REPORT OF THE
VIRGINIA DEPARTMENT OF TRANSPORTATION

Continuation of the Vehicle Cost Responsibility Study

TO THE GOVERNOR AND
THE GENERAL ASSEMBLY OF VIRGINIA

SENATE DOCUMENT NO. 30

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COMMONWEALTH of VIRGINIA

Joint Legislative Audit and Review Commission

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May 27, 1992

Delegate Ford C. Quillen, Chairman
Joint Legislative Audit and Review Commission
Suite 1100, General Assembly Building
Richmond, Virginia 23219

Dear Delegate Quillen:

In accordance with SJR 238 of the 1991 Session of the General Assembly, I am transmitting to you the completed Continuation of the Vehicle Cost Responsibility Study.

SJR 238 required that the Joint Legislative Audit and Review Commission (JLARC) "review and comment on the methods and analysis to be used by the Department, and the Commission shall receive the report of the Department."

During the course of the study, methodological approaches were developed by VDOT and reviewed and commented on by JLARC staff. JLARC staff found the overall study methodology and implementation to be sufficient to fulfill the requirements of the SJR 238.

Earlier versions of this report were presented to JLARC in 1990 and 1991. The Transportation Commission has been invited to make final summary comments on the cost responsibility study process and plan for future updates to the study.

On behalf of the JLARC staff, I wish to express our appreciation to the Commissioner of Transportation and his staff for their cooperation with our review of the study methodology.

Sincerely,

Philip A. Leone
Director

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Enclosure

CONTINUATION OF THE VEHICLE COST RESPONSIBILITY STUDY (SJR 238)

Virginia Department of Transportation
Ray D. Pethtel, Commissioner
1401 East Broad Street
Richmond, Virginia 23219

March 1992

PREFACE

The Virginia Department of Transportation (VDOT) under the direction of Ray D. Pethtel, Commonwealth Transportation Commissioner, was asked by the 1991 General Assembly to continue its study of the vehicle cost responsibility. This report is in response to that requirement.

This report was prepared under the direction of Mary Lynn Tischer by Amelia E. Jordan of the VDOT Policy Office, with sections written by Kenneth H. McGhee and Alice Phillips of the VDOT Research Council, Robert O. Biletch of the VDOT Policy Office, Robert M. Ketner, III of the VDOT Maintenance Division, and Ralph M. Davis of the Department of Motor Vehicles (DMV).

Technical assistance was provided by William S. Fulcher of the State Corporation Commission (SCC), Ralph M. Davis and Jerry M. Fern of DMV, J. Lynwood Butner of the VDOT Traffic Engineering Division, and Kenneth J. Jennings of the VDOT Maintenance Division. Susan B. Edwards and Margaret W. Redford prepared the tables, typed and edited the report.

The study was organized by a Steering Committee composed of the following individuals:

Chairman:	Mary Lynn Tischer, VDOT Policy Office
Members:	Gary R. Allen, VDOT Research Council
	Ralph M. Davis, DMV
	William S. Fulcher, SCC
	R. Kirk Jonas, Joint Legislative Audit and Review Commission
	Robert M. Ketner, III, VDOT Maintenance Division
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EXECUTIVE SUMMARY

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The General Assembly, through Senate Joint Resolution 238 (SJR 238), required the Virginia Department of Transportation (VDOT) to "...continue its study of vehicle cost responsibility and include an analysis of the effect of traffic levels on pavement performance, an evaluation of the use of deterioration models, and a proposal for periodic review of vehicle cost responsibility on a ten-year cycle." In addition, the Department was asked to evaluate the tax increases proposed in Senate Bill 895 (SB 895), introduced during the 1991 Session, with respect to cost allocation equity, and determine the effects of a tax increase on the industry.

SJR 238 is a continuation of the study mandated by Senate Joint Resolution 121 (SJR 121) in 1989. Senate Document 26 of the 1991 Session is the product of the Vehicle Cost Responsibility Study and should be considered the source document for SJR 238. As such, it may be helpful to refer to Senate Document 26 for further history and background on cost responsibility, as well as the details from that study.

Overall study direction was provided by the Office of Policy Analysis, Evaluation and Intergovernmental Relations. This study was conducted by a team composed of staff from the Office of Policy Analysis, Transportation Research Council, Maintenance and Traffic Engineering Divisions, the State Corporation Commission (SCC), and the Department of Motor Vehicles (DMV). The methodology was reviewed by the Joint Legislative Audit and Review Commission (JLARC) as mandated by SJR 238.

To obtain continuing input from the public, the study was announced in Virginia newspapers, and meetings with both the general public and various interest groups were held.

Recommendations of Senate Joint Resolution (SJR 121)

In 1989 the General Assembly required VDOT in conjunction with the Joint Legislative Audit and Review Commission to "...review the cost responsibility of vehicle classes using the highways, roads and streets of the Commonwealth and make recommendations to the 1991 General Assembly on the need for modifications to the current mix of revenues from the vehicle classes." In order to meet that requirement, the costs of highway construction and maintenance occasioned by various vehicles was determined and compared with the revenues generated on behalf of these same vehicles. The report was presented to JLARC in December 1990 and January 1991. The main finding was that passenger vehicles paid more in taxes and fees than they occasioned in costs; all other classes of vehicles underpaid, although to varying degrees.

The revenue-to-cost ratios are as follows:

- Passenger vehicles 1.06
- Buses .30
- Light trucks .77
- Single units .85
- Combinations .93

Recommendations based on the SJR 121 study were:

- A full cost responsibility study should be performed at least once every decade, as well as in conjunction with any tax or fee increases,
- Supplemental studies are needed to ensure that state-of-the-art developments in pavement and bridge theory can be incorporated into future cost responsibility studies,
- If it is the desire of the General Assembly that VDOT undertake periodic cost responsibility studies, the Department should perform a study of the effect traffic levels have on pavement performance and evaluate the use of deterioration models,
- If charged with another study, the Department should review its electronic databases to ensure accessibility of information for cost responsibility determination, and
- If there is interest in determining user fee equity for a larger number of vehicle types or within vehicle classes, revenue agencies would need to collect information at the appropriate level of detail.

Purpose and Scope

The overall purpose of this study is threefold. The first aim is to evaluate the use of deterioration methodology to allocate pavement rehabilitation costs and whether its application would alter the cost responsibilities of the vehicle classes found in SJR 121. The second goal is to propose improvements in data collection and processing to enhance the next cost responsibility study. The third purpose is to examine tax equity proposals and their possible effects on the motor carrier industry.

The major objectives of the study are as follows:

- Examine the use of pavement deterioration models,

- Develop a data collection plan for the next major cost responsibility study, and
- Analyze the effect of any fee increase on the trucking industry.

PAVEMENT DETERIORATION
(pp. 4-16)

A major objective of the Cost Responsibility Study follow-up was to analyze information on the effects of traffic on pavement performance and evaluate models relating pavement deterioration and the resulting rehabilitation costs to vehicles.

In the Cost Responsibility Study a designed-based approach was employed for new pavement costs; the same methodology was used for rehabilitation costs. At the time, it was noted that there was an alternative approach to estimation of costs for rehabilitation. It involved a deterioration methodology whereby the costs of major rehabilitation were charged to vehicles on the basis of the amount of damage they cause. For this study, the General Assembly mandated an evaluation of the use of deterioration models for allocating pavement rehabilitation costs.

A Review of the Literature

A thorough review of the literature regarding the relationship between pavement performance and axle loadings was conducted during 1991. The review included models developed through studies by the Federal Highway Administration (FHWA) and American Association of State Highway and Transportation Officials (AASHTO), as well as others reported in the literature.

The conclusion from this literature review was that the state-of-the-art has not progressed to the point where acceptable models are available for testing. Based on the models considered by the SJR 238 study team, it is apparent that the issues of cost responsibility associated with pavement deterioration under traffic are extremely complex and that there is no widely accepted model to analyze those issues. For this reason the team recommends that the Department make no immediate attempts to model pavement deterioration through mechanistic or empirical models available at this time. Rather, the Department should position itself through the identification and development of the proper databases to make use of the ***nationwide pavement cost model*** to be released in 1992 by FHWA.

Pavement Deterioration Modeling

One of the objectives of SJR 238 was to develop pavement deterioration models with existing data. The purpose of this task was to more equitably allocate pavement reconstruction costs to vehicle classes based on the amount of damage caused. This objective involved determining the statistical relationship between vehicle loadings and the resulting damage to pavements.

In order to test the feasibility of developing such models, data from VDOT's Pavement Management System were examined. The model estimation process involved testing models for the best statistical fit. The regression equations resulting from this analysis provided fits that were better than those achieved in the 1991 Vehicle Cost Responsibility Study and were a step in the right direction in the modeling of roadway damage. The regression models developed in this study are not statistically robust enough to be a basis for tax policy, however. But, the modeling process does warrant further study.

DATA COLLECTION PLAN
(PP. 16-21)

Another mandate of the study was to identify required information to perform future cost responsibility studies and to develop a plan for data collection in order that the data will be available when needed.

Data Used in SJR 121

The data used in SJR 121 fell into four categories: expenditures, vehicle activities, revenues, and highway descriptors. Many, but not all of these data were available at VDOT. Other agencies from which data were obtained were the Department of Motor Vehicles and the State Corporation Commission. The data used in SJR 121 will be needed for the next cost responsibility study either from the same, or new, sources.

Additional Data for the Next Study

In addition to the data used in SJR 121, new data systems will be available in the future. A universal project number is being developed as part of Phase II of the Financial Management System (FMS) at VDOT. This number will be a cross-reference field in many operating systems used by the Department, and will facilitate gathering complete project construction and expense data.

New technologies will alter the data available for the next cost responsibility study, as well. Weigh-in-motion (WIM) studies, which were a new data source for the 1990 study,

will have been conducted at a larger number of sites and should be an important data source. The Traffic Monitoring Guide, which presents guidelines for gathering traffic data for federal reports, is currently being redesigned to utilize WIM technology. A library of data from all WIM studies will be maintained at the Department, making such data available for research.

The Strategic Highway Research Program (SHRP), now being implemented, will provide continuous WIM data collection as well as pavement performance indicators for sites in Virginia. By the time the next cost responsibility study is begun, several years of data from these sites will be available. By providing accurate information on vehicle weights, the SHRP data will allow the truck factor used in pavement management to be calculated more precisely.

The Highway and Traffic Record Information System (HTRIS), which is currently being implemented at the Department, will be another database used in the next cost responsibility study. Many types of data that are now kept in various formats will reside on this system and be tied together through a common locator. There may well be other technologies and systems in place by the next study. Those discussed above are either in place or being installed.

Revenue Data in More Classes

The number of classes for which cost responsibility could be analyzed was limited by the fact that revenue data are not collected by many vehicle classes or by weight. For SJR 121, revenue data were spread over five classes; in contrast, cost data were available for 13 vehicle classes. One recommendation of SJR 121 was to determine the type of information that would be required to collect revenue data for a larger number of classes and across weight groups.

If, when the next cost responsibility study is conducted, special studies for revenue data do not collect information on more vehicle classes, the study will still be limited to five classes of vehicles. One of these classes will contain all combination units, singles and doubles, making it impossible to ascertain cost responsibility for different combinations and weights.

In order to analyze cost responsibility for more vehicle classes or within weight groups, it will be necessary to relate operating and registered weight of vehicles. Revenues are collected by registered weights; however, costs are calculated based on operating weights. The operating weight distribution of each vehicle determines the amount a vehicle should be paying. In order to relate this to what is actually paid, the registered weight for the vehicle needs to be determined. A special study would need to be performed using the best technology available at the time of the next cost

responsibility study to ascertain the relationship between registered and operating weights.

IMPACT OF FEE INCREASES ON THE INDUSTRY
(pp. 21-49)

The Department was asked to evaluate the tax increases proposed in Senate Bill 895 (SB 895) with respect to cost allocation equity, and to determine the effects of a tax increase on the industry. This major section of the report considered:

- Senate Bill 895 of the 1991 Session,
- Overweight trucking operations in Virginia,
- Impact of transportation taxes and fees on the trucking industry,
- Taxes and fees as a proportion of operating expenses, and
- Tax competition with surrounding states.

Senate Bill 895 - 1991 Session

Senate Bill 895 of the 1991 Session (SB 895) was introduced to correct inequities with the structure of highway user fees found in SJR 121. The bill was designed to recover some of the costs not currently paid by the various truck classes and thereby make user fees more equitable among the various vehicle classes. There also was a substitute version of SB 895 later during the Session. It did not, however, improve equity and was not reported out of the Senate Transportation Committee.

The key provisions of SB 895 were:

- Temporary registration fees for heavy trucks and equipment were changed from ten cents per mile to $2.50 for each 1,000 pounds of registered weight. This would have made this registration fee more consistent with other registration fees for cars and trucks,
- The flat fee component of truck registration fees were increased and a 50 percent increase in the portion of the fee based on weight was identified. This would have helped recover costs from two- and three-axle trucks, and to a lesser degree from combinations,

- A surcharge of two percent was added to the motor vehicle sales and use tax for all two- and three-axle trucks purchased in Virginia. These truck classes were found to be underpaying by the greatest amount,

- The road tax was increased from 19.5 cents to 21.5 cents. This would recover costs primarily from large combination trucks. This change would have ensured that non-resident trucks using Virginia highways help to contribute more equitably to the costs they occasion,

- Hauling permit fees were modified to include a flat fee, as well as a fee based on the amount of excess weight and distance traveled, and

- Free commodity overweight permits would be discontinued. The fee for containerized freight would have been a flat charge plus an amount based on the weight and distance traveled. Haulers of coal, concrete, solid waste, and farm produce would have paid a flat fee of $350 per year.

Overweight Trucking Operations

One issue addressed by Senate Bill 895 and the Vehicle Cost Responsibility Study was the amount paid by overweight trucks traveling on Virginia's roads. Overweight trucking operations fall into one of three categories: (1) vehicles traveling under a hauling permit, (2) trucks operating with an overload permit, and (3) illegal operations. All of these overweight vehicles are putting extra stress and wear on the pavements of the Commonwealth. To achieve equity in cost responsibility, the fees for permits and fines for illegal operations should capture the costs of pavement damage. Increases in the fees for permits were part of SB 895. This study recommends a review of the fines for liquidated damages; the level of the fine has not changed in 35 years.

Impact of Transportation Taxes and Fees on the Trucking Industry

A literature review, conducted as part of the assessment of the impact of increases on the industry, examined studies from the 1980's and early 1990's. Most of the literature indicates that segments of the trucking industry that are able to do so will in all likelihood pass along to shippers and consumers any increases in operating expenses. A number of variables influence the probability that a motor carrier can and will increase rates to recover an increase in operating costs. These include the general economic climate, the elasticity of demand for the commodity, the elasticity of demand for the trucking service, the proportion that transport costs comprise of the commodity's total cost, competitiveness within the carrier industry, and the ability of that carrier to incorporate productivity improvements that offset an expense increase. The ability to pass on increases in operating costs is determined by the type of market in which the carrier

operates and its position in that market. If competition is strong and/or demand for the goods carried is relatively elastic, the operator will have a difficult time increasing rates.

Impact Analysis: Taxes and Fees as a Proportion of Operating Expenses

Using information from Virginia carriers, as well as information provided in the literature, of the dollar impact of the tax and fee increases proposed in SB 895 can be examined. Although registration, fuel and vehicle sales taxes would increase at different rates, SB 895 would result in an average increase of 26 percent. The range of this increase would vary from 16 to 46 percent according to the type of truck. Transportation fees are generally three to five percent of operating costs and the analysis suggests the overall impact of the tax increase would not be significant. Several case studies of Virginia carriers are discussed in the text.

Tax Competition with Surrounding States

One issue identified in discussions with the trucking industry in Virginia is the effect of increasing taxes relative to the taxes charged in surrounding states. Some argue this would create incentives for the industry to base-plate elsewhere.

This study found that Virginia falls close to the middle of this group of states on most tax issues. For taxes and fees paid to operate a typical 18-wheeler, Virginia also ranks in the middle of all 50 states and the District of Columbia.

It has been argued that the level of motor carrier taxes and fees in Virginia explain a low level of registration. Our analysis does not support this. Because the motor fuel tax rates and registration fees paid by motor carriers are apportioned based on miles traveled within each state, they do not significantly impact base-registering decisions. The only taxes that are not apportioned by mileage are sales and personal property. Since the vehicle sales tax is a component of the purchase price of a motor vehicle and personal property taxes increase annual operating costs, these taxes may figure into base-registering decisions. However, considering the wide variation in personal property taxes within Virginia, it is clear that if cost were an issue, companies could locate in a low cost county. Sales tax is amortized over the life of the vehicle and is not enough of an incentive to base-plate elsewhere. The number of vehicle registered in the various states considering their tax rates suggest other factors are of greater significance to the base-plating decision. The literature would indicate the most important variable influencing location decisions is proximity to markets.

Determining Industry Impact

The challenges of the previous decade have yielded a motor carrier industry in transition, moving from an inefficient, regulated industry to a more efficient, more competitive one. Increased market entry in the truckload (TL) market, in particular, has promoted strong competition in that segment of the industry. In the less than truckload segment (LTL), competition coupled with economic downturns have forced many companies out of the marketplace. Operating costs are up but rates have not kept pace. Nevertheless, predictions for the future of this industry are largely positive based on the technological improvements that will permit greater efficiencies.

The proposed tax burden would vary by firm size and attributes. However, information from Virginia carriers indicates that if all the proposed taxes were enacted the proportion of operating costs attributable to Virginia taxes would increase by a relatively small amount. Although there is concern about the recent economic recession, forecasters predict a better future in which higher freight rates can compensate for the higher operating costs that result from increased taxes. The ability to achieve a more equitable distribution of cost responsibility and to increase the efficient use of Virginia's highways will likely offset any cost impacts from the proposed tax and fee increase on the industry.

STUDY CONCLUSION AND RECOMMENDATIONS
(pp. 49-53)

The results of this study confirm the conclusions reached in SJR 121. Preliminary modeling using a pavement deterioration methodology to allocate rehabilitation costs indicated results not dissimilar to those found in SJR 121 using a design-based allocation method. Passenger vehicles overpay from a cost occasioning perspective; truck and bus classes underpay. The revenue-to-cost ratios found in SJR 121 continue to represent the relative payments for use of the roads with respect to the costs occasioned by the vehicle classes.

Equity from a cost occasioning perspective can be accomplished with tax increases such as those reflected in SB 895, introduced in the 1991 Session of the General Assembly. The revenue-to-cost ratios for vehicle classes found in SJR 121 and SB 895 are listed in Table A.

TABLE A REVENUE-TO-COST RATIO		
Vehicle Class	SJR 121	SB 895
Passenger Vehicles	1.06	1.03
Buses	.30	.30
Light Trucks	.77	.96
Single Unit Trucks	.85	.98
Combination Vehicles	.93	.96

Whether the General Assembly determines that it is appropriate to obtain such equity depends on how the role of the trucking industry in Virginia is viewed as well as beliefs about the economic consequences of tax increases on the industry.

The Cost Responsibility Study was performed by allocating highway user taxes and fees to vehicle classes. However, user taxes and fees are not the only source of revenue dedicated to transportation. One-half percent of the State retail sales tax is allocated to the Transportation Trust Fund for construction. It was excluded from revenue attribution because consumers, not highway users, pay this tax. The General Assembly may wish to apply the state retail sales tax as a subsidy for truck and bus classes.

The General Assembly may take the perspective that trucking is not to be viewed simply as an economic entity subject to typical market force discipline but as an enhancer of economic development. In this view, the overall contribution of the industry to Virginia's economy would be recognized and addressed through a general tax subsidy.

Others might argue that such subsidies allow carriers to be inefficient and bolster marginal carriers who would otherwise be required to face competitive market forces. It could also be argued that such subsidies unfairly affect the rail mode which would be the competitor for some of the business. If it is assumed that trucking should bear the full costs of the use of the roads, the tax package represented by SB 895 would meet the equity goal. Whether this is an appropriate time to increase taxes on the industry is another question.

Virginia is now positioned in the middle of surrounding states with respect to taxes on the industry. Analysis of the relative tax burden indicates that SB 895 would not affect base-plating decisions. Since most of the fees are apportioned to states based on mileage, only the sales tax could make a difference. Analysis indicates it does not. The literature suggests that proximity to markets is the more important variable in location decisions.

It is recommended that, whenever highway financing issues are addressed by the General Assembly, the equity of allocation to vehicle classes also be reviewed. Legislation to increase transportation taxes and fees should provide the opportunity to obtain equity in vehicle class payments. In addition, a review of liquidated damages assessed on illegal overweight trucks is recommended.

Recommendations with respect to cost responsibility methodologies follow.

Pavement Deterioration Modeling

The state-of-the-art has not progressed to the point where acceptable models are available for testing. It is recommended that the Department make no immediate attempts to model pavement deterioration through mechanistic or empirical models at this time. Rather, the Department should position itself through the identification and development of the proper databases to make use of the model to be released in 1992 by FHWA as the ***nationwide pavement cost model.*** Among the data elements needed are:

- Pavement condition parameters (roughness, cracking, rutting),
- Threshold values or action levels for the condition parameters,
- Pavement maintenance and rehabilitation costs as they relate to condition parameters,
- The distribution of vehicles by class in the traffic streams corresponding to the pavements defined above,
- The distribution by axle loads of the weights of vehicles, and
- Growth rates for vehicle weight distributions by class.

If the Commonwealth desires to allocate pavement construction and rehabilitation costs equitably among vehicle classes based on the consumption of pavement life by those classes, it is recommended that the following actions be taken:

- Develop a full, system-wide database of weigh-in-motion data which will provide weight data obtained without enforcement and present results on a broader spectrum of vehicle classes and weights than is available today.
- Continue to develop pavement performance information in the Pavement Management System. These data can be analyzed with the equivalent single axle load (ESAL) data to develop load-performance relationships.

- Ensure VDOT's continued involvement in the Strategic Highway Research Program and ability to fund programs that address the interactions of pavement performance, vehicle loadings, and environmental factors.

Revenue Data

This study has identified the information needed to perform future cost responsibility studies. Some improvements in the current data will come from improved technology, particularly with WIM, but an improvement in the number of revenue classes to which costs can be allocated may only be possible with the collection of significant amounts of data. If, when the next cost responsibility study is conducted, special studies do not collect revenue information on more vehicle classes, the study will still be limited to five vehicle classes. It will continue to be impossible to ascertain cost responsibility for different vehicle combinations and weights and to evaluate equity within vehicle classes.

The General Assembly may wish to mandate special studies for the first year of a cost responsibility study that would require:

- A special study by the SCC to determine payment of road use taxes by type of truck,
- A special study by DMV of sales and use taxes paid by vehicle class, and
- A special study by DMV of registration fees by vehicle class.

The Cost Responsibility Study (SJR 121) and its Continuation (SJR 238) have investigated the cost responsibility of vehicle classes using the roads of the Commonwealth. This study attempted to apply pavement deterioration models to rehabilitation costs, but found that, while appropriate models are forthcoming, the technique had not progressed to the point where its implementation significantly enhanced the current methodology. The numbers and mix of vehicles using the highways of the Commonwealth will continue to change over time and necessitate periodic review of cost responsibility. The recommendations of this report will enable the next study to more precisely define costs for the various vehicle classes.

INTRODUCTION

Mandate for Senate Joint Resolution 238 (SJR 238)

The General Assembly, through Senate Joint Resolution 238, required the Virginia Department of Transportation (VDOT) to "...continue its study of vehicle cost responsibility and include an analysis of the effect of traffic levels on pavement performance, an evaluation of the use of deterioration models, and a proposal for periodic review of vehicle cost responsibility on a ten-year cycle."[1] In addition, the Department was asked to evaluate the tax increases proposed in Senate Bill 895 (SB 895), introduced during the 1991 Session, with respect to cost allocation equity, and determine the effects of a tax increase on the industry.

Recommendations of Senate Joint Resolution 121 (SJR 121)

SJR 238 is a continuation of the study mandated by Senate Joint Resolution 121. In 1989 the General Assembly required VDOT in conjunction with the Joint Legislative Audit and Review Commission (JLARC) to "...review the cost responsibility of vehicle classes using the highways, roads and streets of the Commonwealth and make recommendations to the 1991 General Assembly on the need for modifications to the current mix of revenues from the vehicle classes."[2] In order to meet that requirement, the costs of highway construction and maintenance occasioned by various vehicles were determined and compared with the revenues generated on behalf of these same vehicles. The report was presented to JLARC in December 1990 and January 1991, the main finding was that passenger vehicles paid more in taxes and fees than they occasioned in costs. All other classes of vehicles underpaid, although to varying degrees. The revenue-to-cost ratios are as follows:

- Passenger vehicles 1.06
- Buses .30
- Light trucks .77
- Single units .85
- Combinations .93

Recommendations based on the SJR 121 study were as follows:

- A full cost responsibility study should be performed at least once every decade, as well as in conjunction with any tax or fee increases.

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[1] Senate Joint Resolution 238 of the 1991 General Assembly.

[2] Senate Joint Resolution 121 of the 1989 General Assembly.

- Supplemental studies are needed to ensure that state-of-the-art developments in pavement and bridge theory can be incorporated into future cost responsibility studies,

- If it is the desire of the General Assembly that VDOT undertake periodic cost responsibility studies, the Department should perform a study of the effect traffic levels have on pavement performance and evaluate the use of deterioration models,

- If charged with another study, the Department should review its electronic databases to ensure accessibility of information for cost responsibility determination, and

- If there is interest in determining user fee equity for a larger number of vehicle types or within vehicle classes, the revenue agencies would need to collect information at the appropriate level of detail.

Senate Document 26 of the 1991 Session is the product of the Vehicle Cost Responsibility Study (SJR 121) and should be considered the source document of SJR 238. As such, it may be helpful to refer to Senate Document 26 for further history and background on cost responsibility.

Purpose and Scope

The overall purpose of this study is threefold. The first aim is to evaluate the use of deterioration methodology to allocate pavement rehabilitation costs and whether its application would alter the cost responsibilities of the vehicle classes found in SJR 121. The second goal is to propose improvements in data collection and processing to enhance the ability of the Department to perform the next cost responsibility study. The third purpose is to examine tax equity proposals and their possible effect on the motor carrier industry.

Study Objectives

The major objectives of the study are as follows:

- Examine the use of pavement deterioration models,

- Develop a data collection plan for the next major cost responsibility study, and

- Analyze the effect of any fee increase on the trucking industry.

Study Approach

Overview

The Cost Responsibility Study was continued during 1991. Overall study direction was provided by the Office of Policy Analysis, Evaluation and Intergovernmental Relations. This study was conducted by a team composed of staff from the Office of Policy Analysis, Transportation Research Council, Maintenance and Traffic Engineering Divisions, the State Corporation Commission (SCC), and the Department of Motor Vehicles (DMV). The methodology was reviewed by the Joint Legislative Audit and Review Commission (JLARC) as mandated by SJR 238.

To obtain continuing input from the public, the study was announced in Virginia newspapers, and meetings with both the general public and interest groups were held. Comments from the general public were taken at the public meeting itself or forwarded to the Department.

Study Activities

Relationship Between Traffic and Pavement Performance

Activities were undertaken to refine cost responsibilities of vehicle classes and weights by developing the relationships between traffic and pavement performance through the use of deterioration models. These activities included:

- A literature review to identify relationships between pavement performance and traffic, models employed to relate traffic and deterioration, and data requirements of the models,
- A search for commercially available software to perform analysis of models identified for application in Virginia,
- Data evaluation to determine whether appropriate information is available for Virginia, and
- Model testing, after deciding upon the approach to be taken.

Data Collection Plan

A data collection plan was developed for use in designing the next full cost responsibility study. Activities accomplished for this purpose included:

- An identification of the data and data sources used during SJR 121 and a discussion of their future usefulness in meeting cost responsibility data needs,

- A determination of additional data and sources that may be available to assist in refining cost responsibility for the next study, and

- An exploration with SCC and DMV of the possibility of a more detailed revenue database, one which would enable cost shares to be determined for more than five vehicle classes.

Impact of Fee Increases on the Industry

Activities were undertaken to determine the effect of possible fee increases on the trucking industry in Virginia. The activities included:

- An evaluation of the impact of fee increases such as those proposed in SB 895,

- A literature review of the impacts of taxes and fees on the trucking industry including transportation cost elasticities,

- A comparison of Virginia fees on the industry with those in other states, with emphasis on surrounding states.

Organization of Report

The following sections of the report provide the methodological basis and the results of the continuation of the Vehicle Cost Responsibility Study: Pavement Deterioration, Data Collection Plan, Impact of Fee Increases on the Industry, and Study Conclusion and Recommendations.

PAVEMENT DETERIORATION

Relationships Between Pavement Performance and Axle Loadings

One of the major objectives of the Cost Responsibility Study follow-up was to analyze information on the effects of traffic on pavement performance and evaluate models relating pavement deterioration and the resulting rehabilitation costs to vehicles.

The cost parameters for the Cost Responsibility Study involved estimating costs for roads, bridges, and administrative and other costs. Road costs were categorized into:

preliminary and construction engineering, right-of-way, grading, drainage, shoulders, lane width, and new and reconstructed pavements.

A designed-based approach was employed for new pavement costs; the same methodology was used for rehabilitation costs. At the time, however, it was noted that an alternative approach to estimation of costs for rehabilitation involved a deterioration methodology whereby the costs of major rehabilitation are charged to vehicles on the basis of the amount of damage they cause. For this study, the General Assembly mandated an evaluation of the use of deterioration models for allocating rehabilitation costs of pavements.

Pavement deterioration is a function of axle loads, as well as pavement strength, the quality and types of materials used in the pavement, and the environment to which the pavement is exposed. The direct costs of damage to a pavement are represented by the costs of restoring the pavement to its original condition; indirect costs (commonly referred to as user costs) are marginal costs related to vehicle operation on substandard pavements and include costs related to delay, vehicle wear, and fuel consumption. These issues were raised by the Trucking Research Institute in their report on the rationalization of procedures for highway cost allocation.[3] In this report, the truckers made a case for building stronger, longer-lived pavements where the initial investment can be spread over a longer period of time while resurfacing and other major maintenance activities would be performed less frequently. Thus, both capital recovery and user costs would be reduced. It is appropriate to note here that Virginia already uses a life-cycle cost approach in the new pavement design process. For existing pavements, the analysis applies only at the time rehabilitation strategies are under development.

The 1982 Federal Highway Cost Allocation Report represented an early attempt at attributing the costs associated with the restoration of pavements to vehicles based on the damage caused by those vehicles.[4] In that study, pavement distresses were related to traffic loadings through mathematical modeling using empirical data and a model called Viscoelastic System (VESYS). Other examples of such a modeling approach have been noted in the literature and will be discussed later.

The 1990 Methodology Report for the Virginia Vehicle Cost Responsibility Study suggested the use of deterioration models for the attribution of pavement rehabilitation costs. Because of the need to meet the time schedule of the legislation, thorough evaluation of models cited in the literature was not accomplished. At the same time,

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[3] Rationalization of Procedures for Highway Cost Allocation, Trucking Research Institute, Alexandria, Virginia, October 1990.

[4] Final Report on the Federal Highway Cost Allocation Study, U.S. Department of Transportation, Washington, D.C., May 1982.

attempts to develop models specific to Virginia conditions were only partially successful and the results of those attempts were not sufficient for use in the cost allocation process.

A Review of the Literature

The literature distinguishes between damage to flexible and rigid pavements and attributes causation differently to each type of payment. However, in view of the relatively small mileages of portland cement concrete (rigid) pavements on Virginia's highway systems the following discussion of relevant literature is restricted to that applicable to flexible pavements.

Approaches to Pavement Condition Evaluation

Since its completion in the early 1960's, many people have used the tools developed at the AASHO Road Test in the evaluation of pavement performance.[5] In that work, pavements were viewed from a perspective of how they function over time. The functional performance of pavements was, therefore, adopted as the evaluation standard. This approach attempts to quantify the traveling public's perception of pavement performance based essentially on ride quality. The parameter most often employed in this approach is the present serviceability index, a zero to five rating of how well a pavement serves its intended function.

Because they are charged with maintaining pavements at a serviceable level, highway engineers often prefer an evaluation of performance based on less subjective characteristics such as cracking, deformations, and other distresses. This approach, sometimes referred to as the structural performance approach, is intended to keep pavements at a level of serviceability such that adverse public reaction is minimized. In many cases the condition parameter is a composite index reflecting a variety of distresses and usually employing a deduct system where a perfect pavement is assigned a rating of 100. As the pavement deteriorates, deduct points, depending upon the density and intensity of distresses, are assigned. When a predetermined threshold score is reached, the pavement is programmed for rehabilitation. Such an approach is employed in Virginia's Pavement Management System (PMS).[6]

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[5] Special Report 61E, "The AASHO Road Test, Report 5, Pavement Research.", Highway Research Board, Washington, D.C., 1962.

[6] K. H. McGhee, Status Report, Implementation of a Pavement Management System in Virginia, VTRC No. 87-R19, Virginia Transportation Research Council, Charlottesville, Virginia, 1987.

Axle Loading Evaluation

The AASHO Road Test also evaluated the impacts of vehicle loadings on pavement performance. Inasmuch as vehicles come in various configurations and are loaded in many ways, a load normalizing parameter called the equivalent single axle load (ESAL) was defined for the Road Test.[7] An 18,000 pound (18 kip) single axle load, the maximum legal single axle load at the time of the Road Test, was selected as the standard to which all other loads were compared. As part of the Road Test, highway segments were tested to failure under known axle loadings and numbers of load repetitions. Depending somewhat on pavement details, these tests showed that pavement damage is related to increased loading by approximately the fourth power (i.e., doubling the load causes a $2^4 = 16$ fold increase in pavement damage). The tests also showed that a 34,000 pound (34 kip) tandem axle loading is approximately equivalent to the 18 kip single axle in terms of pavement damage. Axle equivalency factors for various loadings on various pavement configurations are listed by AASHTO and are used in the evaluation of traffic streams as pavement design inputs by most highway agencies.[8] Generally, this parameter expresses the total equivalent single axle load contribution of the traffic stream. One publication shows that about 9,600 small passenger cars are equivalent in axle loading to one loaded 18-wheeler.[9]

Of critical importance in determining realistic ESAL values is the validity of truck weight data. Studies have shown that most historical truck weight data are biased to the low side because they are collected by weighing activities associated with or perceived to be associated with enforcement of weight laws. National data collected by varying methodologies show a wide dispersion of measured average truck weights and confirm such a bias for enforcement-oriented data.[10] An analysis of recent non-enforcement weigh-in-motion (WIM) data for Virginia showed that historically, typical truck weights had been underestimated by enough to produce approximately a 50 percent error in ESALs. For example, the average truck factor (representing a mix of empty, partially loaded, fully loaded, and overloaded trucks in the total traffic stream) for a tractor-semitrailer (3S-2) increased from a historical 0.88 to 1.28 for the WIM data; that is, each pass of a 3S-2

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[7] Ibid.

[8] Guide for Design of Pavement Structures, American Association of State Highway and Transportation Officials, Washington, D.C., 1986.

[9] Our Highways, Why Do They Wear Out, Who Pays For Their Upkeep, American Association of State Highway and Transportation Officials, Washington, D.C., 1984.

[10] Statewide Highway Planning Procedures, Federal Highway Administration Contract DTFH 61-87-R-00148, U.S. Department of Transportation, Washington, D.C., 1988.

vehicle, on the average, contributes 1.28 ESALs to the total.[11] Clearly this single factor will have significant implications in future cost responsibility studies.

Although used widely in pavement design calculations, many are reluctant to use the AASHTO equivalencies in assessing pavement damage for the allocation of pavement maintenance and rehabilitation cost responsibilities. The lack of use of the AASHTO results for that purpose stems mainly from what are generally recognized as two problems with the Road Test, both of which could influence a given pavement's response to loads. These are (1) the Road Test was conducted on only one site so it does not reflect geographic factors, and (2) the Road Test was conducted over a short period of time so it does not reflect long term climatic factors. For these reasons the long term pavement performance analysis, as a major portion of the massive Strategic Highway Research Program (SHRP), has been initiated.[12] It is a 20-year, $50 million effort; a major objective is to contribute to the knowledge concerning the interactions between the environment and axle loadings.

Load-Performance Relationships

As discussed earlier, most recent pavement technologists recognize at least two types of pavement performance, functional and structural. Some of the modeling implications of these are discussed briefly below.

Functional Performance

Researchers at the AASHO Road Test in the late 1950's identified a pavement deterioration equation:

$$g = (W/p)^B \qquad (1)$$

where

- g = the damage function
- W = the normalized load, climatic cycles, or elapsed time to reach the level g
- p = the quantity of W until g reaches a value of 1, usually assumed to be a function of structural variables
- B = a power which dictates the degree of curvature of the curve relating g and W/p

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[11] K. H. McGhee, 18-Kip Axle Equivalency Factors (ESAL) Calculations Based on Weigh-In-Motion (WIM) Data", Virginia Transportation Research Council, Charlottesville, Virginia, August 6, 1991.

[12] Special Report 202, America's Highways, Accelerating the Search for Innovation, Transportation Research Board, Washington, D.C., 1984.

The quantity g is further defined as a serviceability index ratio

$$g = (P_o - P)/(P_o - P_f) \qquad (2)$$

where

P = serviceability index at a given time
P_o = initial serviceability index
P_f = minimum serviceability index

Equations 1 and 2 can be combined to provide a generalized performance curve equation.

$$P = P_o - (P_o - P_f)(W/p)^B \qquad (3)$$

Equation 3 in a different format is identical to the equation used in the Virginia PMS to define pavement performance and to develop budget projections for pavement rehabilitation outlays. However, conceptually the Virginia PMS approach more closely resembles the structural performance concept discussed below.

Villarreal[13] and Myers[14] go one step further to define the S-shaped serviceability index curve often observed for pavements which are permitted to continue to deteriorate to a very low level-of-service, i.e., the deterioration curve levels off at a plateau. The form of the equation is very similar to Equation 1 except the deterioration function is exponential. Due to the relatively high level-of-service in Virginia, this type of curve generally does not reflect actual conditions.

Structural Performance

It is noted that pavement distress can be represented by two components, density and severity. Density may be an areal or other measurement while severity typically will be subjective. Each of these components may be represented by mathematical functions similar to those discussed above for functional performance. (Such an approach is used in the Virginia PMS). Villarreal and Myers each note that pavements may be seriously distressed and in need of major rehabilitation before the serviceability index drops to its

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[13] Arturo Villarreal, Alberto Garcia-Diaz and Robert L. Lytton, Pavement Cost Allocation Model Updates, U.S. Department of Transportation/Federal Highway Administration, Contract No. DTFH61-87-R-00021, Washington, D.C., September 1987.

[14] Monty G. Myers, Stephen B. Seeds and B. Frank McCullough, Interim Report, Pavement Cost Model for Truck Policy Analysis, U.S. Department of Transportation/Federal Highway Administration, Contract No. DTFH61-88-C-0091, Washington, D.C., March 1989.

terminal value. The distresses examined include rutting, raveling, flushing, cracking, and patching, all distresses which are consistent with the Virginia experience. Interestingly, Trucking Research Institute work mentioned earlier showed highly significant correlations between cumulative axle load applications (on a log scale) and pavement distress. Again, this issue is examined elsewhere in the present document.

Pavement Damage Models

Table 1 presents a summary of the types of distresses that have been employed in the literature. A summary of the various pavement damage models can be found in Appendix B.

TABLE 1

FLEXIBLE PAVEMENT DISTRESSES CONSIDERED IN PAST MODELS

Pavement Condition Rating	Transverse Cracking
Serviceability	Fatigue Cracking
Roughness	Low Temperature Cracking
Rut Depth	Skid Resistance
Flushing	Expansive Clays (PSI)
Corrugation	Pot Holes
Patching	Base Failures
Alligator Cracking	Pavement/Shoulder Joint
Longitudinal Cracking	

Review of the existing models most likely to contribute to development of a pavement deterioration model for Virginia indicates that the ***nationwide pavement cost model,*** under development by the Federal Highway Administration (FHWA), is the most promising. Based on the modelling performed in the Federal Highway Cost Allocation Study, existing models are being respecified and data requirements streamlined.[15] The initial models were developed to provide a procedure that can be used to evaluate the costs of pavement damage as a function of vehicle class. The damage equations are functions of pavement structure, the environment, traffic, pavement age, and subgrade

[15] Final Report on the Federal Highway Cost Allocation Study, U.S. Department of Transportation, Washington, D.C., May 1982, p. B-2.

soils. However, the equation for each distress requires a separate load equivalency factor (LEF) table. An attendant program called DAMAGE is used to select the proper LEFs. The LEFs are then used to allocate damage and cost responsibility to the various vehicle classes. Unfortunately, several problems associated with unreasonable results and with poor documentation have led to efforts to refine the models.

In the updated version, regression equations are used to predict loss in serviceability, rut depth, and the amount of fatigue cracking. Input requirements are structural, environmental, and traffic. These equations have been incorporated in an updated DAMAGE program which can be applied to 40 predetermined load configurations. Again, LEFs are used to allocate the responsibility to each class. Individuals in the FHWA again characterized the results as "unreasonable" such that the update has never been officially published.

The model based on Economic Analysis of Roadway Occupancy for Maintenance and Rehabilitation (EAROMAR) is also promising as an alternative. The EAROMAR model was developed at the Massachusetts Institute of Technology (MIT) for the FHWA in 1984. It contains no newly developed models, but is an aggregation of models from various sources. Predictive damage models address serviceability, roughness and several key distresses. According to the researchers, "a wide array of input data is required to drive the system; structural characteristics, pavement condition, environmental data, traffic (loads and composition), maintenance and rehabilitation policies, cost/productivity data, and economic data." The ESALs associated with each vehicle class must be calculated and loaded by the user. The program can then allocate the damage and costs back to vehicle classes. A major disadvantage of the EAROMAR model is its complexity.

In 1986 the FHWA updated EAROMAR to incorporate the AGENCY model within its framework. All of these models were derived from the AASHTO Guide for Design of Pavement Structures - 1986. EAROMAR includes recent modifications, based on mechanistic considerations, to the original AASHO Road Test pavement performance equations. Required inputs are reliability (the probability that the pavement will not fail prior to the end of its design life), predicted ESALs, loss in serviceability, and subgrade resilient modulus. These inputs or their surrogates are available in most department of transportation databases.

The flexible pavement element of the AGENCY model is based on flexible pavement damage equations developed for Brazilian roads by the World Bank. It calculates equivalent uniform annual costs (EUAC) from maintenance expenditures related to loss in serviceability and to distresses. The model will not consider specific vehicles. Instead, the ESALs estimated for a traffic stream are input along with a growth rate. While the model has generally given reasonable results, it has not been widely used due to its demands for a comprehensive database of site specific maintenance costs not often available in DOTs. While the program now is considered to be complete and functional,

it still had not been thoroughly tested. Also, the computer code is considered "tightly integrated" making it not readily adaptable to many users.

The Highway Performance Monitoring System (HPMS) analytical process was developed by the planning division of the FHWA and was intended to provide a means of analyzing the huge HPMS data base of some 90,000 roadway sections across the country. The model contains deterioration equations based on the AASHO Road Test and is capable of dealing with maintenance and rehabilitation costs, reconstruction costs, and user costs. Unfortunately, use of the model in cost responsibility studies is limited by its inability to effectively address individual traffic mixes (the traffic input is overall average ESALs per vehicle).

That criticism does not apply to NULOAD. This model was developed in 1979 by Austin Research Engineers under contract to FHWA. The purpose was to determine the effects of changes in truck size, weight, and configuration on pavement performance and the associated costs. The program predicts performance and costs for both existing and proposed axle load limits. It can accommodate up to ten trucks in the traffic stream. The model uses some modifications of the AASHTO performance equations to predict when pavements will reach terminal serviceability. The model is data intensive, but was considered by the reviewers to be the closest of any individual model to meeting their cost allocation objectives.[16]

Conclusions From Literature Review

The state-of-the-art has not progressed to the point where acceptable models are available for testing. Based on the models considered by the SJR 238 study team, it is apparent that the issues of cost responsibility as associated with pavement deterioration under traffic are extremely complex and that there is no widely acceptable model for analyzing those issues. [17] [18] For this reason the team recommends that, with the exception of in-house regression modeling done as a part of this study, the Department make no immediate attempts to model pavement deterioration through mechanistic or empirical models available at this time. Rather, the Department should position itself

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[16] Interim Report, Pavement Cost Model for Truck Policy Analysis, U.S. Department of Transportation, Federal Highway Administration, Washington, D.C., March 1989.

[17] Arturo Villarreal, Alberto Garcia-Diaz and Robert L. Lytton, Pavement Cost Allocation Model Updates, U.S. Department of Transportation/Federal Highway Administration Contract No. DTFH61-87-R-00021, Washington, D.C., September 1987.

[18] Monty G. Myers, Stephen B. Seeds and B. Frank McCullough, Interim Report, Pavement Cost Model for Truck Policy Analysis, U.S. Department of Transportation/Federal Highway Administration, Contract No. DTFH61-68-C-0091, Washington, D.C., March 1989.

through the identification and development of the proper databases to make use of the model to be released in 1992 by FHWA as the ***nationwide pavement cost model.***[19]

Pavement Deterioration Modeling

As discussed in the previous section, one of the objectives of SJR 238 was to develop pavement deterioration models with existing data. The purpose of this task was to more equitably allocate pavement reconstruction costs to vehicle classes based on the amount of damage caused. Currently, pavement reconstruction costs are allocated using the same methodology as used for construction costs of new pavements. This objective involved determining the statistical relationship between vehicle loadings and the resulting damage caused to pavements. In order to test the feasibility of developing such models, data from the PMS were examined.

Theoretical Background

The relationship between pavement deterioration and traffic loads have been defined using an empirically determined formula developed from the AASHO Road Test. The resulting relationship is of the following form:

$$g = A * ESAL^{B}$$

where g is a distress function denoting loss of serviceability (or, the damage to the pavement), ESAL is the cumulative 18,000 lb. axle loadings on the pavement, and A and B are model coefficients. Expressing the equation in logarithmic form results in a straight line function with a slope of B and an intercept of the logarithm of A:

$$\log g = \log A + B * \log ESAL$$

From a theoretical perspective, the intercept represents the point where distress is initiated. The slope denotes the unit amount of damage caused by a unit increase in load. Since ESALs are measured on a logarithmic scale, the damage to the pavement will be increasingly greater for increasing ESALs. That is, it increases exponentially.

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[19] K. H. McGhee, Virginia Transportation Research Council, Charlottesville, Virginia, and Walter Manning, Federal Highway Administration, U.S. Department of Transportation, Personal Communication, September 22, 1991.

Data Sources

The data used for this analysis come from the PMS. This system was developed by VDOT's Maintenance Division to track the condition of every interstate and primary roadway segment across the State. Information concerning each roadway segment is updated on a two-year cycle from data collected by field personnel. These data consist of a series of subjective ratings of the severity and frequency of each segment's observed distresses (longitudinal cracking, rutting, pushing, ravelling, and patching).

The database consists of information on the location of each roadway section, the date the segment was last resurfaced, a subjective rating of the smoothness of ride, component ratings for the different types of distresses, and an estimate of the cumulative number of ESALs on the segment since it was last resurfaced. In addition, traffic counts, climatological zone, and a measure of the strength of the supporting soil (soil support value, or SSV) have been appended to the database.

The variable used in Virginia to measure the amount of damage that a road has experienced is the Distress Maintenance Rating (DMR). The DMR results from a combination of the five component stresses. In the DMR system, a new or newly resurfaced pavement will have a value of 100 if there is no visual evidence of distress. As the pavement ages and is subjected to traffic loadings, distresses appear and the rating will decrease to a lower value. Minimum thresholds have been set for the determination of which roadway segments are in need of rehabilitation.

As indicated, data for this study represent all roadway segments for the primary and interstate systems. Historical data for the primary system were available for 1983, 1985, 1987, 1989, and 1990. Interstate segments were measured in 1986, 1988, and 1990. The analyses in this study were performed for each study year individually and every combination of contiguous years. For example, interstate models were tested for 1986, 1988, and 1990 separately, as well as for 1986/1988, 1988/1990, and 1986/1988/1990 taken together.

Preliminary Modeling Approach

Many different statistical techniques were applied to the pavement data in order to identify an appropriate modeling approach. The first method applied was factor analysis.

Factor Analysis

Factor analysis is a statistical technique which reduces a set of variables into a smaller set of factors. The procedure formulates linear combinations of related variables and enables the researcher to identify the true underlying dimensions in the dataset. These factors can then be used as independent variables in other analyses. A common

purpose for using factor analysis is to eliminate multicollinearity between variables. Multicollinearity between predictor variables may be a problem in regression because it can cause the results of a regression analysis to be biased. That is, parameter estimates and statistical tests may not represent the true relationships that exist in the data.

Factor analysis was performed on all of the variables considered for predicting pavement damage. These variables were daily ESALs, cumulative ESALs, years since last resurfacing, climatic zone, soil support value, subjective ride rating, and the average daily traffic (ADT) for cars, buses, 2-axle 4-tire trucks, 2-axle 6-tire trucks, single-unit trucks, tractor trailers, twin trailer trucks, and all vehicles. The analysis suggested that there were five underlying dimensions for these 11 variables: (1) a heavy truck dimension (represented strongly by both ESAL measures and the ADT for combinations and all vehicles), (2) a light truck dimension (all other vehicle ADTs), (3) a factor for climatic zone, (4) a factor for SSV, and (5) the subjective ride rating.

The subjective ride rating must be used with caution. The variable serves as a unique predictor of DMR from a statistical perspective, however, its practical interpretation is not that much different than the DMR. Using this variable in a model will yield an empirical relationship that has limited functional value in assigning roadway costs.

Regression Analysis

The factors described above were used in regression analysis for the prediction of roadway damage. In addition, individual variables were chosen to represent each of the factors based on the highest correlations with the individual factors (factor loadings), and were used in regression models. Models were developed individually for all roadways, and for roads by climatic zone, SSV, and climatic zone and SSV taken together. Separate analyses were done for primary and interstate roads for the combination of years mentioned earlier. The results of the regressions varied in terms of statistical fit, but all used similar variables. Generally, the statistical fit of the models improved when separate models were developed for climatic zones or SSV values, and was the best when developed for climate by SSV group. Regression models for each of the component distresses provided poorer statistical fits and thus were abandoned.

Model Selection

The form of the models to be estimated were based on the original model developed from pavement deterioration theory. In addition, interactive terms for other causes of damage were included as possible models. The approach taken here was to model the effects of ESALs on pavement deterioration; damage caused purely by other factors was disregarded. The proportion of the damage attributable to ESALs could be used to determine the portion of total costs that could be allocated to vehicle classes based on the ESALs accumulated in each class. This proportion is measured by the coefficient of

determination. The models estimated were a series of models incorporating ESALs and interactive terms for ESALs with ADT, SSV, and climate.[20] All model terms were expressed as exponential relationships; that is, the variable raised to a power. The regression technique provided estimates of these exponents. These models were estimated for primary and interstate roads separately and for the combination of years mentioned above.

Model Estimation

The model estimation process involved testing the above models for the best statistical fit. Measures used were the coefficient of determination, R^2, which measures the amount of variation in damage that is explained by the model, and the square root of the mean squared error (root MSE), which indicates an average error for all of the roadways (squared values are used so that positive and negative errors do not cancel each other out). The model with the highest R^2 and the lowest root MSE provides the best statistical fit.

All of the models were estimated using nonlinear ordinary least squares and were adjusted for serial correlation using the Cochrane-Orcutt procedure. These techniques were used to assure that the resulting models did not violate any of the requirements of the regression technique.

The regression equations resulting from this analysis provided statistical fits that were better than those achieved in the 1991 Vehicle Cost Responsibility Study and provided models that were a step in the right direction in the modeling of roadway damage. The results were not inconsistent with results found using the design-based approach, and the differences that were produced do not warrant a change in methodologies at the present time. When assessing the effectiveness of a new procedure for tax policies, it is essential to ensure that the procedure achieves a higher standard of performance. The regression models developed in this study are not statistically robust enough to be a basis for tax policy. The modeling process, however, does warrant further study.

DATA COLLECTION PLAN

One mandate of the continuation of the Cost Responsibility Study was to identify information required to perform future cost responsibility studies and to develop a plan for data collection in order that the data will be available when needed. Cost

[20] Models were tested for ESALs alone, ESALs with ADT, SSV, and climate interaction terms individually, and every combination of interactive terms.

responsibility studies are by their nature data-intensive, and the accuracy with which they can assign costs to vehicle classes is dependent on detailed data.

Data Used in SJR 121

The data used in SJR 121 fell into four categories: expenditures, vehicle activities, revenues, and highway descriptors. Many, but not all of these data were available at VDOT. Other agencies from which data were obtained were the Department of Motor Vehicles and the State Corporation Commission.

Expenditure data were categorized by program in order to allocate the proper amount to common costs, road construction, and bridge construction. Vehicle counts, weights, and vehicle miles traveled (VMT) were used to classify traffic by vehicle class and weight group. Highway descriptive information was used to delineate costs for bridges by type of design in order to accomplish bridge cost allocation. Revenue data were used to assign the amount of user taxes and fees paid by each class of vehicles. The data and data sources that were used in SJR 121 are shown in Table 2.

Additional Data for the Next Study

The information shown in Table 2 will be needed for the next cost responsibility study either from the same sources or from new sources. In specifying plans and proposals for data collection and processing for future studies, one must bear in mind that, without a directive to continue certain data collection, the same data will not necessarily be available. For example, in the 1990 study the Summer Survey was used to develop data on vehicle weight by VMT, but the Summer Survey has already been discontinued. Another example is that, between the 1981 study and the 1991 study, traffic counts on the secondary system were no longer collected. However, the new systems described in the next section will provide data that are superior to the discontinued ones.

When the Bid Analysis and Monitoring System (BAMS) data were combined with fiscal data for the 1990 study, the lack of a cross-reference field with an identical format prohibited electronically matching bid estimates with expenditures on many projects. An identical format also inhibited a complete match of BAMS estimates with bridges in the Bridge Inventory. A universal project number to be used in each system is being developed as part of Phase II of the Financial Management System (FMS), making it

TABLE 2

DATA USED IN SJR 121

Data Type	Data	Data Source
Expenditures	Program Expenditures	Reconciled Fiscal Records from Fiscal
	Maintenance Expenditures by Activity	A17-1000-03 from Maintenance
	Project Roadway Expenditures (ROW, PE, CE, Construction)	BAMS Data from Construction and Fiscal Tapes combined by Information Systems
	Project Bridge Expenditures	Final Payment in BAMS
	Drainage Projects	Final Payment in BAMS
	Elements of Roadway Projects (pavement, grading, etc.)	Bid Estimates in BAMS
Vehicle Activities	VMT in Vehicle Class by Administrative System	VMT from HPMS was estimated for Administrative Systems by Traffic Engineering
	Historical Annual VMT for Heavy Trucks on Interstate, Arterial, and Primary Roads	Travel Records from Traffic Engineering
	Project ADT	Project File in L&D
	Vehicle Weights by Vehicle Classification	Summer Survey and WIM
	Number of Public Use Vehicles	Registrations from DMV
	Mileage and Weight of Public Use Vehicles	Survey of Municipal Governments and Central Garage
	Number of Vehicles	Registrations from DMV
Highway Descriptors	Number and Types of Bridges	Bridge Inventory System
	Bridge Plans	B-79 report from Information Systems
Revenues	Hauling Permits (number, mileage, fees)	Maintenance Division and DMV
	Motor Fuel, Special Fuel, Road Use Tax	CARS Report #1273
	Motor Vehicle License Fees	DMV Special Study
	Motor Vehicle Sales and Use Tax	DMV Special Study
	International Registration Plan	CARS Net Revenue Report
	Truck Tire Tax	Research Council Attribution
	Sales Tax	DMV and R. L. Polk Special Study
	Heavy Use Tax	DMV Registration Records and Truck-Trailer Survey

possible to cross-reference projects among the various operating systems used by the Department including fiscal data, BAMS, the Bridge Inventory System, and HTRIS.

In order to analyze cost responsibility for more vehicle classes or within weight groups, it will be necessary to relate operating and registered weights of vehicles. Revenues are collected by registered weights; however, costs are calculated based on operating weights. The operating weight distribution of each vehicle determines the amount a vehicle should be paying from an occasioning perspective. To relate this to what is actually paid, the registered weight for the vehicle needs to be determined. A special study would need to be performed using the best technology available at the time of the next cost responsibility study to ascertain the relationship between registered and operating weights.

As recommended in the section on Pavement Deterioration Modeling, VDOT should position itself to make use of the ***nationwide pavement cost model*** by identifying and developing the needed data bases.

Among the data elements needed are:

- Pavement condition parameters (roughness, cracking, rutting),
- Threshold values or action levels for the condition parameters,
- Pavement maintenance and rehabilitation costs as they relate to condition parameters,
- The distribution of vehicles by class in the traffic streams associated with the various functional or administrative systems,
- The distribution by axle loads of the weights of vehicles, and
- Growth rates for vehicle class and weight distributions.

New Systems for the Next Study

WIM and the Traffic Monitoring Guide

New technologies will also change the data available for the next cost responsibility study. WIM studies, which were a new data source for the 1990 study, will have been conducted at a larger number of sites and should be an important data source. The Traffic Monitoring Guide, which suggests sampling methodologies for gathering traffic data for federal reports, is currently being redesigned to reflect the use of WIM

technology. A library of data from all WIM studies will be maintained at the Department, making such data available for research.

SHRP

The Strategic Highway Research Program, now being implemented, will provide continuous WIM data collection as well as pavement performance indicators for sites in Virginia. This program will, for the first time, provide vehicle weights and classifications for 24 hours per day, 365 days per year on 48 lanes of traffic. By the time the next cost responsibility study is begun, several years of data from these sites will be available. By providing accurate information on vehicle weights, the SHRP data will allow the truck factor used in pavement management to be calculated more precisely. Because the truck factor is based on the weight distribution taken from trucks that were statically weighed, the number of trucks in the sample was limited. SHRP will greatly increase the sample size and provide a better statistical measure of the true weight distribution of trucks using the highways of the Commonwealth. SHRP data will be used in place of the Summer Survey in the next cost responsibility study and will provide more reliable data.

HTRIS

The Highway and Traffic Record Information System, which is currently being developed at the Department, will be another data base used in the next cost responsibility study. Many types of data that are now kept in various formats will reside on this system and be tied together through a common locator. The subsystems which are, or will be, on HTRIS include the road inventory, pavement management, traffic count analysis, structure inventory, and highway performance monitoring.

There may well be other technologies and systems in place by the next study. Those discussed above are either in place or being installed.

Revenue Data in More Classes

The number of classes for which cost responsibility could be analyzed was limited by the fact that revenue data are not collected by many vehicle classes or by weight. For SJR 121, revenue data were spread over five classes; in contrast, cost data were available for 13 vehicle classes. One recommendation of SJR 121 was to determine the type of information that would be required to collect revenue data for a larger number of classes and across weight groups.

The two agencies that collect revenue data are the SCC (fuel and road use tax) and DMV (registration and vehicle sales tax). The SCC reports that they cannot collect data

by vehicle type on the present tax forms because companies can only report total fleet mileage. They presently obtain fleet mileage and average fleet miles per gallon in order to calculate fuel and road use taxes for the carrier.

The problem in collecting registration and vehicle sales tax by vehicle classes is that, in Virginia, trucks and trailers are registered separately. Typically, trucks and tractor-trailer units are registered based on the highest expected gross weight for any planned combination, however the power unit is not "married" to any one trailer and operates in different combinations over a year.

If, when the next cost responsibility study is conducted, special studies for revenue data do not collect information on more vehicle classes, the study will still be limited to only five classes of vehicles. One of these classes will contain all combination units, singles and doubles, making it impossible to ascertain cost responsibility for different combinations and weights.

The General Assembly may wish to mandate special studies for the first year of a cost responsibility study that would require:

- A special study by the SCC to determine payment of road use taxes by type of truck,
- A special study by DMV of sales and use taxes paid by vehicle class, and
- A special study by DMV of registration fees by vehicle class.

IMPACT OF FEE INCREASES ON THE INDUSTRY

Senate Bill 895 - 1991 Session

Senate Bill 895 of the 1991 Session was introduced to correct inequities within the structure of highway user fees that were found in SJR 121. The bill was designed to recover some of the costs not currently paid by the various truck classes and thereby make user fees more equitable among the various vehicle classes. There also was a substitute version of SB 895 introduced later during the Session. It did not, however, improve equity and was not reported out of the Senate Transportation Committee.

As part of this study the Department was asked to evaluate the tax increases proposed in SB 895 with respect to cost allocation equity and determine the effects of a tax increase on the industry.

The key provisions of SB 895 were:

- Temporary registration fees for heavy trucks and equipment were changed from ten cents per mile to $2.50 for each 1,000 pounds of registered weight. This would have made this registration fee more consistent with other registration fees for cars and trucks,

- The flat fee component of truck registration fees were increased and a 50 percent increase in the portion of the fee based on weight was identified. This would have helped recover costs from two- and three-axle trucks, and to a lesser degree from combinations,

- A surcharge of two percent was added to the motor vehicle sales and use tax for all two- and three-axle trucks purchased in Virginia. These truck classes were found to be underpaying by the greatest amount,

- The road tax was increased from 19.5 to 21.5 cents. This would recover costs primarily from large combination trucks. This change would have ensured that non-resident trucks using Virginia highways help contribute more equitably to the costs they occasion,

- Hauling permit fees were modified to include a flat fee, as well as a fee based on the amount of excess weight and distance traveled, and

- Free commodity overweight permits would be discontinued. The fee for containerized freight would have been a flat charge plus an amount based on the weight and distance traveled. Haulers of coal, concrete, solid waste, and farm produce would have paid a flat fee of $350 per year.

The revenue-to-cost ratio of cost responsibility under the current system, as found by SJR 121, and under the original SB 895 are shown in Table 3.

TABLE 3

REVENUE-TO-COST RATIO

Vehicle Class	SJR 121	SB 895
Passenger Vehicles	1.06	1.03
Buses	.30	.30
Light Trucks	.77	.96
Single-Unit Trucks	.85	.98
Combination Vehicles	.93	.96

The improved equity shown in the table above is particularly evident in the truck classes; trucks would have been paying 96 or 98 cents for each dollar of cost responsibility. SB 895 would have reduced the underpayment of all three truck classes: light trucks from $18 to $3 million, single-unit trucks from $10 to $1.5 million, and combinations from $17 to $7.7 million assuming a $1.5 billion program level.

Overweight Trucking Operations

One issue addressed by Senate Bill 895 and the Vehicle Cost Responsibility Study was the amount paid by overweight trucks traveling on Virginia's roads. Overweight trucking operations fall into one of three categories: (1) vehicles traveling under a hauling permit, (2) trucks operating with an overload permit, and (3) illegal operations. All of these overweight vehicles are putting extra stress and wear on the pavements of the Commonwealth. To achieve equity in cost responsibility the fees for permits and fines for illegal operations should capture the costs of pavement damage. Increases in the fees for permits were part of SB 895. A study of the fines for liquidated damages is recommended; the level of the fine has not changed in 35 years and a review was recommended in Senate Document 6, 1982 and reiterated in Project Streamline. Details on overweight operations are found in Appendix C.

Impact of Transportation Taxes and Fees on the Trucking Industry

The implementation of increased taxes and fees on vehicles traveling the roads of the Commonwealth would impact Virginia trucking operations. To begin assessing the extent of such impact, a review of the literature concerning the impact of increases on the industry in the 1980's follows.

Description of the Industry

Despite several legislative and economic challenges during the 1980's, the motor carrier industry has continued to play a vital role in the economy of both the Commonwealth of Virginia and the United States. At the national level, trucking industry revenues represent close to five percent of the Gross National Product (GNP). Trucks carry over 40 percent of the intercity tons transported in the U.S., representing almost 77 percent of freight revenues.[21] In 1989 the Virginia trucking industry moved almost 80 percent of all manufactured goods in the state and employed one of every eleven workers

[21] Peter Bradley, Rapid Transition Marks the Industry: Purchasing, 109(1) July 19, 1990, pp. 64-74.

statewide.[22] Furthermore, between 1985 and 1989 trucking industry employment increased 21 percent, an amount greater than that of state industry as a whole.[23]

The magnitude of these contributions to the state and national economy necessitates a consideration of how any proposed tax and fee changes might affect both the health of the trucking industry and those that it serves. As suggested by Toft and Sinha,

> Every public policy proposal that affects the bottom line of business such as tax rates, tax abatements, loans, and regulatory fees (including vehicle registrations) must be reviewed in light of its impact on the local and statewide economy and how it changes the competitive position of the state vis-à-vis other states.[24]

This report addresses the impact of the transportation tax and fee increases proposed in SB 895 on the trucking industry in Virginia. This consideration of impacts includes an examination of the distinctive challenges experienced by motor carriers during the past decade, a review of literature on tax increases and demand for trucking services, a description of the industry in Virginia, and an estimate of operating cost increases proposed in the bill.

The 1980's: A Decade of Change and Challenge for Motor Carriers

Several events influenced motor carrier operations during the previous decade. These include the Motor Carrier Act (MCA) of 1980, the Surface Transportation Assistance Act (STAA) of 1982, the Deficit Reduction Act of 1984, economic downturns in the early and later years of the decade, economic expansion in the middle years, and legislated tax increases in a number of states including Virginia.

The 1980 Motor Carrier Act

The 1980 Motor Carrier Act was designed to deregulate the industry by easing entry into the market, encouraging improved quality of service, and permitting more competitive pricing both within the trucking industry and between freight carriage modes.

Effects of the 1980 Act have varied depending on industry sector. The trucking industry includes private carriers and for-hire carriers, which are sub-divided further into

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[22] Trucking in Virginia, American Trucking Association, Atlanta Georgia, 1991.

[23] Ibid.

[24] Graham S. Toft and K. C. Sinha, Possible Impacts of International Registration Plan on Trucking Industry and State Economy: A Case Study of Indiana. Transportation Research Record, #1038, 1985, pp. 77-84.

the truckload (TL) and the less than truckload (LTL) sectors. TL carriers move one load from an origin to a destination while LTL carriers transport and disperse several "loads" through a network of terminals. Eased market entry has occurred to a significant degree in the TL sector of the industry, but consolidation has marked the LTL sector: ten of the largest LTL carriers have two-thirds of the market share.[25]

One of the more positive effects for shippers was the greater rationalization of routes allowed by the Motor Carrier Act. Prior to deregulation, carriers were required to obtain certificates of authority from the Interstate Commerce Commission (ICC) to serve certain routes or markets. Carriers were often unable to change authority if freight demand changed. Deregulation permitted much improved organization and efficiency, however. Flexibility in rate charges to reflect differentiated service components now offered to a shipper was also encouraged.[26]

Shippers have benefitted from increased quality and from lower costs. Deregulation and recessionary economies have exerted strong downward pressure on rates, affording many shippers substantial bargaining power. Rate discounting has slightly increased competition between motor carriers and the rail industry, though mostly for large, truckload shipments in which travel time is less important and rail is competitive. However, for most shippers the competition continues to be intramodal.

Although deregulation has led to several improvements within the industry, the last decade has been a difficult one for many operators.[27] Many analysts argue that increased competition and downward pressure on rates combined with increased taxes and fuel costs have prevented revenues from keeping pace with operating expenses. Figure 1 (United States Growth Rates, 1979-1987) shows that the motor carrier industry experienced a greater failure rate during the early eighties than U.S. industries taken as a whole. However, since 1983, trucking bankruptcies have been less than would be expected from the overall industry trend. Significantly more TL competitors tried to enter the market during the eighties and consequently constitute the largest percentage of these failures. However, of the few LTL firms that tried to establish themselves in the

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[25] Nicholas A. Glaskowsky, Effects of Deregulation on Motor Carriers, ENO Foundation for Transportation, Westport, Connecticut, 1985.

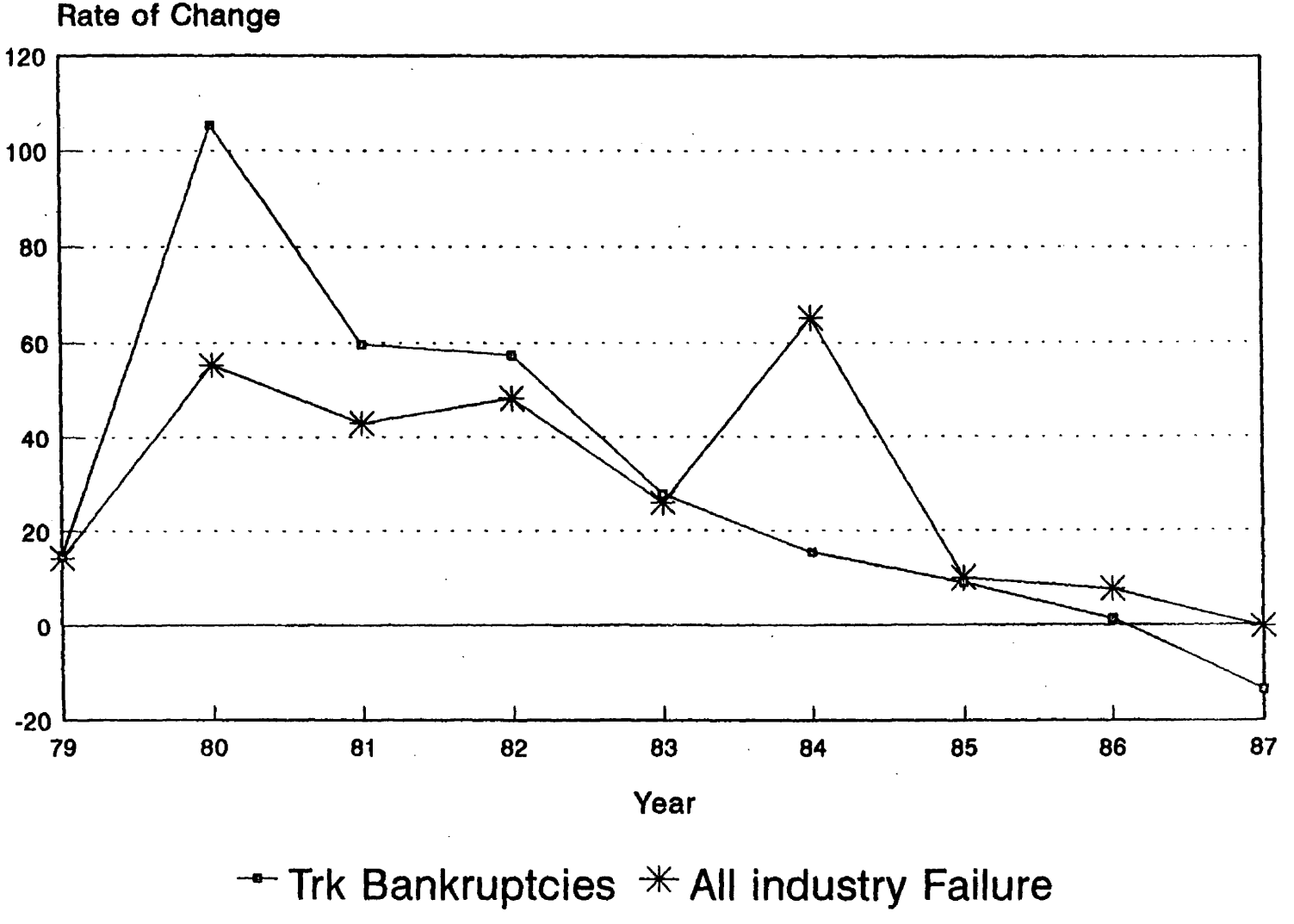
[26] Ibid., p. 15.

[27] Peter Bradley, Rapid Transition Marks the Industry: Purchasing, 109(1) July 19, 1990, pp. 64-74.

FIGURE 1

United States Growth Rates, 1979-1987

Trucking Failures, All Industry Failures



Sources: Transport Topics, Business Statistics, Surveyof Current Business, SCC Data

market, no large (ICC Class I) companies succeeded and only a few Class II and III competitors did so.[28]

Figure 2 (Virginia Growth Rates, 1979-1988) compares the number of trucking establishments in Virginia with the number of overall business establishments in the state. (Establishments are defined as single physical locations where business is conducted; changes in the number of overall businesses established in Virginia can be used to indicate the level of entry, exit and consolidation.) Here the rate of change in the number of trucking establishments has followed a trend similar to that of industry establishments as a whole. Figure 2 indicates that in the eighties the Virginia trucking industry experienced entry and exit trends similar to that of other industries except in the latter years of the decade.

Predictions for the Future of the Trucking Industry

As turbulent as the last decade has been, estimates of the future of the trucking industry vary. Most of the predictions are for better times, though to varying degrees. Roberts and Fauth predict that as the U.S. achieves a better trade balance, international and intermodal exports will climb and trucks will benefit.[29] They suggest that the LTL sector will continue to struggle with decreasing volume unless members can cut labor costs thereby lowering rates and achieving greater backhaul competitiveness. Roberts and Fauth also predict that specialty carriers will experience only modest growth toward the end of the century and that competition between rail and truck will continue to increase as both work to incorporate technological improvements.

Most forecasters indicate that an increased emphasis on technology will enhance the quality of service and allow the trucking industry not only to maintain its market share but also to achieve greater profit margins. Among the technology gains are new air ride suspension systems that decrease freight damage, satellite communication networks that permit constant freight tracking, continued engine improvements that increase gas mileage thereby lowering operating costs, and computerized intermodal arrangements that streamline delivery. Still, competition within the industry is expected to remain keen. Owner-operators and small companies may be hit hardest by the emphasis on technology improvements, because they may lack the capital necessary to employ new techniques and systems.

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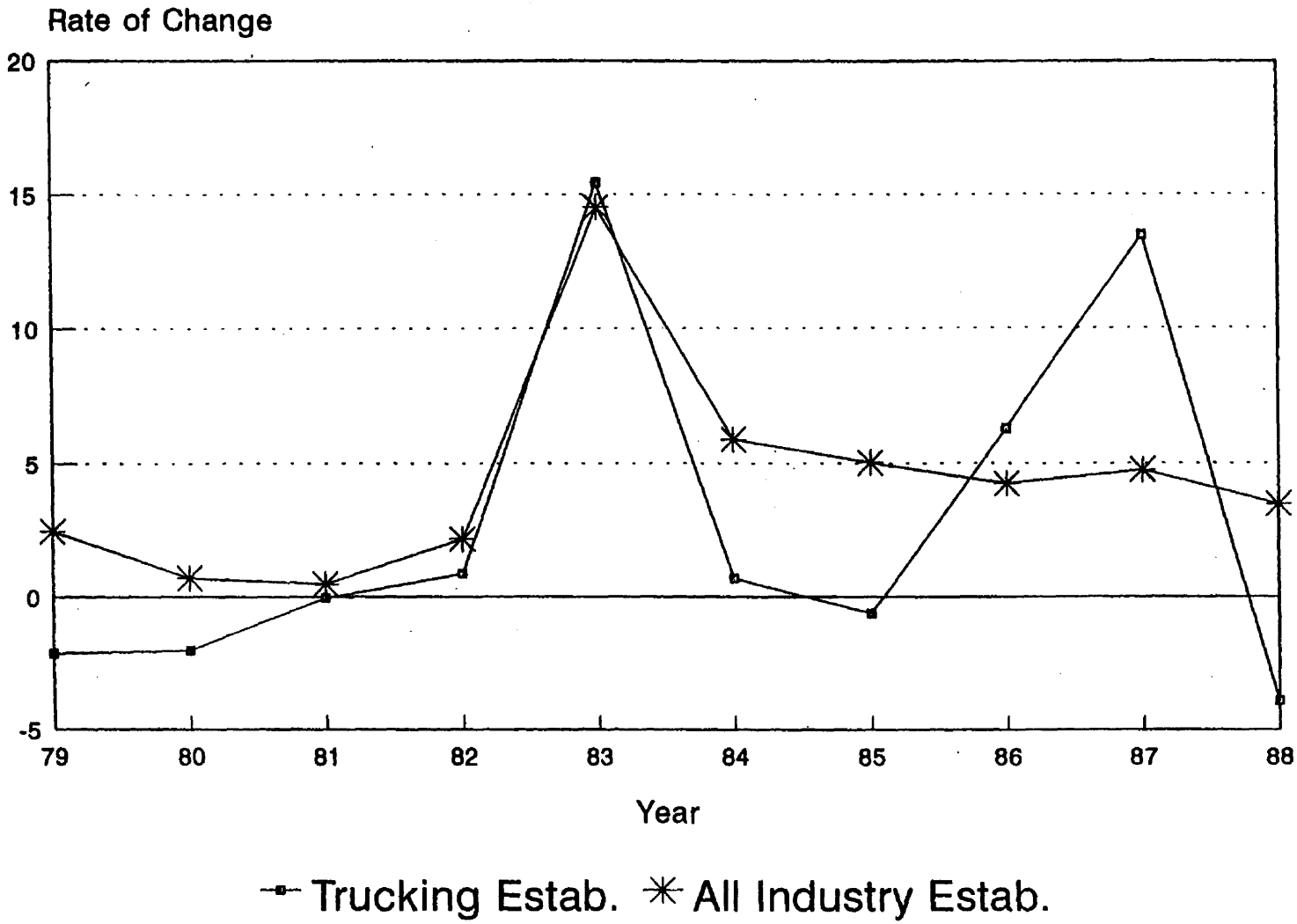
[28] Nicholas A. Glaskowsky, Effects of Deregulation on Motor Carriers, ENO Foundation for Transportation, Westport, Connecticut, 1986, p. 8.

[29] Paul O. Roberts and Gary R. Fauth, The Outlook for Commercial Freight: In A Look Ahead: The Year 2020, Transportation Research Board, Washington, D.C., 1988.

FIGURE 2

Virginia Growth Rates, 1979-1988

Change in Number of Establishments



Source: County Business Patterns, Virginia

Impact of Prior Tax and Fee Increases on the Industry

The trucking industry faced few increases in taxes and fees at either the federal or state levels until the 1980's. Then for the first time in 25 years, the federal government increased fees. An overview of these increases follows in order to provide some insight into how the increases proposed in the 1991 General Assembly might affect the trucking industry in the Commonwealth.

The 1982 STAA and the 1984 Deficit Reduction Act

The 1982 Surface Transportation Assistance Act and the 1984 Deficit Reduction Act are significant federal legislative initiatives to keep in mind when evaluating the industry trends shown in these graphs. The 1982 STAA raised federal trucking taxes for the first time in 20 years, reapportioned the tax burden to heavier trucks, and relaxed size and weight regulations. The 1984 Deficit Reduction Act placed a cap on the heavy vehicle tax, but further increased the fuel tax, thereby shifting some of the burden back to lighter vehicles. Together these changes combined to increase the average federal tax on a tractor trailer by 125 percent from 1982 to 1985.[30]

Changes in Truck Taxes in Virginia

The Virginia General Assembly also increased taxes on the trucking industry in the 1980's. In 1982 the Legislature raised the registration fee for trucks over 10,000 pounds for the first time in almost 20 years and increased the registration fee for smaller trucks for the first time since 1974. Fees for trucks less than 10,000 pounds rose again in 1986, the year the General Assembly increased the vehicle sales and use tax to three percent from two percent, the rate originally legislated in 1966.

The 1982 Surface Transportation Assistance Act Fee Impacts

After the increase in 1982, federal transportation taxes ranged from 1.3 percent to 3.4 percent of total vehicle costs, both ownership and operating, and averaged about 2.6 percent of these costs.

The Federal Highway Cost Allocation Study (FHCAS) estimated 1985 vehicle costs and used these as a base case against which to compare several alternatives: a 1985 tax structure based on a 36.6 percent increase for each vehicle class; a group of options that matched user charges with cost responsibilities and eliminated existing tax exemptions; and an option that matched user charges with cost responsibility and maintained existing exemptions. In these scenarios fuel tax would have increased 45

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[30] William L. Maraschiello, Will Taxes Run Over Trucking, Industry Week, 228, March 1985, pp. t25-t28.

percent and use tax anywhere from 110 percent to 988 percent, depending on carrier operations.

The analysis revealed that total vehicle cost increased an average of 0.9 percent for all trucks types across all alternatives, with some smaller trucks experiencing a 0.7 percent decrease and other large trucks facing a 3.7 percent increase depending on the tax package. The aggregate net increase of these user charge alternatives amounted to no more than 0.2 percent of operating revenues or 0.6 to 0.9 cents per vehicle mile.

In order to estimate the effect of the tax increases on industry profit, the researchers performed an analysis based on three assumptions: (1) that all new vehicle costs would be passed on to shippers; (2) that all other costs are proportional to traffic level; and (3) that profit per unit is constant. They estimated that the tax and fee proposals would increase the costs of freight shipment 0.2 percent or 0.06 cents per mile, resulting in a loss of 1.5 to 2.0 billion ton-miles from the 93 billion projected ton-miles for 1985. This decrease in truck volume would lead to a profit loss of $5 to $8 million to the trucking industry based on 1985 projected revenues of $4 billion.

Evaluating macroeconomic effects (such as GNP, employment, and price indicators), the researchers determined that "an increase of $2.7 billion in user fees, accompanied by an increase in highway construction expenditures, does not have a substantial impact on macroeconomic indicators".[31] The report demonstrated that although the industry impacts of increased transportation taxes are not negligible, they are not substantial enough to offset the benefits of increased equity in cost responsibility and improved highway funding.

The American Trucking Association (ATA) argued the 1982 STAA's productivity gains were not available to all types of carriers and, because the existing recession combined with deregulation had already made for difficult financial circumstances, the authors contended that the higher taxes would eliminate the "industry's extremely thin, marginal profit levels".[32]

They do not detail the methodology of the study nor the source of the data; however, they report that in 1982 taxes and licenses for Class I vehicles constituted 2.4 percent of total revenues at the existing prevalent 0.5 percent profit margin. The report also pointed out that many firms operated at an expense-revenue ratio over 100 in 1982 and that 43

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[31] Final Report on the Federal Highway Cost Allocation Study, Federal Highway Administration, Government Printing Office, Washington, D.C., pp. VI-84.

[32] The Effect of Increased Highway Taxes on Motor Carrier Operating Expenses and Profitability, American Trucking Association, Washington, D.C., 1983, p. 3.

percent of all carriers ended 1982 with a loss. 1982 was one of the worst recent financial years in the history of the trucking industry. The recession combined with continuing adjustments to deregulation and the subsequent change in tax structure make 1982 a difficult standard against which to evaluate user fees and highway taxes as a proportion of operating expenses and profit yields.

The General Accounting Office (GAO) suggested that while all sectors of the industry could benefit from improved highways, only some were able to take advantage of longer, wider, and/or heavier trucks. Owner-operators and truckers who transported long haul and/or truckloads would not have benefitted from the new regulations nearly as much as short haul, LTL drivers because the weight limit was not increased nearly as much as the length and width. Any trucker who "cubes out" before he "weighs out" (i.e., amount carried is restricted more by volume than by weight limitations) or usually carries relatively lighter loads is reported as receiving a greater benefit.

In terms of passing along the cost through rate increases, the GAO reported that carriers in "clogged" markets would have a difficult time increasing their rates as would those who hauled for industries significantly affected by recession. Accordingly, those carriers who did short haul, LTL carriage of highly valued goods would be best able to pass along higher tax and fee expenses because rate increases would have less impact on the demand for their services than that of the long haul, TL carrier of lower value goods.

Morash and Enis also concluded that owner-operators and firms which use them would be more adversely affected than other industry segments and the most disadvantaged type of carrier would be a specialized, truckload (TL), rail competitor who did not operate in the eastern portion of the United States. This last result arises from the fact that TL carriers could not benefit from the new authorization for doubles and, since longer trailers were already permitted in the East, no new savings would be generated.

In studying whether a tax increase in the form of a weight distance tax could cause a diversion of freight from truck to rail, the FHWA found that it would not unless the increase was significant.[33] This was found to be true even for rail competitive operations. McGinnis, in reviewing 12 studies completed before and after deregulation, concluded that while rates have gained in importance since deregulation, service is almost always more important; price becomes a critical factor after service requirements have been met.[34] His findings suggest that service is at least as important if not more

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[33] The Feasibility of a National Weight-Distance Tax, Federal Highway Administration, Office of Policy Development, Washington, D.C., 1988. p. VII-11.

[34] Michael A. McGinnis, The Relative Importance of Cost and Service in Freight Transportation Choice: Before and After Deregulation, Transportation Journal, 30(1) Fall, 1990, pp. 12-19.

important than rates in gaining a truck firm a contract with a shipper and its piece of the freight transport market.

A University of Montana study investigated the possible effects of a weight-distance tax on the delivered price of goods shipped by truck. The researchers reapportioned the entire tax increase onto the price of goods in an effort to consider the maximum effect on consumers. The increase in cost per mile expenses for the trucking industry depended on the type of truck used (i.e., the gross vehicle weight), the intensity of use (i.e., the distance travelled), and the fuel consumed. The researchers issued the following conclusions for the consumer:

> For most goods bought by the consumer, the possible effect of the proposed Montana weight-distance tax is negligible...As a generalization, one may say that the value of materials hauled must be less than three cents per pound for a realistic haul to result in increased charges...the likely increases represent fractions of one percent of retail prices. Many of these increase would be lost, both in magnitude and traceability, in the general costs of doing business.[35]

Elasticities of Demand for Motor Carriers

A number of studies investigated whether or not service characteristics affect the demand for truck transport as well as how responsive the market is to changes in motor carrier rates (i.e., a change in the quantity of truck transport demanded given a change in the price of either intra- or intermodal competitors). These studies suggest that the price elasticity of demand for truck transport is slightly less than or close to one. This implies that motor carriers can increase rates without losing substantial market share or total revenue. Results show that intermodal competition does exist between truck and rail in some markets, but that the trucking industry has advantages in most areas. Shippers of high value and/or perishable goods as well as others for whom transit time is an important service component prefer the truck mode. Most of the researchers that investigated quality of service variables found that these variables were the significant determinants of modal choice. The major competition for high cost or time sensitive products is within the trucking industry itself.

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[35] William S. Peters and Frederick W. Harris, The Effect of Commercial Vehicle Taxation on Consumer Prices, Montana State University, School of Business, 1956.

Indirect Impacts of Increased Trucking Taxes and Fees on Shippers and Consumers

Most of the literature indicates that segments of the trucking industry that are able to do so will in all likelihood pass along to shippers and consumers any increases in operating expenses. Given this logic, any increase in highway taxes, fuel taxes, or registration fees imposed on a trucking company would theoretically be reflected in higher rates for shippers, who would charge higher rates to wholesalers, who would charge higher rates to retailers, and so on to the consumer.

A number of variables influence the probability that a motor carrier can and will increase rates to recover an increase in operating costs. These include the general economic climate, the elasticity of demand for the commodity, the elasticity of demand for the trucking service, the proportion of the commodity's total cost comprised of transport costs, competitiveness within the carrier industry, and the ability of that carrier to incorporate productivity improvements that offset an expense increase. As pointed out in the 1988 FHWA Weight-Distance Tax Study, the ability of an operator to pass on increases in operating costs is determined by the type of market in which the carrier operates and its position in that market. If competition is strong and/or demand for the goods carried is relatively elastic, the operator will have a difficult time increasing rates.

Trends during the 1980's indicate that despite federal and state tax increases and rising fuel costs, the substantial downward pressure on rates prevented revenues from keeping pace with costs and led to smaller profit margins.[36] The Wharton Econometric Group (WEFA) found that as the economy began to weaken in the late eighties, demand for trucking decreased while fuel costs increased, allowing motor carriers to pass on only about half their extra costs.[37] Even super-sized truckload carriers like J.B. Hunt began to experience tougher times as its operating ratio (operating expenses divided by total revenues) increased from 77 percent in 1986 to over 90 percent in 1990.[38] An ATA spokesperson noted that costs are rising disproportionately with revenues because the industry continues to adjust to the new deregulated market:

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[36] Peter Bradley, Rapid Transition Marks the Industry: Purchasing, 109(1) July 19, 1990, pp. 64-74.

[37] Freight Rates Move Slowly Despite Higher Fuel Costs: Purchasing, 109(9) Staff, December 13, 1990, p. 39.

[38] John Harris, Rough Road. Forbes, 146(12), November 26, 1990, pp. 209-211.

> The change in these [operating] expenses is transitional--the cost of adjusting to today's freely competitive environment in trucking. Carriers are augmenting their professional staff with sales and marketing executives, pricing specialists, data processing professionals and general managers."[39]

As the market settles down and carriers are able to consider passing on their costs, the shipper and consumer will bear some of the burden of higher operating expenses in the form of higher shipper rates and consumer prices.

Description of the Trucking Industry in Virginia Using TIUS

In understanding the impact of fee increases on the trucking industry it is helpful to have a description of the industry in Virginia. The Truck Inventory and Use Survey (TIUS) provides data that is specific to the Commonwealth.

The Truck Inventory and Use Survey is part of the economic census taken every five years by the U.S. Census Bureau. TIUS is a survey of owners for a sample of private and commercial trucks registered in each state; government owned trucks are excluded from the survey. The study has an expansion factor for each type of truck in each state to allow a description of the population of trucks in each state as well as the country as a whole. TIUS describes the 1987 industry; in this report the vehicle miles traveled has been expanded to 1988. Personal use vehicles and two-axle, four-tire trucks are excluded. In reviewing TIUS data for Virginia, one must remember that no out-of-state trucks traveling in Virginia are included; also out-of-state travel by Virginia registered-trucks is included.

TIUS estimates that 59 percent of trucks registered in Virginia are light single-units, 22 percent heavy single-units, and 19 percent combinations. Of the combinations 89 percent are tractor, semi-trailer trucks. The average VMT per truck for 1988 was 22,069 miles and the total for all trucks registered in Virginia was 2.63 billion; an average of ten percent of this mileage is driven out of state.

The average maximum weight of these trucks is shown in Table 4. For combinations, 1.16 percent average a gross registered weight over 80,000 pounds. The average percent of mileage traveled carrying a full cargo size is reported to be 42.4 percent and the average percent of trucks carrying a full cargo weight is 37.8 percent.

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[39] Truckers Face Ongoing Battle of Higher Operating Expenses, Traffic World , 3(216) Staff, August 27, 1990, pp. 17-18.

TABLE 4

MAXIMUM REGISTERED WEIGHTS OF VIRGINIA TRUCKS

Truck Type	Average Maximum Weight (Mean)	Most Common Maximum Weight (Mode)
Light Single-Unit	17,355	10,000
Heavy Single-Unit	42,176	50,000
Combinations	64,004	80,000

Source: Truck Inventory and Use Survey

Most single-unit trucks operate within 50 miles of their home base: 72.7 percent of light single-units and 65.8 percent of heavy ones. For combination vehicles 42.8 percent operate most of their miles within 50 miles of homebase, 33.1 percent within 200 miles, and 24.1 percent over 200 miles.

Table 5 presents the major business use of the vehicles and Table 6 displays VMT by type of product carried.

TABLE 5

MAJOR BUSINESS USE OF VIRGINIA REGISTERED TRUCKS

Type of Business	Percent of Trucks
Agriculture	17.22
Forestry	4.36
Construction	18.59
Contractor	7.11
Manufacturing/Refining	5.15
Wholesale	8.64
Retail	8.78
Services	4.77
Utilities	3.10
Mining	2.14
Daily Rental	1.21
Not in Use	2.07
For Hire	16.86

Source: Truck Inventory and Use Survey

TABLE 6

1988 VMT OF VIRGINIA REGISTERED TRUCKS BY PRODUCT

Product	Percent of VMT	Product	Percent of VMT
Animal	3.6	Machinery	3.1
Farm	7.6	Furniture	3.8
Foods	12.7	Glass	0.6
Mining	1.5	Textiles	2.0
Building	17.1	Moving Van	1.8
Forest	3.6	Tools	4.9
Lumber	4.0	Refuse	3.1
Paper	3.1	Industrial Water	0.3
Chemicals	2.4	Hazardous Waste	0.4
Oil	4.8	Mixed Cargo	9.9
Plastic	1.3	Miscellaneous	3.1
Fabricated Metal	1.5	Transportation Equipment	2.8
Metal	1.2	Total	100.0

Source: Truck Inventory and Use Survey

Impact Analysis: Taxes and Fees as a Proportion of Operating Expenses

To understand the impact of tax and fee increases on the industry, it is helpful to look at such increases as a proportion of operating expenses. A 1990 Traffic World article indicated that, for truckload firms, tax and licensing expenses comprise on average five percent of all costs to do business, while for less than truckload firms they average 3.26 percent.[40] This will be discussed in a later section. LTL carriers have higher overall

[40] Truckers Face Ongoing Battle of Higher Operating Expenses, Traffic World, 3(216) Staff, August 27, 1990, pp. 17-18.

operating expenses resulting from higher overhead, labor, and purchased equipment and supplies; costs and therefore taxes and fees are a smaller proportion. Several other variables affect the amount of taxes and fees as a part of the total costs to do business, among which is the base state of the vehicles.

A 1987 Distribution article shows that for private carriers, taxes and fees comprise 3.6 percent to 3.9 percent of operating expenses.[41] The authors suggest that straight-truck fleets are more expensive than tractor-trailer fleets primarily because straight trucks are generally involved in shorter hauls in urban areas. Again, as other expenses increase, the percentage of expenses occasioned by taxes and licenses will decrease.

The most readily available operating expense profiles are usually for large Class I and II motor carriers that are required to report their expenses to the Interstate Commerce Commission. A 1989 Commercial Carrier Journal article indicates that taxes and fees comprise an average 4.7 percent of all costs to do business for Class I carriers (those with annual revenues in excess of $5 million).[42] Fuel taxes were responsible for the largest part of this percentage.

These sources suggest a range of percentages that may be distinguished by the type and size of firm examined. These values vary from about three to five percent.

Trucking in Virginia

In order to gain a perspective from the trucking industry in Virginia, contacts were made with trucking organizations and individual truck companies. Questionnaires were sent to 483 companies and 37 organizations. The companies surveyed were drawn from a State Corporation Commission list of companies that have paid road taxes in Virginia; the organization names were provided by the Virginia Trucking Association. Information was requested on operating characteristics (such as LTL versus TL) and operating expenses, as well as responses to tax and fee increases. Unfortunately, due to the low response rate of 15 percent, it is not possible to describe the impacts of tax and fee increases on the industry as a whole. However, the information can illustrate the effects of the tax on particular types of operations and individual companies in the Commonwealth.

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[41] Private Fleet Costs, Distribution, 86 (8) Staff, August 1987, pp. 50-56.

[42] Parry Desmond, Report Reveals Updated Linehaul Cost Data, Commercial Carrier Journal 146(1), January 1989, pp. 45-46.

Case Studies of Individual Companies Operating Trucks in Virginia

The companies that provided information about operating trucks in Virginia were for-hire carriers and private carriers, as well as owner-operators. One company operated nine tractor trailers hauling household goods interstate. The trucks were base-plated in Virginia. Transportation taxes and fees represented 3.6 percent of the company's operating costs. Another company that ran an interstate operation of 147 Virginia-based trucks reported that their fees represented 1.5 percent of operating costs. Most, but not all, of the trucks in the case studies were base-plated in Virginia.

In these examples, total taxes and fees ranged from .96 percent of the total costs for an operation with two vehicles to 6.59 percent for one firm with 147 Virginia-based trucks. The example of the highest proportion of operating costs represented by Virginia taxes and fees was 4.2 percent for a one truck owner-operator; several were more similar to the seven truck firm with 2.75 percent, and one ten truck operator reported 0.70 percent.

When asked how companies generally respond to increases in operating expenses, the following were provided:

- A for-hire transporter operating one short haul, single-unit truck indicated he would increase the rates,
- A for-hire carrier that operates six tractor trailers under a two-year hauling contract would try to absorb increased costs,
- A for-hire less-than-truckload interstate carrier of forestry products who operated four tractor trailers would generally cut expenses,
- A for-hire truckload carrier, with 150 tractor trailers, making short hauls for retail trade would attempt to contain other costs,
- A private carrier of retail trade who operated six less-than-truck-load, single-units would try to increase volume,
- A for-hire operator with three single-units that is a short-haul, general-freight carrier would try to diversify services and operations, and
- A household goods, for-hire carrier operating nine tractor trailers would defer other purchases.

Information From Organizations Representing the Trucking Industry in Virginia

Organizations whose members own and operate motor carriers in Virginia were also contacted to obtain opinions on tax increases. Those who answered represent approximately 19,200 business establishments from the following industries: construction, mining, agriculture, utilities, for-hire transport, daily rental, solid waste, retail trade, contractors and forestry/lumber. They reported profit margins for the industries ranging from 1.5 to 8 percent.

They were asked to rank three categories of tax increases (registration fees, fuel taxes, and vehicle sales and use tax) in order from the most negative impact on operating costs to the least. Eighty percent ranked fuel and road use taxes as having the most negative impact. An equal number identified vehicle sales and use taxes and registration fee increases as the second most negative impact. A representative of short haul, intrastate construction companies felt registration fee increases had the most negative impact.

When asked if tax and fee increases affected their members differently than other motor carrier groups, approximately 50 percent indicated they did not. A representative of the utility industry whose carriers were largely short haul and intrastate, stated that its members needed SCC permission to raise rates and thus had a more difficult time passing along tax increases. Representatives of utilities, construction, and mining indicated that members would have to increase rates to survive, while one (construction) reported that passing along cost increases was extremely difficult due to competition within the industry. Three implied that Virginia truckers could not survive tax increases and one for-hire transportation representative suggested that such increases might force members to do business in another state. Appendix D presents details.

They were also asked how their industries had changed since 1985 and to react generally to the potential impact of tax increases. Several organizational representatives indicated that, since 1985, significant consolidation had occurred, competition had increased, and the economy had forced rates down.

Impact Analysis: Increases in the Proportion of Taxes

Using information from Virginia carriers as well as information provided in the literature, a picture of the impact of the tax and fee increases proposed in SB 895 can be examined. While registration, fuel and vehicle sales taxes would increase at different rates, SB 895 would result in an average increase of 26 percent. The range of this increase would vary from 16 percent to 46 percent according to the type of truck.

The following illustrates possible effects of a tax increase on Virginia firms:

- A company operating one single-unit coal hauling truck, base-plated in Virginia: This company is a truckload, general freight carrier that operates as a short haul, interstate carrier, with a typical profit margin of ten percent; 10.81 percent of its operating expenses are Virginia taxes. Operating expenses per vehicle mile are $0.74; under the proposals in SB 895, operating expenses per vehicle mile would be $0.78.

- A company operating three trucks, mostly single-units, base-plated in Virginia serving the construction industry: The company is a truckload carrier that transports general freight on short hauls interstate, operating last year at a loss. Two and three-fourths percent of its operating expenses are Virginia user fees and taxes. Operating expenses per vehicle mile are $1.098; under the proposals in SB 895, operating expenses per vehicle mile would be $1.112.

- A company operating seven trucks, mostly tractor trailers, base-plated in Virginia, serving the manufacturing industry: The company is a truckload carrier that transports special and general freight on long and short hauls inter- and intrastate, with a profit margin of 0.09 percent. Two and one-half percent of its operating expenses are Virginia user fees and taxes. Operating expenses per vehicle mile are $1.349; under the proposals in SB 895, operating expenses per vehicle mile would be $1.354.

- A company operating 150 trucks, mostly tractor trailers, of which 147 are base-plated in Virginia, serving the retail trade industry: The company is a truckload carrier that transports general freight on short hauls interstate, with a typical profit margin of two to three percent. One and one-half percent of its operating expenses are Virginia registration, fuel and user taxes and fees. Operating expenses are $1.274 per vehicle mile; under the proposals in SB 895, operating expenses per vehicle mile would be $1.277.

The Virginia Trucking Association also provided some information on Class I motor carriers' profit margins for the third quarter of 1991. The Virginia carriers that had over six million dollars of revenue for the quarter, showed variability in their profit margins: 16.48 percent, 8.91 percent, 4.66 percent, and -13.46 percent. The profit margins illustrate that not all companies could equally absorb higher taxes and fees.

Tax Competition with Surrounding States

One issue identified by the trucking industry in discussions about competitiveness is the amount of the Virginia tax relative to the rates in surrounding states. Some argue that higher taxes provide an incentive for carriers to base-plate in other states.

The effect of a state's tax structure on a firm's location decisions in general or motor carriers base-registering decisions (base-plating) specifically is debatable. For example, representatives of the trucking industry feel that Virginia's sales or titling tax structure may be the reason for the slow growth in motor carrier registrations.[43] The Corporation for Enterprise Development, a nonprofit independent consulting firm, in contrast, indicated the following:

> Other factors such as proximity to markets or quality of life for employees are more important to employers and generally overwhelm whatever short-term advantages may be created by tax differentials.[44]

Pratt and Hoffer found that being a center for manufacturing affects the number of heavy vehicle registrations in a state and that the state's registration fee and property tax rate did not affect the numbers registered.[45]

Before discussing individual user taxes and fees, it is useful to examine how they combine to affect a typical five-axle tractor semi-trailer.[46] Nationwide, for this vehicle class, 52 percent of the states have total transportation fees higher than Virginia. For fuel taxes, 46 percent are higher and, for registration fees, 50 percent are higher.

In the next section a comparison of motor fuel taxes, vehicle registration fees, vehicle sales/excise taxes and property taxes in Virginia and for neighboring states is presented. All of these taxes except sales/excise and property taxes are apportioned by mileage. The comparison is limited to neighboring states because they are the primary competitors

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[43] Comment by Mr. Dale Bennett, Executive Vice-President of Virginia Trucking Association, to the SJR 30 Transportation Policies Working Group, February 4, 1991.

[44] The 1991 Development Report Card for States, Corporation for Enterprise Development, Center for State and Local Development, April 1991, p. 73.

[45] Michael D. Pratt and George E. Hoffer, Effects of IRP Membership on Revenues from State Heavy Vehicle Registrations, Transportation Journal, Vol. 24, Spring, 1985, pp. 47-55.

[46] Transport Topics, American Trucking Association, October 21, 1991.

to the motor carrier fleet in Virginia. The states included are: Kentucky, Maryland, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. Second, motor carrier registrations in Virginia in 1989 are compared to those in neighboring states.[47] While information is included on all vehicles, the analysis focused on interstate motor carriers since they have the option to base-register in the state of choice.

Motor Fuel Taxes

Motor fuel taxes in Virginia and neighboring states vary from fixed cents-per-gallon taxes to combination taxes based on cents-per-gallon and motor fuel prices (called "variable"). Table 7 compares the effective gasoline and diesel tax rates as of July 1991.

With tax rates of 17.7 and 16.2 cents-per-gallon respectively, Virginia ranks third from the bottom for both the gasoline and diesel tax rates of the seven states. Four states assess higher taxes and two lower. The gasoline tax rates vary from a low of 15.0 cents-per-gallon in Kentucky to a high of 22.6 cents-per-gallon in North Carolina. Similarly, diesel tax rates vary from 12.0 cents-per-gallon to 22.6 cents-per-gallon in Kentucky and North Carolina, respectively.

These fuel taxes are included in the pump price and are paid by the consumer when fuel is purchased regardless of where the fuel is used. In concert with the tax at the pump, all of the states assess road use fuel taxes on certain motor vehicles. These taxes minimize the incentive for interstate motor carriers to legally purchase fuel in a low tax state, while equitably apportioning the taxes across states and eliminating double taxation. The road use taxes are typically based on the number of miles traveled in a particular jurisdiction relative to total miles traveled. Additionally, a tax credit or refund is generally granted for taxes on fuel purchased at the pump.

Table 8 shows road use taxes in the subject states. At 19.5 cents-per-gallon, Virginia's tax rate is higher than four states but lower than those in North Carolina and West Virginia. Note that the tax is generally the same as the diesel tax. Virginia and Kentucky are the exceptions, with 3.5 and 7.2 cents-per-gallon surtaxes, respectively. The surtaxes purport to capture the higher costs occasioned on the highways by heavy motor carriers.

[47] For the purpose of this study, a motor carrier is a truck tractor but may include some large trucks that are used regularly with full trailers.

TABLE 7

GASOLINE AND DIESEL TAX RATES AS OF JULY 1991
CENTS-PER-GALLON

State	Gasoline	Diesel	Type
North Carolina	22.5	22.5	Variable
Tennessee	21.4	17.4	Cents/gallon
West Virginia	20.35	20.35	Variable[2]
Maryland	18.5	18.5	Cents/gallon
Virginia	**17.7**	**16.2**	**Cents/gallon**
South Carolina	16.0	16.0	Cents/gallon
Kentucky	15.0	12.0	Variable[3]

[1] 17 cents-per-gallon plus 7% wholesale average

[2] 15.5 cents-per-gallon plus 5% wholesale average

[3] 9% wholesale average plus one cent increase for each two cent decrease in wholesale price

Source: Highway Users Federation, "State Motor Fuel Tax Rates, July 23, 1991

TABLE 8

ROAD USE TAXES ON MOTOR VEHICLES AS OF JULY 1991
CENTS-PER-GALLON

State	Road Use Tax	Diesel Tax	Difference
North Carolina	22.6	22.5	0.0
West Virginia	20.35	20.35	0.0
Virginia	**19.5**	**16.0**	**3.5**
Kentucky*	19.2	12.0	7.2
Maryland	18.5	18.5	0.0
Tennessee	17.4	17.4	0.0
South Carolina	16.0	16.0	0.0

* Vehicles with combined gross weight over 59,999 pounds

Source: Department of Motor Vehicles

Motor fuel and road use taxes are considered operating costs by motor carriers. Increases in these taxes increase operating costs that are either absorbed or passed on to the consumer in terms of higher prices for goods and services. However, because road use taxes are based on relative miles traveled in a particular jurisdiction and must be paid regardless of where the fuel is purchased, the effect of nominal road use taxes or increases in these taxes on the base-plating decisions of interstate motor carriers is minimal.

Vehicle Registration Fees

Table 9 ranks the states by the annual vehicle registration fees levied on an 80,000 pound for-hire motor vehicle. As the table shows, the registration fees range from a low of $800 in South Carolina to a high of $1,300 in Tennessee. Virginia ranks in the middle at $1,219.

All of the states included are members of the International Registration Plan (IRP), a special registration plan for vehicles involved in interstate commerce. Under the IRP, fees due a particular jurisdiction are apportioned based on the jurisdiction's registration schedule and miles traveled in the jurisdiction relative to total miles traveled in all jurisdictions.

Registration fees represent an annual operating cost for motor carriers. Because they are apportioned based on miles traveled in a particular jurisdiction and cannot be avoided if travel occurs, increases in registration fees will increase operating costs but will have no real effect on base-registering decisions.

TABLE 9

VEHICLE REGISTRATION FEES
80,000 POUND FOR-HIRE MOTOR VEHICLE

State	Registration Fees - Dollars
Tennessee	1,300
Maryland	1,280
Kentucky	1,260
Virginia	**1,219**
West Virginia	1,131
North Carolina	923
South Carolina	800

Source: Department of Motor Vehicles

Motor Vehicle Sales Taxes

As Table 10 shows, the types of motor vehicle sales/excise taxes assessed are as varied as the number of states. Because the base upon which the tax is assessed varies, and an accurate ranking of states cannot be obtained from the rates alone, a hypothetical interstate motor vehicle with an $80,000 sale price and including a $15,000 trade-in is used to rank the states.

Virginia has the third highest tax when compared to neighboring states. Kentucky and West Virginia have higher taxes, while the taxes are lower in North Carolina, South Carolina, Maryland and Tennessee. Note that South Carolina and Maryland exempt road tractors, and Tennessee exempts interstate carriers, from their sales taxes.

In contrast to taxes and registration fees, the motor vehicle sales tax is paid only when a vehicle is purchased or titled and, therefore, is not incurred annually. Where a carrier has a choice of base-plating, because his fleet operates in several states, location decisions may be influenced by the sales tax rate. With an average vehicle turnover of five years, a carrier has a five year period to amortize the costs, however.

TABLE 10

MOTOR VEHICLE SALES TAXES

State	Tax on $80,000 Interstate Motor Carrier	Tax Rate	Trade-In
Kentucky	$3,420	6%, 90% retail price	Yes
West Virginia	3,250	5%, vehicles over 55,000 pounds exempt if buy license at time of purchase	Yes
Virginia	**2,400**	**3%, minimum $35**	**No**
North Carolina*	1,000	3%, maximum $1,000 minimum $40	Yes
South Carolina	300	2%, road tractors exempt	Yes
Maryland	0	5%, road tractors exempt	No
Tennessee	0	5.5%, interstate exempt	Yes

* North Carolina's minimum tax will go to $1,500 on July 1, 1993.

Source: Department of Motor Vehicles

Personal Property Taxes

Personal property taxes are typically assessed by local rather than state governments. Moreover, each locality generally sets its own tax rate, assessment ratio, and assessment value. For example, in Virginia, the property tax rates per $100 of assessed valuation on trucks of two tons or more vary from $0.39 (Bath County) to $21.90 (Dickenson County).[48] The assessment ratios in these localities are 30 percent and ten percent, respectively. Bath County uses the average retail value as the basis for its tax, and Dickenson County uses the average loan value. Using these two localities as examples, the property tax on an $80,000 motor vehicle ranges from $93.60 in Bath County to $1,752 in Dickenson County.

Because personal property taxes are generally local and vary greatly across localities, a state-to-state comparison of these taxes is of questionable value. Accordingly, Table 11 is limited to information on whether or not the subject states impose the tax. Tennessee and Maryland are the only states that do not impose a personal property tax on motor vehicles.

TABLE 11

PERSONAL PROPERTY TAXES ON INTERSTATE MOTOR VEHICLES

State	Personal Property Tax
Kentucky	Yes
Maryland	No
North Carolina	Yes
South Carolina	Yes
Tennessee	No
Virginia	Yes
West Virginia	Yes

Source: Department of Motor Vehicles

Personal property taxes are assessed annually and are, therefore, a component of operating costs. Consequently, those states without a personal property tax may have a competitive advantage when it comes to base-plating decisions. However, it is

[48] Virginia: Local Taxes on Manufactures, Virginia Department of Economic Development, November 1990.

important to point out, that the only taxes and fees that could create incentives for base-plating elsewhere (because other taxes are based on mileage) are sales tax and possibly property tax. However, if cost were an issue, the carrier could locate in a low cost county within Virginia.

Motor Carrier Registrations

The number of motor carrier registrations in Virginia and surrounding states are shown in Table 12. Virginia ranks third in the group with 16.6 percent of the trucks.

TABLE 12

1989 MOTOR CARRIER REGISTRATIONS*

STATE	REGISTRATIONS	PERCENT SHARE
North Carolina	56,914	32.1
Tennessee	38,359	21.6
Virginia	**29,532**	**16.6**
Kentucky	17,073	9.6
Maryland	16,737	9.4
South Carolina	13,816	7.8
West Virginia	5,124	2.9
Total	177,375	100.0

* Truck tractors may include some large trucks used regularly with full trailers

Source: Highway Statistics, Annual Volumes, Federal Highway Administration

Looking at the number of vehicles registered in the two states that have neither a sales nor personal property tax, one realizes that other factors must be involved in the base-plating decision. Tennessee has 22 percent of the trucks; but Maryland only has nine percent. In addition, the state with the highest sales tax for an $80,000 truck (Kentucky) also levies property taxes but has more registrations than Maryland with neither tax. It is clear that the issue is not as simple as some would suggest and that one must look to other reasons to explain the level of truck registrations in a state.

Summary of Registrations and User Taxes

It has been argued that the level of motor carrier taxes and fees in Virginia explain a low level of registration. Our analysis does not support this. Because the motor fuel tax rates and registration fees paid by motor carriers are apportioned based on miles traveled within each state, they do not significantly impact base-registering decisions. The only taxes that are not apportioned by mileage are sales and personal property. Since the vehicle sales tax is a component of the purchase price of a motor vehicle and personal property taxes increase annual operating costs, these taxes may figure into base-registering decisions. However, considering the wide variation in personal property taxes within Virginia, it is clear that if cost were an issue, companies could locate in a low cost county. Sales tax is amortized over the life of the vehicle and is not enough of an incentive to base-plate elsewhere. The number of vehicles registered in the various states considering their tax rates suggest other factors are of greater significance to the base-plating decision. The literature would indicate the most important variable influencing location decisions is proximity to markets.

Determining Industry Impact

The challenges of the previous decade have yielded a motor carrier industry in transition, moving from an inefficient, regulated industry to a more efficient, more competitive one. The industry had many opportunities to improve efficiency in the 1980's and it was able to increase vehicle weights and sizes, rationalize routes, increase backhauls, improve fuel economy through engine enhacements, and in some cases reduce labor costs. Increased market entry in the TL market, in particular, has promoted strong competition in that segment of the industry. In the less-than-truckload segment (LTL), competition coupled with economic downturns have forced many companies out of the marketplace. Operating costs are up but rates have not kept pace, thus reducing profit margins. Nevertheless predictions for the future of this industry are largely positive based on technological improvements that will permit greater efficiencies.

Although the deregulated trucking industry of the 1990's may be unlike that of any previous decade, history offers some insight as to how further increases in taxes and fees may affect the transitioning motor carrier industry. According to several analysts, the economic effects of any tax increase depend upon three variables: the ability of the industry to employ efficiency gains (i.e., cut costs); the ability of the industry to raise rates; and the dollar impact of the new taxes on operating expenses.

Whether shippers will pass along any trucking rate increases to their buyers and whether the consumer will eventually bear some of this burden is a complex issue. The literature shows that the eventual impact of a tax and fee increase depends on the market, the commodity, and the degree of the increase.

The proposed tax burden would vary by firm size and attributes. However, information from Virginia carriers indicates that if all the proposed taxes were enacted the proportion of operating costs attributable to Virginia taxes would increase by a relatively small amount. For one large carrier, for example, Virginia taxes make up 1.53 percent of their operating costs and the increases in SB 895 would change that to 1.77 percent. For some carriers, any increase is a problem, however.

Most of the increased taxes proposed in SB 895 would be paid by all interstate carriers since they are either apportioned by miles traveled in each jurisdiction or affect overweight loads that must be moved. Only the sales tax could be considered to provide an incentive for base-plating elsewhere. Here it is worth noting that the increase in SB 895 would apply only to two- and three- axle vehicles, approximately 80 percent of which are not driven interstate, and only ten percent of which travel 50 percent or more of their miles interstate. Thus the vast majority of these vehicles are operating intrastate and are unlikely to relocate. Although there is concern about the recent economic recession, forecasters predict a better future in which higher freight rates can compensate for the higher operating costs that result from increased taxes. The ability to achieve a more equitable distribution of cost responsibility and to increase the efficient use of Virginia's highways will likely offset any cost impacts from the proposed tax and fee increase on the industry.

STUDY CONCLUSION AND RECOMMENDATIONS

The results of this study confirm the conclusions reached in SJR 121. Preliminary modeling using a pavement deterioration methodology to allocate rehabilitation costs indicated results not dissimilar to those found in SJR 121 using a design-based allocation method. Passenger vehicles overpay from a cost occasioning perspective; truck and bus classes underpay. The revenue-to-cost ratios found in SJR 121 continue to represent the relative payments for use of the roads with respect to the costs occasioned by the vehicle classes.

Equity from a cost occasioning perspective can be accomplished with tax increases such as those reflected in SB 895, introduced in the 1991 Session of the General Assembly. The revenue-to-cost ratios for vehicle classes found in SJR 121 and SB 895 are listed in Table 13.

TABLE 13 REVENUE-TO-COST RATIO		
Vehicle Class	SJR 121	SB 895
Passenger Vehicles	1.06	1.03
Buses	.30	.30
Light Trucks	.77	.96
Single-Unit Trucks	.85	.98
Combination Vehicles	.93	.96

Whether the General Assembly determines that it is appropriate to obtain such equity depends on how the role of the trucking industry in Virginia is viewed as well as beliefs about the economic consequences of tax increases on the industry. Demand studies suggest that carriers can raise rates without substantial loss of market share to rail. Even within the industry, service variables are of greater importance to shippers than cost, although carriers able to absorb the costs will have the competitive advantage.

The Cost Responsibility Study was performed by allocating highway user taxes and fees to vehicle classes. However, user taxes and fees are not the only source of revenue dedicated to transportation. One-half percent of the State retail sales tax is allocated to the Transportation Trust Fund for construction. It was excluded from revenue attribution because consumers, not highway users, pay this tax. The General Assembly may wish to apply the state retail sales tax as a subsidy for truck and bus classes.

The General Assembly may take the perspective that trucking is not to be viewed simply as an economic entity subject to typical market force discipline but as an enhancer of economic development. In this view, the overall contribution of the industry to Virginia's economy would be recognized and addressed through a general tax subsidy.

Others might argue that such subsidies allow carriers to be inefficient and bolster marginal carriers who would otherwise be required to face competitive market forces. It could also be argued that such subsidies unfairly affect the rail mode which would be the competitor for some of the business. If it is assumed that trucking should bear the full costs of the use of the roads, the tax package represented by SB 895 would meet the equity goal. Whether this is an appropriate time to increase taxes on the industry is another question.

Transportation taxes and fees represent a small proportion of operating costs. On average, approximately three to five percent of operating costs are attributable to

transportation user fees. Increases identified in SB 895 would not significantly affect the operating cost ratio. The tax increases would affect motor carriers differently depending on their size and operating characteristics. The ability to pass-on the costs depends in part on the competition within the carrier segment. Additionally, some companies have established enough of a profit margin so that they can absorb these increases more easily.

Virginia is now positioned in the middle of surrounding states with respect to taxes on the industry. Analysis of the relative tax burden indicates that SB 895 would not affect base-plating decisions. Since most of the fees are apportioned to states based on mileage, only the sales tax could make a difference. Analysis indicates it does not. The literature suggests that proximity to markets is the more important variable in location decisions.

It is recommended that, whenever highway financing issues are addressed by the General Assembly, the equity of allocation to vehicle classes also be reviewed. Legislation to increase transportation taxes and fees should provide the opportunity to obtain equity in vehicle class payments. In addition, a review of liquidated damages assessed on illegal overweight trucks is recommended by this study.

Recommendations with respect to cost responsibility methodologies follow.

Pavement Deterioration Modeling

The state-of-the-art has not progressed to the point where acceptable models are available for testing. It is apparent that the cost responsibility derived from pavement deterioration under traffic is extremely complex and that there is not yet a widely accepted model to analyzing it. For this reason it is recommended that the Department make no immediate attempts to model pavement deterioration through mechanistic or empirical models at this time. Rather, the Department should position itself through the identification and development of the proper databases to make use of the ***nationwide pavement cost model*** to be released in 1992 by FHWA. Among the data elements needed are:

- Pavement condition parameters (roughness, cracking, rutting),
- Threshold values or action levels for the condition parameters,
- Pavement maintenance and rehabilitation costs as they relate to condition parameters,
- The distribution of vehicles by class in the traffic streams corresponding to the pavements defined above,

- The distribution by axle loads of the weights of vehicles, and

- Growth rates for vehicle weight distributions by class.

If the Commonwealth desires to allocate pavement construction and rehabilitation costs equitably among vehicle classes based on the consumption of pavement life by those classes, it is recommended that the following actions be taken:

- Develop a full, system-wide database of weigh-in-motion information which will provide weights obtained without enforcement and present results on a broader spectrum of vehicle classes than is available today. Among other uses, this database can validate the equivalent axle loadings used in this study.

- Continue to develop pavement performance information in the Pavement Management System. This data can be analyzed with the ESAL data to develop load-performance relationships.

- Ensure VDOT's continued involvement in the Strategic Highway Research Program and ability to fund programs that address the interaction of pavement performance, vehicle loadings, and environmental factors.

Revenue Data

This study has identified the information needed to perform future cost responsibility studies. Some improvements in the current data will come from improved technology, particularly with WIM, but an improvement in the number of revenue classes to which costs can be allocated may only be possible following General Assembly action. If, when the next cost responsibility study is conducted, special studies do not collect revenue information on more vehicle classes, the study will still be limited to five vehicle classes. It will continue to be impossible to ascertain cost responsibility for different vehicle combinations and weights and to evaluate equity within vehicle classes.

The General Assembly may wish to mandate special studies for the first year of a cost responsibility study that would require:

- A special study by the SCC to determine payment of road use taxes by type of truck,

- A special study by DMV of sales and use taxes paid by vehicle class,

- A special study of registration fees by vehicle class, and

- The collection of information to determine the relationship between registered and operating weights.

These special studies could be accomplished by survey but the most effective instrument would be to include several questions on the tax and registration forms. For the SCC, carriers could be requested to keep and report mileage by several vehicle classes for one quarter. For DMV, carriers could be asked to list the expected use of each type of configuration when sales and use tax is paid. For registration, a similar question could be included on the registration form. The collection of operating weight for each vehicle configuration would require special study whereby registered and operating weight would be obtained for the same vehicles.

The Cost Responsibility Study (SJR 121) and its Continuation (SJR 238) have investigated the cost responsibility of vehicle classes using the roads of the Commonwealth. Using a design-based methodology the revenue-to-cost ratios for vehicle classes indicated that equity had not been obtained. This study attempted to apply pavement deterioration models to rehabilitation costs, but found that, while appropriate models are forthcoming, the technique had not progressed to the point where its implementation significantly enhanced the current methodology. The numbers and mix of vehicles using the highways of the Commonwealth will continue to change over time and necessitate periodic review of cost responsibility. The recommendations of this report will enable the next study to more precisely define costs for the various vehicle classes.

APPENDICES

APPENDIX A

SENATE JOINT RESOLUTION NO. 238

Requesting the Virginia Department of Transportation to continue and expand its study of the cost responsibility of vehicles using the highways of the Commonwealth.

Agreed to by the Senate, February 20, 1991
Agreed to by the House of Delegates, February 15, 1991

WHEREAS, the highway system of the Commonwealth is built to accommodate a variety of vehicles which have a wide range of requirements for pavement width and strength; and

WHEREAS, in cases in which construction and maintenance expenditures are made due to the needs of particular vehicles, those costs would be borne by the vehicle classes that require them; and

WHEREAS, the Virginia Department of Transportation has completed a study of vehicle cost responsibility which suggested that in a $1.5 billion program of expenditures attributable to highway users, personal use vehicles overpay for their costs by $66 million, and that buses and trucks underpay for their costs by $66 million; and

WHEREAS, the study by the Virginia Department of Transportation indicated that the use of pavement deterioration models might enhance the cost allocation methodology; and

WHEREAS, changing factors such as travel and economic conditions alter cost responsibility of the vehicle classes over time; now, therefore, be it

RESOLVED by the Senate, the House of Delegates concurring, That the Virginia Department of Transportation continue its study of vehicle cost responsibility and include an analysis of the effect of traffic levels on pavement performance, an evaluation of the use of deterioration models, and a proposal for periodic review of vehicle cost responsibility on a ten-year cycle. The Department shall include in its report specific plans and proposals for improvements in data collection and processing to facilitate the future studies of vehicle cost responsibility.

The Joint Legislative Audit and Review Commission shall review and comment on the methods and analysis to be used by the Department, and the Commission shall receive the report of the Department. The Virginia Department of Transportation shall complete its work in time to submit its findings and recommendations, including any comments and recommendations by the Joint Legislative Audit and Review Commission, to the Governor and the 1992 Session of the General Assembly as provided in the procedures of the Division of Legislative Automated Systems for the processing of legislative documents; and, be it

RESOLVED FURTHER, That the Clerk of the Senate transmit copies of this resolution to the Commonwealth Transportation Commissioner and the Director of the Joint Legislative Audit and Review Commission.

APPENDIX B

DAMAGE AND COST MODEL SUMMARY MATRIX

Predicted Performance or Distress (or Cost Component Considered) \ Models	AASHTO Guide [89 - 8]	AGENCY [86 - 1]	ARE/ADOT [88 - 8]	ARE/FHWA [75 - 1]	Arizona DOT [87 - 13]	COPES [85 - 5]	Cost Allocations [84 - 1]	Cost Alloc. Up. [87 - 7]	DNPS86 [87 - 12]	Euromar II [81 - 6]	Euromar SW [86 - 3]	FHWA/FM [88 - 10]	GEIPOT [87 - 13]	HDM 3 [87 - 8]	HPMS [87 - 10]	NCHRP1 - 10B [77 - 1]	NULOAD [78 - 1]	PennDOT Study [87 - 5]	REHAB [81 - 4]	RENU [81 - 4]	RPRDS [82 - 3]	RTIM2 [87 - 13]	Small, et.al. [88 - 7]	Stat. Cost Func. [82 - 1]	Wash. Pvt. Perf. [88 - 1]
Flexible																									
Pavement Condition Rating												x													x
Serviceability	x	x					x	x	x	x	x			x	x		x	x		x			x		
Roughness		x	x		x					x	x		x	x								x			
Rut Depth		x					x	x		x	x			x		x				x					
Flushing																				x					
Corrugation																				x					
Patching																				x		x			
Ravelling		x												x						x					
Alligator Cracking					x								x							x		x			
Long. Cracking																				x					
Trans. Cracking																				x					
Fatigue Cracking		x		x			x	x		x	x			x		x									
Low Temp. Cracking							x			x															
Skid Resistance							x																		
Expansive Clays	x						x		x																
Potholes		x								x	x			x											
Base Failures										x															
Pvt. / Shoulder Joint										x															
Rigid																									
Pavement Condition Rating												x													x
Serviceability	x	x				x	x		x	x	x				x		x			x			x		
Roughness								x		x															
Number of "Failures"								x												x					
Pumping		x				x	x	x		x	x														
Joint Deterioration						x	x	x																	
Faulting	x	x				x	x	x		x	x														
Depressions & Sweels							x	x																	
Skid Number							x	x																	
Cracking		x				x	x	x		x	x										x				
Patching		x									x														
Spalling										x															
Joint Stripping										x															
Pvt / Shoulder Joint										x															
Joint Sealing											x														
Blowups										x															
Expansive Clays	x								x																
Cost Models																									
Routine Maintenance		x							x	x	x	x		x	x		x		x	x	x		x	x	
Rehabilitation		x							x	x	x	x		x	x		x		x	x	x		x	x	
Budget Constraints										x	x	x		x	x		x			x	x				
New Construction									x	x		x			x				x				x		
User Costs										x		x		x	x						x		x		
Analysis Period / Int. Rates		x							x	x	x	x		x	x		x		x	x	x		x		
Cost Growth / Inflation		x							x	x	x	x		x	x		x		x	x	x		x		
EUAC/NPV		x							x	x	x	x		x	x		x		x	x	x		x		
Optimization																					x		x		
Salvage Value		x							x	x	x			x			x			x	x				

Appendix C

Overweight Operations in Virginia

Overview of Permit Operations

The Commonwealth of Virginia, like most other states, has in effect special highway-use-laws authorizing the issuance of vehicle permits for movements in excess of legal dimension and weight limits. Sections 46.2-1139 through 1149 and 33.1-12 (3) of the Code of Virginia provide the legal basis of this authority promulgated to the Commonwealth Transportation Board. Non-divisible cargo exceeding the specified limits in length, width, height, or weight must obtain a permit before shipment by highway; construction equipment, mobile homes, and large electrical transformers are examples of commodities for which permits are usually granted. Virginia also grants permits for reducible loads composed of commodities that the General Assembly has exempted from the non-divisible specification.

The primary objectives of Virginia's permit operation are to control shipments of overlimit and not readily dismantled cargo in order that the structural integrity of the highway system is protected and such shipments do not create traffic safety hazards or undue delays for motorists.

Types of Permits

Virginia offers two types of size and weight control permits: single-trip permits and multiple-trip blanket permits. A single-trip permit is good for a single, one-way or round trip as specified in the permit. Single-trip permits are valid for thirteen days.

Blanket permits cover movements within a certain period of time, for up to two years. Generally, blanket permits are issued to manufacturers, contractors and others who frequently need to ship the same kind of overlimit load over the same routing. An additional single-trip permit is still needed if the size or weight of a cargo shipment exceeds the limits specified on the blanket permit.

Table I summarizes permit operations during the last six years.

TABLE I

SUMMARY OF HAULING PERMITS ISSUED
FISCAL YEARS 1986 - 1991

Fiscal Year	Single Trip Permits	Blanket Permits	Total Permits	Total Fees Collected
1986	36,113	20,638	56,751	$835,584
1987	37,189	20,688	57,877	881,918
1988	41,358	22,683	64,041	1,017,076
1989	49,620	16,755	66,375	1,016,913
1990	48,900	34,958	83,858	1,112,613
1991	46,826	22,376	69,202	1,181,078
Totals	260,006	138,098	398,104	$6,045,182

Source: Maintenance Division, Virginia Department of Transportation

For a company needing an overweight permit, it is possible to order a single permit and pay the permit fee and ten cents per mile for use; or to order a blanket permit, paying the permit fee and paying the ten cents per mile to DMV through a monthly return which reports mileage.

Blanket Permits

A blanket permit allows a truck to travel overweight for a longer period of time than for just one trip. Permits are also written for overdimensional vehicles. However, in determining the cost responsibility of different types of vehicles using the highways, it is not necessary to look at overdimensional mileage and fees.

The filing of tax returns to DMV for blanket permits is on the honor system; it is not audited. Two alternatives to more accurately capture fees due for overweight mileage are:

- Set up an audit function to compare fees collected to permit use, or
- Charge a flat fee for annual use of a blanket permit regardless of mileage.

Charging a flat fee seems to be preferred by some of the trucking firms because it would relieve them of the burden of having to file a monthly return on mileage to DMV. It also would be less expensive to administer than an audit function. It would however, charge the same fee to those who drive many miles on permits as it would to those who drive few.

Free Commodity Permits

Free commodity permits are special types of blanket permits for which there are no fees. A free commodity permit allows a truck carrying concrete mixed-in-transit, containerized cargo, coal, farm produce, or solid waste to travel overweight. In fiscal year 1989, there were over 6,700 of these permits. The maximum axle configuration, weight, and distance traveled for each of these commodities is set out in the Code. For instance:

- Three-axle trucks carrying concrete mixed-in-transit can travel 25 miles from the plant at 60,000 pounds if they travel ten miles an hour slower than the speed limit. In fiscal year 1989, 718 free permits were issued for concrete mixed-in-transit,

- Containerized cargo under permit can now travel to and from a seaport at 90,000 pounds. In fiscal year 1989 3,122 free permits were issued for containerized cargo traveling to and from Virginia ports. (This type of free permit is no longer limited to only Virginia ports so more will probably be issued per year in the future.),

- Coal in a three-axle truck can weigh 60,000 pounds, in a four-axle 70,000, and in a five-axle 90,000. In actuality coal permits are more complicated because the load is computed by the average weight of coal which will fit in a certain bed size, and a peek hole is cut at that level for inspection. In fiscal year 1989 1,602 coal hauling permits were issued,

- Virginia grown farm products, while limited to 80,000 pounds on five axles, may travel on the Eastern Shore with tandem axles weighing 36,000 rather than 34,000 pounds. In fiscal year 1989 953 farm produce hauling permits were issued, and

- Solid waste haulers may weigh 40,000 pounds for a two-axle vehicle and 60,000 for a three-axle vehicle when traveling within the county or city in which they are garaged, if they travel ten miles per hour slower than the speed limit. In fiscal year 1989, 355 solid waste permits were issued.

Because there is no fee for free commodity permits, some companies order more than they use and others order permits for business they hope will develop. For these reasons not all free permits are used.

Special Overload Permits Issued by DMV

The 1982 General Assembly established an overweight permit general use statute to replace the tolerance policy. This legislative revision was incorporated in Section 46.2-1128 of the Code and provides for the assessment of a fee to cover a previously allowed free administrative tolerance by the Department of State Police. The specific statutory language is as follows:

> The owner of any motor vehicle may obtain an extension of single axle, tandem axle and gross weight by purchasing an overload permit. The permit extends the single axle weight limit of 20,000 pounds, tandem axle weight limit of 34,000 pounds and gross weight limit based upon axle spacing and number of axles. However, no permit authorizes the operation of a motor vehicle whose gross weight exceeds 80,000 pounds nor does any permit authorize any extension of the limitations for interstate highways.

Permits are valid for one year and may be purchased annually at the time of registration at the following costs:

TABLE II

SPECIAL OVERLOAD PERMITS

Percentage Overload Permitted	Fee For Permit*
1%	$ 35
2%	$ 75
3%	$115
4%	$160
5%	$200

* The cost of these permits for farm vehicles shall be 50% of the fee.

Source: Code of Virginia

The Department of Motor Vehicles makes these permits available to vehicles registered outside Virginia under the same conditions as those registered in Virginia.

Further Extensions of Weight Limits

An additional five percent overload weight extension is authorized pursuant to Section 46.2-1129 of the Code for certain vehicles hauling Virginia-grown farm or forest products.

These permits extend the single axle weight limit, tandem axle weight limit, and gross weight limit, based on axle spacings and number of axles on such vehicles up to five percent. Weight extensions provided are in addition to those provided in Section 46.2-1128 of the Code as described above.

Illegal Operations

When a vehicle travels at a weight above that allowed by its registration, hauling permit, or overweight permit, it is in violation of the weight laws of the Commonwealth. To enforce the law, trucks are weighed checking total weight as well as axle weight and spacing. Virginia operates 14 permanent weigh stations with 72 platform scales. These are run by employees of VDOT with Weight Enforcement Officers of the Department of State Police issuing citations. In addition to the permanent weigh stations, the Department has 11 floating parties that weigh trucks at mobile scales set up at different locations around the state.

Vehicles found to be overweight are fined for liquidated damages, civil penalties, processing fees, and weighing fees. The current fine structure for liquidated damages was adopted by the 1956 General Assembly. The fines were established at a level of two cents per pound for overweight vehicles under 5,000 pounds and five cents per pound for those exceeding 5,000 pounds. There is also a provision in the law for a one cent per pound fine for those vehicles which exceed the axle limit but not the gross weight limitation and are less than 2,000 pounds overweight. If, however, the vehicle is over the weight specified on a permit, the fine is 10 cents per pound. If a vehicle is found to be overweight on axle and gross weight, the vehicle is only assessed liquidated damages for the larger violation.

This fine structure has now been in effect for 35 years and has amounted to the collection of over $54.5 million in revenues for the Department. In addition, nearly $25 million in fines and $16 million in court costs were collected for the literary fund. This represents over $95.5 million dollars and over one million summonses. For a number of years, the Federal Highway Administration has requested that Virginia consider increasing the liquidated damage fines to a level which would be more of a deterrent to overweight loads. Table III illustrates Virginia's fines vis-à-vis surrounding states.

TABLE III

CHARGES FOR 6,000 POUNDS OVER LEGAL WEIGHT LIMIT
VIRGINIA AND SURROUNDING STATES

State	Liquidated Damages	Court Costs and Other Fees	Total
West Virginia	$60	$56	$116
New Jersey	180	-	180
Tennessee	180	-	180
Ohio	250	-	250
Virginia	**300**	**47**	**347**
Delaware	345	29	374
Pennsylvania	450	75	525
Kentucky	540	60	600
North Carolina	600	100	700
Maryland	720		720

Source: Traffic Engineering Division, Virginia Department of Transportation

Over the years, there have been some changes to the weight limits at which trucks may legally travel and the 1986 General Assembly assigned the collection of fines to DMV while imposing a fee of $25 civil fine, $20 processing fee, and a $2 weighing fee in addition to the liquidated damages assessed.

A review of the current liquidated damages fee structure has been recommended in Senate Document 6, 1982 and reiterated in Project Streamline, a Department report submitted to the Secretary's office August 2, 1990. This report also recommends that liquidated damages be studied. Possible improvements in the fee schedule include charging a flat fee of $50 for each overweight violation in lieu of the current $47 (civil, processing, and weighing fees) and, perhaps, doubling liquidated damages. Industry has indicated a recognition of the need for such an increase, but would like a built-in tolerance of 1,000 pounds. However, no tolerance is possible on interstate highways due to federal mandates and this amount of tolerance may already be purchased for state roads.

To address repeat offenders, it also may be appropriate to consider increasing the flat fee to more than $50 for repeat offenders. This would require some detailed

consideration because it would not seem appropriate to classify a company running many trucks as an habitual offender for a few violations, treating them the same as an independent operator who routinely exceeds weight laws with only several trucks. Tables IV and V summarize the last ten years of truck weighing operations.

TABLE IV

TEN YEAR SUMMARY OF OPERATIONS
1981 - 1990

Calendar Year	Number of Vehicles Weighed	Number of Citations
1990	11,545,350	69,265
1989	10,975,150	70,748
1988	10,459,538	73,672
1987	9,725,342	69,174
1986	9,882,809	64,142
1985	9,330,821	62,301
1984	9,295,958	59,924
1983	7,697,551	63,243
1982	7,254,241	44,856
1981	6,842,501	22,481
Totals	93,009,261	599,806

Source: Maintenance Division, Virginia Department of Transportation

TABLE V

TEN YEAR SUMMARY OF COLLECTIONS
1981 - 1990*

Year	Liquidated Damages	Civil Penalties	Processing Fees	Weighing Fees	Fines	Cost of Court
1990	$3,226,690	$1,636,254	$1,283,132	$162,549	$ -	$ -
1989	3,571,222	1,659,376	1,327,552	133,047	-	-
1988	3,415,572	1,706,595	1,366,364	141,731	-	-
1987	3,376,378	1,635,375	1,308,300	130,830	-	-
1986	2,780,966	-	-	-	1,675,213	1,266,579
1985	2,634,536	-	-	-	1,587,006	1,199,888
1984	2,306,407	-	-	-	1,382,373	1,045,757
1983	2,126,754	-	-	-	1,725,273	1,375,490
1982	2,350,979	-	-	-	1,013,335	767,364
1981	2,649,525	-	-	-	647,862	495,894
Totals	$28,439,029	$6,637,600	$5,285,348	$568,157	$8,031,062	$6,150,972

* Effective January 1, 1987 the schedule of fines and fees changed.

Source: Maintenance Division, Virginia Department of Transportation

Appendix D

Organization Representatives' Answers to the Question

"Is there anything else that should be considered in trying to estimate the impact of increased taxes and fees on the trucking industry?"

"The price per ton of coal has decreased about 30 percent in the last three years. All costs to operate have increased--insurance, taxes, parts, tires, labor, new trucks."

About 60 percent of the time solid waste trucks are empty or partly loaded. Any weight-distance tax would be proportionately worse on our industry."

"It appears that VDOT's mind is made up. Trucks are the criminals and they shall pay through the nose! The study is predicated on an unlevel field of play. The only thing you left out is having AAA endorse your study."

"Moving companies service the individual person, similar to service by bus companies. Any additional taxes will have a serious adverse effect on the Moving and Storage Industry, as well as the trucking industry in general. Due to the economy and the number of unemployed, Virginia's Moving and Storage Industry did not take any increase in freight rates this year. The last rate increase was effective 4 May 1990."

"The profit margin is too thin on most trucking operations to support additional tax increases. The trucking industry is being regulated by government to an extreme, thereby substantially increasing operating costs. The only way the trucking industry could sustain increased taxes would be passing them on to the consumer. This is extremely difficult to do given the extreme competitive nature of the industry. I feel that if fees are increased, some Virginia carriers cannot survive. Less competitive with rail due to increases."

"Whenever government considers changes to fees and taxes, it should also consider the overall effect these changes may have on the economy. Increased taxes and fees will result in an increase in the operational costs of businesses resulting in an increase in the prices of goods and services. The higher prices which consumers must pay for goods and services can easily cause a decrease in sales resulting in an decrease or retraction in the growth of the economy."

"Increased fuel and road use taxes would have to be born by the dairy farmer, which is already a dying breed. Increased vehicle sales tax will tend to slow the fleet replacement process thereby putting more pressure on an area that is already

suffering. Increased registration fees would tend to reduce the number of vehicles registered. We would see the "spare" or back-up units being retired or disposed of. This could have a spin-off into truck safety. It could also affect the timely movement of products from farm to market."

"The cost for materials for residential, commercial, industrial, municipal, and VDOT construction will have to increase in the long run for these companies to survive. The consumer pays more in the long run if transportation taxes are increased than if he is taxed directly by auto fuel and registration taxes or even increased sales taxes. This is due to the "pass through" effect of transportation taxes as raw materials move through manufacturer, wholesaler, retailer, and eventually to the consumer, as the tax administrative costs and profit need to be added at each entity in the manufacturing and distribution chain."

"Any increases should be equitably assessed and be reflective of the costs occasioned by the various vehicle classes. Secondly, all vehicle classes should be included in your analysis with no exclusions provided for any particular vehicle classes...as each class benefits from improved roads/highways. If exclusions are provided then the remaining vehicle classes should not be burdened with the excluded class costs. Finally, all monies collected through increased fees and/or taxes on trucking should be dedicated exclusively to the highway trust fund and used exclusively for the purposes in which they were collected...Monies generated by the trucking industry or any other vehicle class should not be diverted for any other purposes."