax SU	1.85	2.54	0.73
4 Ax+ SU	0.09	0.14	0.62
4 Ax– STT	1.53	1.51	1.02
5 Ax STT	17.33	29.71	0.58
6 Ax+ STT	0.41	0.62	0.65
5 Ax– MTT	0.61	1.11	0.55
6 Ax MTT	0.10	0.14	0.72
7 Ax+ MTT	0.02	0.06	0.26
Bus	0.41	1.00	0.41
Total	100.00	100.00	1.15

Table 14 Equity ratios by broad vehicle class, Texas, 1998

	Generalized Method	Modified Incremental Approach	Proportional by ESALs	Variable Lanes Approach	FHWA Software
Auto	1.15	1.15	1.34	1.12	1.16
Pickup	1.47	1.45	1.73	1.40	1.35
Other Single-Unit trucks	1.04	0.94	0.80	0.95	0.82
Combination Trucks	0.60	0.62	0.51	0.66	0.65
Buses	0.41	0.40	0.23	0.32	0.30

Directions for Future Research

HCA models are developed not only to evaluate the existing taxes on highway users, but also to evaluate potential changes. Thus, we recommend as a follow-up to this project the use of our framework to simulate scenarios for changes in fuel taxes, registration fees, or other taxes and charges on highway users.

In addition, we recommend that research commence soon to enhance our framework and to update it to 2002, the reference year for the next Vehicle Inventory and Use Survey. One possible enhancement would the inclusion of costs and revenues associated with local roads, which fell outside this study's focus on state-maintained highways.

Also worthwhile would be a more rigorous treatment of the role of traffic capacity, which depends on the number of lanes. For pavement costs that are load-related, the usual HCA practice is to allocate costs based on traffic loads only. The variable lanes approach used in this study was only a nominal effort to factor in traffic capacity. A more adequate treatment should be feasible, however, with fuller utilization of the generalized method. The allocation of bridge costs also calls for a new approach, since the modified incremental approach used in this study assumed the number of lanes to be fixed.

Research to implement these enhancements should commence by September 2003 to dovetail with the schedule for release of data from the Vehicle Inventory and Use Survey. An updated HCA model will require detailed results from the survey that will become available on CD-Rom in the autumn of 2004. If research to enhance our framework were to commence by September 2003, the research would be completed by the time the CD-ROM becomes available, and an update of the database to 2002 could be completed soon thereafter. A much later start on the research could delay completion of the enhancements and update until late 2005 or beyond, making the age of the data sources more vulnerable to criticism.

1.1.4 HCA Models Compared with Other Frameworks

Further research is also recommended to develop an integrated framework for evaluating taxes and charges on Texas motorists. An HCA model belongs in that framework, but it leaves certain gaps for other models to fill.

Among the gaps in HCA studies is the omission of fairness dimensions other than equity among vehicle classes. Other dimensions, such as equity among income classes, have also influenced highway-user taxes and charges. One indication is that Texas collects higher registration fees from newer cars than from older ones, presumably because owners of the older vehicles are deemed less affluent on average.

Another gap in HCA studies is the lack of focus on economic efficiency, the ideal behind many proposals related to highway-user taxes and charges. Congestion pricing, for example, has the rationale that without it, inefficient utilization of a major economic resource—the highway network—produces excessive traffic delays. HCA studies have focused principally on fairness and on the costs incurred by highway agencies (in our case TxDOT.) To analyze highway-user taxes and charges from the perspective of economic efficiency requires both a theoretical approach different from that in traditional HCA studies, and consideration of a broader range of traffic-related costs—in particular, the costs from congestion and traffic-induced pollution.

References

Euritt. M. A., Walton, M. C., Goff, Z., and Burke, D. 1994. *Texas Highway Cost Allocation Analysis and Estimates, 1993–1995.* Research Report 1919-3F/1910-4F. Center for Transportation Research. The University of Texas at Austin.

Federal Highway Administration. U.S. Department of Transportation. 1999 and earlier years. *Highway Statistics.* Recent editions are available on the Web at http://www.fhwa.dot.gov/ohim

Luskin, D., Garcia-Diaz, A., Lee, D., Zhang, Z. and Walton, C. M. 2001. *A Framework for the Texas Highway Cost Allocation Study*. Research Report 0-1810-1. Center for Transportation Research and Texas Transportation Institute.

Luskin, D., Garcia-Diaz, A., Lee, D., Zhang, Z. and Walton, C. M. 2001. *Highway Cost Allocation in Texas*. Research Report 1810-2. Center for Transportation Research and Texas Transportation Institute.