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AN INVESTIGATION OF TRUCK SIZE AND WEIGHT LIMITS
Technical Supplement Volume 2

TRUCK AND RAIL COST EFFECTS OF TRUCK SIZE AND WEIGHT LIMITS

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FINAL REPORT

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16. Abstract

This volume presents reported truck and rail operating data and analytical methods developed to estimate changes in transportation prices attributable to specific sets of truck size and weight limits. A system of cost based "rates" (or average shipment charges) is developed for differentiating among specific truck and rail transport services by allocating full economic cost to appropriate vehicle payloads. The affects of various truck size and weight limits are examined in terms of changes in the competitive relationships among various highway and rail carrier services.

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PREFACE

This is one of several technical reports prepared in support of the Secretary of Transportation's Report to Congress on the DOT Truck Size and Weight (TS&W) Study mandated by Section 161 of the Surface Transportation Assistance Act of 1978. This Volume, No.2, documents the conduct and results of one of the many specific areas of investigation, the effects of truck size and weight limit changes on carrier costs, and average freight charges.

This report presents the basic data and analytical methods required to estimate likely changes in average prices of various transportation services attributable to specific changes in truck size and weight limits. Cost based "rates" (or average unit revenues) are calculated for specific services by allocating the full economic cost of specific truck trips to appropriate truck payloads. Changes in freight rates attributable to changes in the truck performance characteristics could affect the competitive relationships among the various highway and rail carrier groups and could cause substantial changes in highway traffic growth patterns.

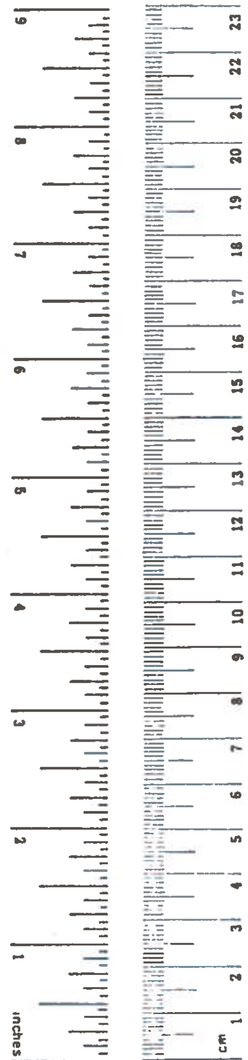
The extensive data collected and the preparation, analysis, and documentation have been the responsibility of the joint authors under the overall technical direction of Domenic J. Maio, Manager of the TSC portion of the DOT TS&W Study. Validation of the TSC cost/rate models to published tariffs and disaggregate average revenues for general freight, as documented in Appendix I, was performed by Wayne Stoddard of Raytheon Service Company. Comparison of TSC cost/rates for specialized truck services with published commodity truck rates, presented in Appendix K, was performed by Patricia Kurkul of Raytheon Service Company.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

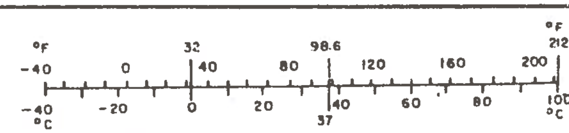
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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1. SUMMARY

This Technical Supplement Volume provides an evaluation of impacts on the economics of various truck and rail freight markets that could result from changes made to the present system of limits on truck sizes and weights. It documents the basic data, the analytical tools and the preliminary findings concerning potential cost effects on various carrier groups and price effects on various shipper groups resulting from specific changes to the truck size and weight limits. The overall TSC project, of which this is a part, requires assessment of impacts in terms of changes in carrier operating costs, prices of specific market services, market shifts among carrier groups, and energy consumption. The methods and data encompassed in this report were designed to be generally applicable to any carrier group or market situation by modifying certain key inputs.

The focus of this report is on the development of estimates adequate to represent price and profitability level changes for each of several carrier groups attributable to specific alterations to the present truck and rail operating environment. Thus, this report attempts to represent, as a base, the truck and rail carrier services as they existed in the 1977 base year and then estimate changes in their respective systems that could occur if a primary factor such as vehicle load capacity were affected by specific changes to size and weight limits.

Transportation prices, developed as an end product of the method herein described, represent all freight carrier costs of providing a specific service including some average level of carrier profit. The price (or cost/rate, as it is referred to in this paper) is calculated as a specific average charge and is used as a surrogate for a freight rate taken from a published tariff for a specific movement. Comparisons of these cost/rates with actual rates taken from published tariffs and comparison with disaggregate average revenues of actual shipments indicate that this approach will be accurate enough for the intended use. It is presented as the only feasible forecast of a constant dollar freight charge in a future year for a specific truck size and weight scenario, given the complex rate structure and the unpredictable result of the rate making process. The published applicable freight rate may, at some future time, actually return a greater than average or less than average profit for a given movement and a direct pass-through to the rate of specific cost changes may or may not occur depending upon the level of profit and the degree of competition in the specific market.

Although this pricing method has been developed with the objective of highlighting specific vehicle configuration and load capacity changes resulting from specific changes to certain size and weight regulations, they are easily applied to the analysis of variations in truck and rail operations induced by other regulatory changes.

The cost estimates developed in this report for both truck and rail apply mainly to the most predominant truck and rail configurations currently involved in the transport of shipments. However, they have been adapted to represent Western Doubles,[1] Turnpike Doubles,[2] and Triple 27s.[3]

Specifically, truck costs have been developed for dry van operations used for general freight merchandise traffic, as well as other dedicated services requiring specific equipment types, such as refrigerated vans, tanks, platform/racks, auto transports, and bulk dump operations. Rail costs for conventional general service box carload, TOFC/COFC[4] dry vans and specific equipment types of refrigerated cars, tanks, platform/racks, auto transports, hopper/gondola unit trains, and TOFC refrigerated vans are presented to be comparable with highway operations.

The cost formulae developed have enough flexibility to reflect variations for both truck and rail in terms of operations, equipment, as well as any projected changes (in excess of general cost inflation) in fuel prices, labor rates, highway user charges, and other items. Basic parameters isolated for both truck and rail cost development were carrier type, equipment type, shipment size, and geographical region. The resulting costs reflect significant differences among these modal subdivisions. Because of the many parameters needed to be studied and the need to isolate sensitive components of cost, none of the currently available costing tools were

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1 A Western Double represents a tractor-trailer combination in which the prime mover is a two-axle cab over engine tractor pulling two 27-foot trailers. The overall length of a Western Double is 65 feet, and the axle configuration can be noted as 2S-1-2.

2 A Turnpike Double represents a tractor trailer combination in which the prime mover is a three-axle tractor pulling two 40-45-foot trailers. The overall length of a Turnpike Double varies between 102-108 feet depending on the type of tractor used (cab over vs. cab behind) and the axle configuration can be noted as 3S2-4 or 3S2-3.

3 A Triple 27 represents a tractor-trailer combination in which the prime mover is a two or three-axle cab over engine tractor pulling three 27-foot trailers. The overall length of Triples is 95 feet, and the axle configuration can be noted as 2S1-2-2 or 3S1-2-2.

4 Trailer/container on flat car (TOFC/COFC) trains represents an interaction between truck and rail modes in which the services of both modes are used in the transport operation. For this study, TOFC operations were estimated assuming trailers of 40 and 27-foot lengths.

found to be suitable in terms of comprehensive treatment of total trip cost, compatibility among carrier groups, treatment of varying carrier capital structures and levels of profit, and data quality. However, selected components of the existing tools were used.

A parametric analysis presented in Section 5 suggests that the elimination of current state prohibitions on the general use of Western Doubles will reduce the cost of transporting less than truck load shipments by regular route common carriers by about 11 percent. This increases the competitive advantage of truck over rail for a market which is already dominated by motor carriers. The very small rail share of LTL market is in Freight Forwarder use of TOFC. Even if the 27-foot twin trailer rigs were used by the Forwarder, the cost savings in the collection/distribution would not compensate for the cost increases for rail terminal handling and line haul of 27-foot trailers on flat cars using existing technology and operations. Western Doubles can provide savings of 10 percent to 16 percent for all low density truck load traffic, but, the greatest attraction at present is the reduction of cross dock handling offered to regular route motor common carriers of LTL traffic. It is not clear whether or not the truck load carriers would opt for Western Doubles for low density traffic if the present prohibitions were lifted. The present non-uniform situation imposes a requirement for a mixed fleet of equipment which negates the potential carrier cost savings.

Axle load and gross weight changes of about 10 percent (the current range above and below the federal standard for the conventional tractor trailer combination) reduce competitive general freight truck load shipment costs by 7 percent to 9 percent, thus extending the break-even haul distance between highway and rail TOFC from 310 to 360 miles. Highway user tax levels would have to increase to about five times the 1977 level in real dollar terms to negate the competitive price advantage that would be gained by highway carriers over rail TOFC carriers of general freight by a 10 percent capacity increase.

Rising fuel prices tend to have a slightly greater impact on truck cost/rates than on rail cost/rates, but not enough to significantly change the competitive price relationships between the highway and rail carriers. A five-fold increase in fuel costs (which implies the product of fuel price and efficiency) above the 1977 levels would increase the truckload general freight cost/rate by 29 percent on the highway and by 22 percent on rail TOFC. This closes the rail/truck differential by 7 percent in the shorter ranges and just begins to compensate for the 7 percent to 9 percent capacity induced truck price improvement.

The potential reduction in cost/rates attributable to use of turnpike doubles in lieu of conventional semis is directly related to the higher payloads specific truck services can attain. For full truck load shipments, turnpike doubles can provide a 13 percent saving for vans carrying general service merchandise, while dump trucks carrying products of mining, or platform trucks carrying heavy manufactures can realize the largest cost/rate reductions of around 23 percent. Truck's competitive position with rail services is improved with the availability of turnpike doubles. Dry van truck load services, with gross weight limits controlled by the bridge formula and single/tandem axle loadings of 22.4k and 36k pounds, will be competitive with rail TOFC at distances up to 650 miles. Refrigerated vans utilizing turnpike doubles appear even more attractive compared to rail TOFC. Motor carriers are able to compete with TOFC refrigerated vans up to distances of 1150 miles at these high weight limits.

Axle and gross weight limit changes will have a greater economic effect on special commodity services than general commodity services because line haul costs represent the major portion of total cost/rates for special commodity services. Cost/rates of special commodity services using conventional semis will increase around 10 percent, if GCW limits are rolled back from the current federal level (80/20/34) to the 1956 level (73/18/32). Only a 4 percent decrease in cost/rates will be realized if GCW limits are increased to the heavy axle limits (22.4/36) compared to the current federal level. The largest productivity gain (11 percent for dry and refrigerated vans, 14-16 percent for other special commodity services) for full truck load services will be realized if turnpike doubles are substituted for conventional semis while maintaining the current federal axle limits (20/34).

2. BACKGROUND

The Department of Transportation is conducting a broad and comprehensive study of truck size and weight limits in response to Section 161 of the Surface Transportation Act of 1978. The DOT study is designed to provide estimates of economic, institutional and social impacts and to develop policy recommendations relative to uniformity of maximum truck size and weight limits throughout the United States. Seven major areas of investigation have been identified and responsibility for each has been assigned to various organizations within the Department.

1. Intermodal Competition
2. Highways and Bridges
3. Non-Uniformity Among States
4. Highway and Motor Carrier Safety
5. Energy Consumption
6. Environmental Quality
7. Policy Analysis, Development and Recommendations

The Transportation Systems Center (TSC) has been assigned the task of investigating the Intermodal Competition and Energy Consumption impacts of truck size and weight limit changes and the development of forecasts of highway freight traffic which are critical inputs to the other areas of investigation. The TSC assignment involves estimation of the effects of defined specific changes in the present system of vehicle size, configuration, axle and gross weight limits on both truck carriers and rail carriers in terms of changes in their respective operations, costs, profitability and service performance, as well as fuel consumption. Changes in the performance characteristics might translate into changes in freight rates and/or service quality offered to shippers and receivers. Such price and service changes could effect the competitive relationship among the various highway carrier and rail carrier groups and could cause substantial changes in highway traffic growth patterns by causing shifts of markets (e.g., between truck and rail carriers and between private and for-hire trucking). The balance that may currently exist in certain markets and/or the modal growth trends recently observed could be substantially changed.

It is apparent that the accuracy of projected impacts in each of the above listed areas of investigation is dependent upon the accuracy of the estimates of future growth of highway freight traffic developed as part of the Intermodal Competition Study. In turn, the accuracy of the traffic growth forecasts is dependent upon the accurate representation of truck and rail operations, services and the economics of the for-hire motor carrier, private trucking, and the competing rail services. It is necessary, therefore, to apply the most comprehensive and accurate costing methods available to assess the competitive impacts of specific truck size and weight scenarios and to forecast potential market shifts and the resultant effects on the growth patterns of highway freight traffic.

The present state-of-the-art in cost modeling was reviewed by TSC and was found to be inadequate for this Truck Size and Weight

(TS&W) Study. In general, prior costing efforts were each found to be deficient in one or more of the following areas:

1. Functional costing categories cover only one portion of the total cost of the actual operation (i.e., line-haul).
2. Inadequate or considerably outdated data bases could not be updated without surveys or other expensive and time consuming methods.
3. Not applicable on other than a national aggregate basis.
4. Not reflecting current financial or capital requirements.
5. Containing an indexing procedure to update costs that is not current for all regions or carrier types.
6. Containing unit cost outputs that are not compatible for more than one mode or one carrier group.
7. Cost cannot be converted to match any particular service or equipment type.
8. Rates or rate models used are not sensitive to changing profit level variations among types of carriers or markets, nor are they sensitive to changes in carrier operating costs attributable to system or technology changes.
9. Requires estimation or sampling procedure of a larger data base, but cannot identify any specifics such as equipment types, operating types or regional analysis.
10. Contains no return to invested capital other than debt expense.

11. Not amenable to changes in the necessary input variables to measure future impacts.

12. Individual carrier groups or operating types cannot be isolated.

Several of the models were investigated and seven (7) proved to have applicability in some areas. These are the Association of American Railroads[5] truck cost model, the C.A.C.I.[6] modal simulations, rate models used in the M.I.T. City-Pair Logistics Model,[7] H. O. Whitten Transport Cost Functions,[8] M.I.T. Econometric Cost Functions,[9] and the TSC Rail and Truck Cost Models.[10,11] These previous costing efforts were developed for special purposes and each has been found unsuitable for

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5 Martin, W. AAR Truck Cost Model, Association of American Railroads Technical Memorandum 78-12. October 16, 1978.

6 "Freight Transportation Energy Use." Report No. DOT-TSC-OST-79-1, prepared for U.S. DOT, TSC, by CACI, Inc. July 1979 Final Report.

7 "An Equilibrium Analysis of Selected Intercity Freight Markets: Trucks With Double Trailers Vs. TOFC Shuttle Trains As Energy Conservation Alternatives." M.I.T. Center for Transportation Studies, CTS Report #77-25. December 1977.

8 "Development of Transport Cost Functions." Herbert O. Whitten & Associates. August 26, 1976.

9 "Equity, Efficiency and Resource Allocation in the Rail and Regulated Trucking Industries." M.I.T., Center for Transportation Studies for U.S. DOT, March 1979.

10 "Freight Market Sensitivity to Service Quality and Price." U.S. DOT/TSC Staff Study, SS-223-U1-32. December 1977.

11 "Railroad Cost Modeling, Volume I," by John F. Murphy, US DOT/TSC Staff Study, SS-212-41-27. September 30, 1976.

exclusive use in this project. However, portions of these previous modeling efforts have been used either in our actual calculations or as a guide for development of the TSC models.

An approach was needed for the TS&W Study that would provide a relatively simple and systematic method of estimating potential changes to transport prices. It is necessary to estimate price changes through changes in carrier costs for specific services, and average profit levels for specific regional carrier groups. Actual market specific rates or rate models based on a sampling of rates would require extensive data gathering and modeling of substantial scope. The product of such an effort would represent the present rate structures which are a reflection of the competition, route, ease of entry, market size, and existing regulatory systems. However, use of historical rates or aggregate rate models may not reflect what could occur if any of these current constraints were changed. Therefore, it is simpler, less costly, and as informative in any intermodal competition or market shift study of this nature to estimate the full economic cost of the affected transport services.

Although the chosen approach is to use carrier reported costs for specific services in specific markets, rather than the published freight rates, the necessary rate/revenue/cost relationships are included. The cost/rates produced by the TSC models include the industry average profit for the operation. The existing rate/revenue/cost relationships are, therefore, reflected in these cost models.

These rate surrogates are created by calculating an average return to total capitalization for each carrier group including not only debt cost, but the historical dollar profit levels that each carrier group has been earning in the chosen base year. Any change to the operating cost attributable to changes in truck capacity will be assumed to be directly passed on to the consumer/shipper in the form of reduced or increased rates or charges for services.

It is not clear at this point in the study just how much pass-through of cost changes to freight rates can be projected in markets of high or low competition and low or high profit levels. It might be assumed that in markets of low competition profits are higher than average and, therefore, cost reductions are slow to pass-through; while in markets of high competition, the reverse might be true. Pending further study on this issue, it was decided that the carrier cost plus the average capital structure and returns for each carrier group was the most appropriate means of reflecting impacts on the transport prices.

The basic assumption behind the approach to pricing is that average revenue yields, over the long run, will approach costs plus some acceptable return to capital. Therefore, an approach such as this, in general, recognizes current government regulatory efforts to increase market competition and to provide carriers more pricing flexibility. Thus, assuming some degree of success at providing the industry with greater competition and pricing freedom, in general, prices will begin to develop a consistent relationship with the costs of providing the service. This approach also provides the means to reliably assess impacts on carrier costs and specific market prices attributable to specific changes in the TS&W limits.

Various equations and input data from the above listed existing cost models were synthesized to develop sets of equations (models) that are responsive to the TS&W project's needs. Specifics on these costs and equations are more thoroughly discussed in following sections of this report.

2.1 Purpose and Scope

The Transportation Systems Center (TSC) has been assigned a series of specific tasks in the aforementioned overall DOT TS&W Study. The assignment is to evaluate certain impacts of changes to the present federal and state limits on truck size and weights. TSC must evaluate the effects of such changes on both motor and rail carriers in terms of these carriers' operations, costs, revenues, profit levels, and fuel usage. Changes to the carrier operations and their economic situations could result in changes to the related freight rates charged to the consumer of these services (shippers and receivers). This in turn could cause shifts in certain markets among various carrier groups. The potential shifts in markets among modes and carrier types, the resultant truck traffic attributable to the altered operations, and the economics of these carriers must all be estimated by TSC.

This TSC Technical Supplement Volume concentrates on the cost tradeoffs involved in alternative sets of limits that might be imposed on truck and rail services in the interest of establishing national uniformity among states. The intent of this report is to provide an understanding of the sensitivity of transport economics to the alternative TS&W limits, to describe the cost analysis used, and to document the input data and the basic assumptions made in this effort. This report provides the results in the form of a parametric cost analysis reflecting the potential impacts of a large array of possible changes on the economics of various carrier groups. These potential cost/rate impacts are demonstrated through the applications of the appropriate costs to the various configurations and volume/capacity scenarios outlined in another technical supplement volume.[12] The results in Section 5 show what economic benefits or liabilities could occur to competing carrier groups if the present system of limits is changed, and what effects on the competitive relationships certain changes could cause. No attempt has been made as yet to size the individual markets effected. This will be the subject of a subsequent report.

In conclusion, the cost/rates are presented as the average prices for various shipment categories reflecting 1977 average profits for the carrier types/groups, and 1977 average levels of labor, capital,

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12 "Analysis of Truck Payloads Under Various Limits of Size, Weight and Configuration," by J. Mergel. Technical Supplement Vol. 1, November 1980.

maintenance, fuel price, and fuel consumption rates, and highway user taxes, etc., required for each unit of throughput. The cost/rate estimates presented in this paper are inputs to subsequent steps in the TSC project of analyzing the potential shifts of markets between specific carrier groups and modes which are reported in Technical Supplement Volume 4.

3. OVERVIEW OF MODELS AND DATA

3.1 Primary System Parameters for Costing

The models developed here should be described as the result of an engineering, cost accounting, and an economics approach. They incorporate a wide range of primary and secondary parameters that are sensitive enough to produce unit costs for specific categories of operations. However, these unit costs are the result of many front-end assumptions concerning the primary parameters and these should be discussed accordingly.

3.1.1 Functional Areas

The first parameter to be considered is one of a functional nature. Reviews of other models reveal that in many cases only the "line-haul"[13] or only a "total cost"[14] was the resulting cost output of the model. Although it is safe to assume that any changes to the present TS&W limits will primarily affect line-haul costs, some changes, such as the use of Western Doubles, may affect "terminal handling" and "pick-up and delivery" costs. Therefore, it is necessary to treat each function separately, when possible. Since it is the door-to-door freight rate or price that is the dominant determinant of the carrier choice, the impacts of changes to the functions most

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[13] Line-haul costs refer to operating expenses incurred in the movement of revenue freight from a specific origin to a specific destination. Other cost components such as pick-up and delivery, platform or terminal handling are excluded from the cost components.

[14] Total cost models deal with aggregate system statistics. The amount of detail of a carrier's operation is low in that one cannot differentiate between individual service movements.

affecting the total price have to be determined. Therefore, the major functions identified as pertaining to that total price are:

1. line-haul
2. other terminal activities
3. pick-up and delivery
4. platform handling
5. all others.

After analysis of these functions it was determined that for purposes of this project they could be aggregated to the two major functional areas of: (1) line-haul and (2) terminal area. These two areas represent the aggregate of:

1. Line-haul -- all costs associated with the transportation from an origin to a destination including equipment ownership and maintenance.
2. Terminal area -- all costs associated with (a) pick-up and delivery; (b) across the platform handling and collection at the origin, destination, intermediate terminals, and other terminal activities; and (c) all other company overhead costs such as bill collecting, marketing, G&A, etc.

Throughout this report, these cost areas will be referred to as line-haul and terminal area.

3.1.2 Body Types: Truck and Rail

Another major cost parameter to consider is the body types that should be used to represent the majority of movements for the particular subgroups of markets under study. In addition, appropriate configurations should be matched to specific services and equipment types to accurately reflect truck and rail operations. General service merchandise dry van trailers were isolated and analyzed in the preliminary December 1979 report. This analysis is an expansion of that report, including other body types, such as refrigerated vans, tanks, platform/racks, auto transports, and dumps. The cost of "singles" vs. "doubles" vs. "triples" is analyzed for all equipment types. Different truck configurations and body types have inherent advantages for different commodities and shipment sizes.

Rail is treated on a comparable basis with truck operations in this report. Rail costs have been developed for general service boxcar, dry van and refrigerated van TOFC/COFC, refrigerated car, tank car, platform/rack car, auto transport car, and hopper unit train car. Specialized car types are differentiated from general freight operations by estimating the effects ownership, maintenance and fuel costs among the various services involved.

3.1.3 Shipment Size

Two major types of shipment sizes have been isolated in this paper. There are major differences between types of operations which characterize less than truckload[15] (LTL) and truckload[16] (TL) services. The costs associated with these different shipment sizes are isolated. In addition, truck configurations are separated out and matched with specific types of traffic.

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[15] Less than truck load shipments, by I.C.C. definition, means any shipment which moves a single bill of loading and weighs less than 10,000 pounds, actual weight.

[16] Truck load shipments, by I.C.C. definition, means any shipment which moves on a single bill of lading and weighs 10,000 pounds or greater, actual weight and fully utilizes the weight and/or cubic capacity.

In the terminal area, LTL traffic requires additional costs in pick up and delivery and terminal handling because of the inability to fully load the line haul truck. TL traffic minimizes costs in pick up and delivery and terminal handling because the truck is usually loaded to its capacity. TL traffic in some instances does incur terminal costs. Because of this it was necessary to separate TL traffic into full truck load (FTL) and partial truck load[17] (PTL) shipments. PTL traffic, unlike FTL traffic, does not quite fill up the line haul truck and is usually sent to the terminal to be topped off with LTL traffic. PTL shipments will incur additional costs in pick up and delivery and terminal handling, but not as great as LTL traffic.

Line haul costs ($/truck mile) for the three shipment sizes are essentially equal. The payloads associated with the predominant shipment sizes will vary and is the controlling variable to differentiate the cost/rates. Line haul movements of LTL and PTL shipments are represented by light density loads and usually "cube-out" before reaching the legal weight limit. An average design density of 12 pounds per cubic foot is used here to compute truck payloads for LTL and PTL shipments. A maximum legal weight load for FTL shipments is also computed to reflect the other end of the spectrum of loads. In certain analyses it may be appropriate to use other load conditions to better represent a particular flow of traffic.

General service merchandise dry van movements of LTL, FTL and PTL shipments are costed for regular route common carriers. The main difference among these three common carrier services is reflected in the terminal area costs, while line-haul costs would be essentially

[17] Partial truck load shipments is a truckload rated shipment, i.e., greater than 10,000 pounds which does not fully utilize both the weight and cube capacity.

identical for all three. Irregular route/contract carriers, private carriage and other specific commodity carriers represent FTL services and are costed as such to represent their door to door operation.

Rail costs are segregated among different shipment sizes to be compatible with truck costs. Dry van dedicated TOFC/COFC is the only true rail alternative to truck movements of LTL, FTL and PTL shipments and is costed for these services. General service box carload services, along with special car types are represented in movements of average shipment or single car and multi-car shipments. Cost differences for these shipments are again reflected in the terminal activities, while line-haul costs are identical. Bulk movements in hopper/gondola cars are represented and costed in multi-car and unit train shipments.

3.1.4 Geographical Regions

Another major decision area involved was of a geographical nature. The decision to be made was whether to develop cost in a national aggregate or develop costs that would reflect geographical, climatic, and regional labor and traffic congestion differences. Preliminary research suggested that the U.S. could and should be separated into major geographical areas. Underlying this decision were the basic assumptions that:

- terrain, climate and regional congestion yield different costs to accomplish a given job;
- regulatory constraints on TS&W are regional and thus affect costs in a regional manner;
- haul-distance, which affects equipment and driver utilization tends to be of a regional nature;

- o carrier labor costs for both functions of line-haul and terminal area tend to be of a regional nature;
- o local taxes, registration and licensing and insurance are of a regional nature;
- o because of the various market structures and the physical characteristics of shipments and commodities, carrier costs to build LTL and collect FTL loads are of a regional nature.

On the basis of these assumptions, a preliminary analysis focussing on general service merchandise dry van operations isolated four geographical regions for cost estimation. Underlying the four costing regions are the nine Interstate Commerce Commission (I.C.C.) rate reporting regions. The rate regions are aggregated because the actual differences were not great enough to warrant the added burden of developing and applying that many sets of cost equations. Little insight would be gained into carrier group operations or costs by using the more detailed breakdown.

When revising the preliminary analysis to include other special commodities, equipment types, and shipment sizes, it was also necessary to alter the truck costing regions. Five truck costing regions have been developed to have boundaries consistent with the ten TS&W Study regions, because using ten cost regions was infeasible. The ten TS&W Study regions were formed on the basis of each state's current TS&W limits in order to receive a good approximation to regional impacts.

Rail costing regions utilize three geographical areas. The costing areas for rail are identical to the I.C.C. rail cost regions. It was not necessary to revise the rail regions for this updated version.

Appendix A provides individual maps for the preliminary and revised costing regions, in addition to the ten TS&W Study regions. A matrix identifying the corresponding regional breakdowns of truck, rail and the overall study regions is included.

3.1.5 Carrier Groups

3.1.5.1 Highway Carrier Groups - The next major consideration was to develop a classification scheme for the many types of trucking operations that would be manageable, yet reflect major differences among carrier services that were significant to TS&W issues. The carrier groups selected were regular route common general freight; contract, irregular route common general freight; private carriage; and specialized commodity carriers.

Cost and service characteristics are generally assumed to be homogeneous within each of the previously listed groups and relatively divergent among them because of the character of their operations. It is because of this that the carrier groups should respond differently to changes in size and weight limits such that the resulting cost changes may result in different equipment choice decisions and submodal shifts as well as intermodal shifts. Some of the characteristics of firms within the operating carrier groups are listed below and serve as additional justification for the previous assumptions on homogeneity.

- Regular route common (RRC) carriers are also the general freight carriers.
- RRC carriers are those carriers that primarily aggregate LTL shipments into truckload intercity movements and as a result require local systems for pick-up and delivery

at both origin and destination as well as facilities for intermediate cargo transfer.

- RRC carriers of general freight also generally set the pattern for LTL rates/tariffs.
- Irregular route/contract carriage and special commodity carriers deal generally with truckload lots, are non-scheduled, and selectively solicit a particular type of freight and maintain terminals, if any, in base area only.

3.1.5.2 Rail Carrier Groups - Major considerations for determining which rail carrier groups should be selected for this TS&W Study were the transportation technologies railroads use and services they offer that would be competitive with alternative motor carrier services. These rail services involve a distinctly different set of equipment and/or manner of operation which results in different service levels and/or price. The rail service operations chosen to directly compete with general freight truck operations were the dedicated TOFC/COFC trains and the general service box carload mixed consist operations. Specialized car types were isolated and differentiated from general freight operations by examining the effects of ownership, maintenance, and fuel costs among the various car types involved. Although not a major consideration, it was necessary to distinguish what rail carriers would be considered in this comparative situation. Most major differences in operations were satisfied when the regional breakdown was made for rail. However, to be able to compare operations, costs, and financial and capital requirements between rail and truck, it was necessary to use only rail carriers that were considered financially viable.[18]

3.2 Secondary Variables: Operating and Economic Environment

In developing these models, major consideration was given to developing primary parameters. One major parameter was the factor input price changes that would or could occur between the base year 1977 and the forecast year 1985. Therefore, the effects of inflation were equalized by projecting all future costs in 1977 constant dollars. This means that in this cost analysis, inflation was assumed to affect all input factor prices equally over the long run, and that significant productivity changes will not occur between the base year and the forecast year except those specifically represented by the primary and secondary parameters. Secondary variables were allowed for in the models to permit analysis of situations where certain anticipated dramatic changes in one or more areas of the operating or economic environment could distort the base year data relationships. The four areas allowed for were:

1. financial structure/capital return factors[19]
2. driver/crew costs
3. fuel costs
4. highway user charges and rail maintenance of way costs.

The models are designed to be responsive to any projected increase or decrease in these secondary variables presented as either a factor applied to the base year vehicle-mile level values, or an

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[18] Financially viable represents ongoing railroad operations in which carriers demonstrate a profitable operating over a suitable time frame.

[19] See discussion Section 3.2.1.

actual forecast value of the market price. These variables should represent the major areas of change that could have a dramatic effect on the cost differences in the various carrier services offered.

All of the parameters and the inputs were designed to produce unit costs that are relatively specific, when applied to a series of particular transport operations, and should represent full economic costs on a truly comparable basis for each competitive service. Consistency in (as well as timeliness and accuracy) levels of detail and in the treatment of all important cost elements and assumptions across all modal carrier groups have been the major criteria for the decisions made in the development of these cost equations.

3.2.1 Financial Structure/Capital Return Factors

For the purpose of this analysis the annual cost of capital of a piece of equipment can be viewed as the recovery of the investment plus the opportunity cost of the investment. This approach will be referred to as the capital recovery method in this analysis. This factor basically computes the annual cost plus a return which recognizes the time-value of money. In addition, this method computes a uniform annual cost scale which covers the economic operating life of the equipment. This method computes the capital cost in such a way as to provide a uniform cash charge for the investment to earn a return of x in n years. In conjunction with this method, the following major inputs are used:

- o replacement costs for equipment (1977):
- o actual cost of capital applicable to each carrier group (1977);

- actual utilization rates for all operating equipment for each carrier group (1977);
- other such factors as apply to each carrier group or subgroup.

This method was used in this report for the specific purpose of making cost comparisons of effects to the various modal groups and subgroups of changes to equipment configurations and capacities that may arise as a result of changes to the present TS&W limits.

This method was used for both the rail and truck carrier groups, but only applies to the actual operating equipment (i.e., trailer, tractor, railcar, and locomotives).

These costs were then reduced to a dollar-per-mile basis for inclusion into a total dollar cost per vehicle or railcar-mile operated for the specific regions and carrier groups.

The other portions of capital costs not treated under this method were all terminal facilities and major rail upgrading. Because of the various problems with obtaining actual replacement costs for buildings, terminals, 50-year old rail lines, highways, these capital items were either treated on an operating cost (maintenance of way and highway user tax) incurred basis or on reported actual capital cost basis. The actual treatment of these items is as follows:

- Major road upgradings that could be identified were treated on an actual capital cost basis and were based on the annual cost of capital for that carrier group applied to the capital investments reported for these upgradings.
- Annual maintenance of way costs for old rail lines were classified as "non-depreciable" and were recorded as a current expense.

- o Terminal (buildings, etc.) facilities for highway and rail carriers were costed by applying the actual carrier group's cost of capital to the investments in those facilities.
- o Annual maintenance of way costs for highway carriers was considered to be represented by the reported highway user taxes applicable to each group.

Therefore, for the purpose of this analysis, all costs were thoroughly represented by an operating cost basis, and capital recovery basis or an actual annual capital charge for all investments.

All of these annual costs were then reduced either to a line-haul charge (rail: per-car-mile, per-trailer-mile; truck: per-truck-mile) or a terminal charge (rail: per ton shipped; truck: per ton shipped). For further details (formula and costs) and calculations, see Tables E-3, E-3.1, E-3.2, E-3.2.1 of Appendix E and Tables F-3, F-3.1, F-3.2, F-3.2.1 of Appendix F.

3.2.2 Driver Costs

Total labor cost for motor carriers was apportioned into two categories: direct and indirect labor. Total expenses, in terms of salaries and wages, miscellaneous paid time off and other fringes for drivers and helpers and owner operator drivers, represent the actual costs for the direct labor category. Indirect labor represents the total salaries, wages, and fringe benefits for officers, supervisory personnel, administrators, and clerical help. The direct labor cost category (referred to as driver costs) is assigned to line-haul and pick-up and delivery functions, and has to be separated when computing line-haul and terminal area cost components for total door-to-door shipment cost/rates.

Direct labor costs for rail services represent the wage expenses which would accrue as a result of operating a rail freight train. Two specific rail freight operations are examined as being the most competitive to motor carrier general freight operations: dedicated rail TOFC and general consist box carload. The major difference in train crew operating strategies between TOFC and conventional carload service is the average crew size working a train. Conventional carload service utilizes five crew members: one engineer, one fireman, one conductor, and two brakemen; while dedicated TOFC trains operate with four crew members -- only one brakeman.

Train crew costs are estimated as a function of crew size and type of services performed. Costs are computed on a dual basis: hourly wage and length of travel. Assumptions underlying computations are that fringe benefits represent 35 percent of total cost, the operation of a train within one crew district represents a daily basic pay regardless of time or mileage, and costs were based either on a four- or five man crew.

For further details (formula and costs) and calculations see Tables E-1, E-1.1, E-1.2, E-1.3 of Appendix E and Tables F-1, F-1.1 of Appendix F.

3.2.3 Fuel Costs

The fuel cost for highway carriers is the product of the 1977 price of diesel fuel and the amount of fuel consumed in normal transport operations. For rail carriers, since operating statistics are not isolated for specific rail services, a simulation model[20] was used to calculate rail fuel

[20] Railroads and the Environment -- Estimation of Fuel Consumption in Rail Transportation, Report No. FRA-OR&D-75-74.1, John Hopkins, May 1975.

consumption. Then the fuel cost was estimated. Underlying the rail cost analysis, the 1977 average diesel fuel price per gallon was estimated to be $0.35.

Expense categories of fuel and oil, lubricants and coolants for line-haul, pick-up and delivery and terminal area transport functions were aggregated to produce a total expense for motor carriers. Line-haul fuel expenses were then apportioned to the appropriate number of truck miles in line-haul service to produce a per-truck-mile figure. Total terminal area fuel costs were expensed to total tons handled to produce a terminal area per ton figure. Refrigerated van carriers have their total fuel costs in an aggregate format such that one cannot differentiate the amount of fuel required to keep the cooling unit operating from the propulsion fuel.[21] Fuel consumption estimates for each region of operation are presented in Appendix E, Table E-2, Truck Average Operating and Traffic Statistics.

Railroad operating statistics are usually not disaggregated enough to allocate costs to a specific train service. In addition, railroads do not typically maintain accounts of fuel consumed by individual trains. Therefore, it was necessary to have a means for fuel consumption. Simulation model calculates fuel consumption based on a set of data inputs which describes the rail service. The model requires detailed inputs on type of terrain, gross trailing tonnage, total horsepower of the train, average train speed, and route geometry. This steady state fuel consumption model does not capture the differences in fuel consumption rates among different types of loco-

[21] For further analysis of refrigerated van and other truck fuel consumption see "Truck and Rail Fuel Consumption Effects of Truck Size and Weight," Technical Supplement Vol. 3.

motives or the idle time which is a necessary part of freight operations.

For special rail services such as refrigerated car and dedicated TOFC refrigerated van operations, compensations were made to the fuel consumption model to account for the operations of the cooling units. Average number of days[22] for each operating function (L/H, PU&D, PLAT, TERM) were calculated from which a consumption rate of .7 gal/hr/ refrigeration unit[23] was applied. Total expenses were then apportioned to line haul or terminal area functions.

3.2.4 Highway User Charges

Motor carrier's highway user charge account represents the total expenses for federal and state operating taxes and licenses. The items included are gas, diesel fuel and oil taxes (federal and state), and vehicle license and registration fees (federal and state). Since other operating taxes, real estate and personal property taxes were not looked at as highway maintenance costs, they were not included in the highway user charge account.

Annual maintenance of roadway costs by railroads are considered to be comparable to the motor carrier highway user charge. The costs are a function of the terrain, climate, surrounding environment (urban versus rural), traffic volume, and line-haul speed. Maintenance costs are intended to include all labor and equipment expenses assigned to line-haul operations. To avoid any double

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22 "Freight Market Sensitivity to Service Quality and Price," USDOT/TSC Staff Study, SS-223-U1-32, December 1977, Appendix A.

23 Conversations with industry representatives: Fruehauf Corporation and Thermo King Corporation.

counting of expenses in relation to capital equipment and maintenance, one must follow I.C.C. individual expense account subdivisions. Expenditures relating to the replacement of part of or the entire roadway are recorded as current expenses and are non-depreciable, while original construction, major upgradings, or one-time improvements will be classified as a capital asset. This item can be more easily costed through normal balance sheet methods. The rail maintenance of way cost is divided into two portions:

1. Fixed costs including vegetation control, drainage clearing, snow removal, service and repair signaling, grade crossings, and structures; and
2. Variable costs including wear and tear on rails, bolt tightening, tire replacements, surfacing, realigning, and miscellaneous expenses (spikes, point bars).

3.3 Functional Unit Costs

This discussion deals with the resulting unit costs that were developed for comparative purposes for all highway and rail carrier groups. The basic units developed were as follows:

- o For highway: Dollar cost per truck mile (represents line-haul costs); dollar cost per ton shipped (represents terminal costs).
- o For rail: dollar costs per car mile (represents line-haul costs); dollar cost per trailer mile (represents line-haul cost for TOFC/COFC); and dollar cost per ton shipped (represents terminal costs).

For this exercise, it was necessary to reduce the costs generated for each mode and subgroup to a unit that would represent the functional activity of that carrier and would represent the cost of each level of activity in that function. As was mentioned earlier, there were two major areas of activity in both rail and highway transport operations. These areas were line-haul and terminal area. Once the areas were isolated, these functions had to be represented by a cost per level of activity in each group in order to be compared between carrier groups or subgroups for measuring any cost advantages or disadvantages for each group. Once these costs were developed, any changes to the input variables such as those mentioned previously (labor rates, fuel costs, etc.) could then demonstrate their effects on each unit applicable to each carrier group. Any cost changes due to changes in the present TS&W limits would lead to a potential advantage or disadvantage to the various carrier groups. This enables a comparison of impacts on costs resulting from changes in TS&W limits or other variables. Although these unit changes will represent only the cost changes and not the service changes that may or may not occur, they will give an indication of the level of effect cost changes may have on rate changes, assuming any benefits are passed on to the shippers by the various carrier groups.

4. DEVELOPMENT OF COST MODELS AND DATA FILES

This section provides documentation of data sources and data used, calculations and tabulations of carrier groups, variable inputs and outputs.

4.1 Truck Model

4.1.1 Data Sources

The data inputs used to develop the needed cost, financial, and traffic information for impact analysis for the regulated carrier groups were based on the 1977 M-1 statistics files of the Interstate Commerce Commission (I.C.C.). The private carrier data files were derived from various sources. The private firms contributing to this file submitted information in a very general format that was just adequate for TSC to develop unit costs generally comparable to those units developed from I.C.C. data. The I.C.C. regulated carrier data files were chosen for the bulk of the costing because they represented the most comprehensive, detailed, up-to-date, and generally acceptable, data base available. In addition, it is the most comparable data base in format and detail of reporting to any rail data base. These files are not the normal I.C.C. "blue book" version of their reports, but an internally reported version generated by the I.C.C. through a special request of TSC.

In order to build preliminary cost breaks and distributions from these files it was necessary to isolate specific carriers that would properly represent the various forms of truck operations in each geographical region and carrier group. Contact and general consultations were held with the American Trucking Associations, the Private Truck Council of America, Common Carrier Conference-Irregular Routes, the Regular Common Carrier Conference, the Contract Carrier Association, the Private Carrier Conference, etc., and some of the carriers themselves in order to develop a basic list of carriers by name, location, region, and code number that would be adequate for representation of the groups and operating regions. The carriers in this basic file were contacted, when necessary, for the purpose of determining the type of truck/van configuration which best represented their equipment fleet. From these contacts, base carrier group operators were identified.

4.1.2 Functional Costs

Once the carrier files were grouped and tested for reporting consistency, the cost aggregation was accomplished. The reported functional costs that were initially analyzed were line-haul costs (including capital) and terminal area costs (including capital).

4.1.2.1 Line-Haul Costs (Operating) - Line-haul costs are basically composed of labor, equipment, maintenance, fuel, oil, lubricants, tire and tube replacement, user taxes, license fees, and other overhead and miscellaneous expenses, some of which required some sub-allocation procedures.[24] Although most of these sub-accounts or common cost areas were allocated to line-haul by the carriers themselves, there were some items that required further allocation. An example of one of the types of these costs is fringe benefits and payroll taxes. These items needed to be further allocated to the labor functions that applied to line-haul or terminal.

[24] See Tables E-1.1, E-1.2, E-1.3, of Appendix E.

Table E-1.3 in Appendix E lists the carrier allocated costs accounts associated with line-haul activities and those special joint items that required further allocation for this project. The annual costs derived in the listing were then used in conjunction with the appropriate traffic data/units of the same carrier to produce average unit costs for that group. The resulting average unit costs which are representative of the type of carrier operation and region of the country, are the derived outputs for the various impact analyses to be conducted in this TS&W Study.

Although only the average unit cost outputs will be presented in this report, the data base compiled by TSC for this cost modeling effort can yield additional detailed information on carrier specific markets, revenues and costs which could be useful in any regional specific case study analyses or issues.

4.1.2.2 Terminal Area Costs (Operating) - Much in the same manner as the line-haul cost, the total terminal area costs are composed of labor, maintenance, clerical and administrative, fuel, etc. However, the terminal area position of this costing represents the aggregate of other functional areas such as;

- o pick-up and delivery;
- o platform handling;
- o billing and collection; and
- o other terminal related or allocated G&A.

Similar to line-haul costing, the terminal area subaccounts were allocated to the individual activities by the carriers and only when these areas were not directly allocable or identified by the carrier did this analysis make any individual allocations. The full allocations are identified in Tables E-1.1 and E-1.2 of Appendix E. The annual costs derived from the listing or summary were used with appropriate traffic data/units of the same carriers to produce average unit costs for that group. The resulting average unit costs which are representative of the type of carrier operation and region of the country are the derived outputs for the various impact analyses to be conducted in this TS&W Study. In addition to the average unit costs, the data in this area -- terminal -- as well as for the sub-areas such as pick-up and delivery, platform, etc., can yield additional detailed information on carrier specific markets and costs which could be useful in any regional specific case study analyses.

4.1.2.3 Capital Costs -- Line-Haul and Terminal Area - One of the important parts of this study or any study dealing with costs is the portion of costs related to the cost of equipment and the return required to keep the carrier's systems operational and economically viable. Traditionally, the area of cost of capital has been the most controversial subject in any costing project. In order to measure and isolate the operating cost effects for each carrier group attributable to truck capacity changes, 1977 replacement cost of equipment and common purchase prices were used in this project for all carriers. One major improvement made by TSC in this costing effort was to reflect the unique capital structures of each carrier group and their 1977 costs of capital. Initial analyses of reported statistics indicated that the capital structures and profit levels are different among the selected carrier groups. Therefore, these individual capital structures and profit levels were incorporated into the capital cost analysis for each carrier group. These cost factors were incorporated into the capital recovery method mentioned earlier and the average cost of the total capital[25] was determined for each group. The cost of capital represents the cost of debt and equity (thus, profitability) weighted by the debt and equity ratio in the carrier group. This factor, when used in conjunction with the capital recovery method, will insure that the debt cost as well as the level of profits and equity sustained by the carrier group through 1977 are totally recovered through the unit cost over the life of the equipment financed. In addition to the cost of capital factor used, the equipment costs for tractors and trailers reflect the 1977 average manufacturer prices. The 1977 operating factors such as economic life, average mileage, etc., were used with the capital recovery method and reflected regional utilization and other regional factors whenever possible. This process removes the possibility of uncomparability among the various truck sub-groups caused by average equipment age for each group. The aforementioned capital recovery method basically represents the capital costing method used for comparing the operating equipment (rolling stock) or the line-haul functions which should be the predominantly affected area in any TS&W limit changes.

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[25] The cost of capital is equal to a weighted average of individual carrier's cost of debt and return to equity. The weighing procedure is accomplished by applying carrier's debt/equity ratio to the respective costs.

The terminal area capital costs were also included in the total cost units, but were computed in a somewhat different manner than the line-haul capital costs. Since it is not feasible to estimate the replacement costs and/or purchase prices of most terminal area facility assets, the approach used was to isolate the annual debt and equity costs as reported by the carriers and apply that cost to the remaining investment in those terminal area facilities thus reducing those costs to an annual cost basis. Once this is accomplished, it is only a matter of applying this annual cost to a tonnage or other factor to develop a unit cost per x item. These annual terminal capital costs will be used in conjunction with the line-haul capital costs, also reduced to a unit basis, to represent the total capital costs involved in a particular type of trucking operation.

Therefore, the total capital cost portion of this truck costing effort is represented through the capital recovery method for the rolling stock cost and an actual incurred type of capital cost for the terminal area facilities portion. This approach will be comparable for rail (see discussion in Section 4.2.2.3). Both methods use the actual cost of debt and equity and thus the actual cost of capital, for each carrier group and region. Details as to actual calculations and account data included to derive the aforementioned components are contained in Tables E-3, E-3.1, E-3.2, and E-3.2.1 of Appendix E.

Because of the limited requirements in this project to determine the capital costs and not the age or present condition of the capital assets the liability and stockholders equity portion of the balance sheet was the primary tool used in the analysis. Although the aforementioned balance sheet items were the primary tools used, the asset side of these carrier balance sheets was used occasionally for special problems and analysis. Two primary reasons for using the asset side were for testing the total investment portfolio to cost only the operating investment portion of the carrier groups, and for analysis of the assets to separate (line-haul) rolling stock and terminal area facilities investment.

The results of the truck capital cost analysis are shown in Tables E-3, E-3.1, E-3.2, and E-3.2.1 of Appendix E.

The remaining portion of truck costs that are not treated as capital costs in this analysis are the road maintenance or "user taxes." For the purpose of this analysis, highway "user taxes" are represented in the motor carrier operating costs and are used as a surrogate for highway capital and maintenance costs. The categories of accounts including "user taxes" are shown in Tables E-1.1, E-1.2 and E-1.3 of Appendix E, and are listed as both line-haul costs as well as terminal area costs.

The aforementioned system of capital costing will isolate major effects of changes to the present TS&W limits in several ways. The cost of capital, derived for each carrier group and region, if applied either to the actual remaining equipment facilities or to the capital recovery method used for rolling stock reflects the required revenue over and above the costs of each of the carrier groups. Therefore, any change in the operating efficiencies, fleet upgrading or restructuring due to vehicle capacity changes resulting from TS&W changes would be assumed to be passed through to the shipper in the form of increased or decreased rate charges.

If any changes to costs resulting from changes to the present TS&W limits caused, for example, a reduction in the total operating costs, it is assumed that the reduced costs would be passed on to the shipper in the form of a reduced tariff for the same shipment. Therefore, any changes in costs will highlight the direction carrier rates will go to compensate for any increase or decrease in the various input factors of production. With regard to identifying actual rates on specific commodities, the needs of this study are such that it is not necessary to identify the individual rate impacts for specific shipments. This analysis is dealing in the realm of the cost and revenue impacts of categories of carriers. Therefore, it is logical to assume that any increase or decrease in costs will be passed through as a freight rate charge offsetting the price of transport in specific markets or be absorbed by the carrier as an increase or decrease in profits and return to capital. In either case, the carrier group has gained or suffered a change in its competitive situation. In addition, to avoid the time consuming efforts of treating the exceptions to the general rule and to simplify the development of the alternative scenarios of truck operations the assumption that the general economic effects apply to profitable or financially viable carriers will also apply to the marginal carriers in the same groups.

4.2 Rail Model

This portion of the cost modeling effort is based on previous work at the Transportation Systems Center, entitled "Railroad Cost Modeling," Staff Study 212-U1-27, by J. F. Murphy, September 1976, hereinafter referred to as the TSC Railroad Cost Model. This model is based on engineered economic costs which reflect the full economic cost of providing the service expressed as an average in dollars per car- or trailer-mile.

Services offered by railroads that are to be applied to the TSC Rail Cost Model are dedicated TOFC/COFC dry van and refrigerated van trains, general service box mixed consist trains, special equipment car types, and bulk unit trains.

It has been determined that this cost model fills the need for a middle ground between the rail cost findings of the I.C.C. and a specific individual railroad operation or service. The goal of this TSC Rail Cost Model was to measure the cost impacts of various proposed changes in rail freight operations. However, before this could be accomplished, it was necessary to relate the representative rail cost factors to actual rail costs at some period in time. The present TS&W Study was able to take advantage of this previous work by only updating the data bases to 1977 and making a few changes to various formulae in order to bring it up to base year representative operations. The formulae originally used by TSC for rail cost analysis were easily amenable to this updating with minor revisions and thus were judged adequate to represent the rail cost side of this study.

4.2.1 Data Sources

As in the truck model previously discussed, the data inputs used to develop the needed cost, financial and traffic information for impact analysis of the rail carrier groups were based on the 1977 R-1 statistics files of the I.C.C. These files are not the normal I.C.C. "blue book" version of their reports, but an internally generated version by the I.C.C. based on a special request of TSC.

Unlike the truck file, it was not necessary to develop a private rail carrier file. All of the carriers chosen were of the Class I regulated rail carrier type. Therefore, the collection of the rail carrier data was already similar to the truck carrier format reported to the I.C.C., and was similar in both terminology and classification. However, to build preliminary files of cost and traffic breakdowns, it was still necessary to isolate specific carriers that would properly represent the various types of rail operations and reflect the geographical regions and the related operations. Since the nature of this analysis requires that total costs related to actual operations be used, bankrupt carriers and carriers such as Conrail were excluded. Including heavily subsidized or bankrupt carriers would distort operating and capital costs by the amounts that were forced to the system outside normal operations. For example, it would be impossible to accurately compute capital costs, especially debt and equity ratios, if negative ratios from bankrupt carriers were used. Therefore, in this study, only the larger, financially and operationally viable carriers were selected to represent the regional rail costs.

4.2.2 Functional Costs

Once the carrier files were grouped, the cost aggregation and analysis was accomplished. The reported functional costs initially analyzed were line-haul costs (including capital) and terminal area costs (including capital).

4.2.2.1 Line-Haul Costs (Operating) - The initial TSC Rail Cost Model dealt separately with six major cost elements which basically included all line-haul and terminal area operating costs. Total capital and overhead costs were not included in the Rail Cost Model, but the following capital and overhead items were included in this analysis: major new road investments; total terminal facilities; and administrative, clerical and overhead operating expenses. The analysis for this project uses this basic model, but includes overhead and capital costs on a regional industry basis. In addition, the TSC Rail Cost Model was developed in such a manner as to output the costs per segment of line operated in a rail network based on the total segment tonnage and segment characteristic inputs. However, for this analysis, these formulae were revised and the inputs are now based on the rail carrier system averages in 1977 for a particular type of train service, car mix, geographic region, average system tonnage, and average haul distance for the representative railroads.

Table F-1.1 in Appendix F lists the carrier cost functions used to develop the line-haul costs and also notes the I.C.C. data inputs and I.C.C. cost scale inputs used in conjunction with the TSC cost formulae. Included in Table F-1.1 of Appendix F is a listing of the G&A and other overhead items, as well as their allocations that were developed under this project. The annual costs and/or units developed from the aforementioned cost formulae and 1977 cost data inputs were used in conjunction with the 1977 traffic data/units of the same carriers to produce the average unit costs for that group or region. These resulting outputs (or average unit costs) previously mentioned in Section 3.3, are used to represent the type of rail operation and region in the various TS&W impact analyses.

As in the case of the truck costs, the data base and updated formulae used in this effort can yield additional detailed information on carrier specific markets, revenue and costs which could be useful in any regional specific or special operation case study analysis that may be necessary in the future.

4.2.2.2 Terminal Area Costs (Operating) - Terminal area costs in the TSC Rail Cost Model are handled in a considerably different manner than in the truck cost portion of this project. Basically, the terminal area operating costs are divided into two parts which are presented by the yard switching costs and the pick-up and delivery costs. For conventional carload service, PU&D are included under the category of total switching. TOFC yard costs represent the functions of loading, unloading, tying and untying trailers from flatcars, switching flatcars among TOFC trains, and other special services. These costs were calculated from data presented by the I.C.C. in the Rail Carload Cost Scales. TOFC trailer and car yard handling are developed in the same manner and TOFC PU&D are provided by the same source.

Railcar handling costs, applied to terminal area related activities, are based on switch minutes per activity for average railcar trains. The costs are engineered on a per switch hour basis but are constructed from base data files of the I.C.C., such as the R-1 reports and the cost scales. The averages were based on the regions the railroads operated in and concentrated on the average yard activities for an average train. Four major flows were considered:

1. originated car flow
2. terminated car flow
3. intermediate car flow
4. through car flow interchanged.

These switch hour or switch minutes are the basic determinants of the activity which is then related to the derived cost for the carriers and region, and then reduced to a cost per ton basis. LTL and Partial Trailer Load Shipments via freight forwarders were not available from these sources. Adequate representations of these cost/rates can be developed from appropriate components in the rail and truck cost tables of the appendices. One such set of estimates is presented and discussed in Section 5. For further detail on cost inputs, outputs and formulae see Appendix F, Table F-1.1.

4.2.2.3 Capital costs - Line-Haul and Terminal Area - In order to put railroad capital costs on a comparable basis with the motor carrier capital costs, the capital recovery method of determining equipment/rolling stock attributable to various operations was used.

As in the capital costs applied to determine motor carrier capital cost, the capital cost factors applied in this rail costing effort reflect the unique capital structures of each carrier group and the group's current cost of total capitalization. This factor -- cost of capital -- is also used with the 1977 replacement cost of equipment and common purchase prices. Initial analyses of the rail carrier reported statistics also indicated that the capital structures and profit levels were different among the selected rail carrier groups. Therefore, these unique debt/equity and return structures were incorporated into the capital cost analysis for each carrier group. These cost factors were incorporated into an annualized cost using the capital recovery method and the average cost of total capital determined for each group. The cost of capital represents the cost of debt and equity (thus, profitability) weighted by the debt and equity ratios for each respective carrier group.

This factor, when used in conjunction with the capital recovery method, will insure that the debt cost as well as the level of profits and equity sustained by each carrier group through calendar year 1977 be totally recovered in the unit cost, as in the case of the truck unit costs, which are comparable at this point, the equipment costs for locomotives, rail cars and TOFC/COFC flatcars reflect the 1977 average manufacturer prices. Also, the operating factors such as economic life,[26] annual mileage, etc.,

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[26] Economic life, as opposed to useful life, is the time period in which one believes an asset can be used at a constant level of performance. The useful life of an asset may be longer than the economic life, but one may experience declining levels of performance in later years.

were used with the capital recovery method to reflect regional utilization. This basically represents the method used in this project for developing comparable line-haul capital cost for the operating equipment.

The terminal area capital costs were also included in total costs, but in a different manner than for line-haul. As in the truck capital costs analysis, it was not considered feasible to estimate the replacement costs and/or purchase prices of terminal area facility assets. Therefore, the approach used was to isolate the annual debt and equity costs as reported by the carriers and apply these factors to the remaining investment in terminal area facilities, thus reducing terminal capital costs to an annual basis. Once the actual annual capital costs relative to terminal area facilities had been determined, aggregation of all capital costs was reduced to a tonnage or other basis for further unit cost applications. In this case, rail terminal capital costs were reduced to a unit cost on a per ton basis in order to be comparable with the truck terminal unit costs.

In the case of truck capital cost, the aforementioned procedure would sufficiently cover the total capital cost requirements of the carrier groups. However, in the case of rail capital costs, it was necessary to include another capital cost item. This item is the capital costs associated with major road upgrading programs now in progress by the various railroads. Throughout this analysis the maintenance of way cost for the present rail maintenance programs has been treated as an annual operating expense and is based on those I.C.C. reported costs for the carriers representing each region. In the case of major rail upgrading and renewal programs these items were assumed to be capitalized and expensed over the economic life of the investment. Tables F-3.2 and F-3.2.1 show the actual reported major upgradings in terms of rail-miles, total investment, economic life, and the 1977 replacement cost of equipment and common purchase prices. These costs are also reduced to a unit cost, or per car-mile basis, and included in the total transport cost.

Therefore, the total capital costs that are included in this rail analysis, as well as the manner of treatment for determining comparable unit cost procedures for this TS&W Study, are as follows:

- o rail equipment/rolling stock -- capital recovery method;
- o terminal area facilities -- actual annual capital costs;
- o major rail upgrading programs -- actual annual capital costs based on capitalization in the project.

Details in terms of formulae, debt and equity costs, equipment purchase prices, and sources can be found in Tables F-3, F-3.1, F-3.2 , and F-3.2.1 of Appendix F.

5. PARAMETRIC ANALYSIS OF TRUCK SIZE AND WEIGHT IMPACTS ON SHIPMENT COST/RATES

This section examines individual shipment cost/rates for general service merchandise and special community truck and rail services and isolates the effects of various TS&W limits as well as external changes to key cost inputs such as fuel costs and highway user taxes. It also analyzes potential changes in the competitive relationships between truck and rail services associated with the various size and weight limits.

5.1 Major Parameters of Truck and Rail Shipment Cost/Rates

5.1.1 Regions

The derived shipment cost/rates reflect geographical, climatic, operational practices; equipment utilization; labor rates; and traffic congestion differences among the regions of the continental United States. Alaska and Hawaii are not represented in this effort. Figures A-1 through A-4 in Appendix A identify the truck and rail costing regions used in this study. Appendices D and H present truck and rail "line-haul" and "terminal area" costs and individual cost components for various shipment sizes and services on a regional basis. One can isolate the effects of regional practices by carriers on such items as line-haul and terminal area labor costs, taxes and registrations, average haul distances, fuel costs, and equipment utilization, as well as the physical characteristics of shipments and commodities transported.

An attempt is made here to examine regional differences in cost/rates rates for LTL and TL shipments with some symmetry on important variable inputs. By holding constant weight limits, load size, equipment type and average haul distance, Figures 5-1 and 5-2[27] present truck and rail general service merchandise LTL and FTL shipment cost/rates for each of the geographic regions. Using conventional semi-trailers, regular route carriers in the Northeast experience the highest level of truck-mile costs for line-haul operations. In contrast, perhaps because of industrial concentration within the Northeast, terminal area costs are reported as the lowest cost per ton of any region. Highway (regular route carrier -- RRC) and rail (TOFC/Freight Forwarder -- TOFC/FF[28]) modal price competition for LTL traffic appears to be intense within the Southern, Midwestern and Western regions. Irregular route carriers (IRC) and private trucks are the most competitive with rail TOFC for FTL shipments.

5.1.2 <u>Shipment Size and Carrier Service</u>

The total distribution of shipment sizes has been aggregated and represented by seven shipment size categories and their related costs have been isolated to differentiate among services which may be competitive among the highway and rail carriers. Motor and rail carriers' cost/rates for general service merchandise freight are estimated for less than truckload (LTL) services, full truckload (FTL) services, and partial truckload (PTL) services. Table 5-1 presents a matrix of highway and rail carrier services described by shipment sizes and related carrier groups. In order to keep the analysis as simple

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27 Refer to Appendix J for tabular presentation of parametric analysis of TS&W impacts on shipment cost/rates.

28 TOFC/FF represents the only real competitive rail service for LTL shipments. It is a service which can be characterized as a consolidation of a third party which performs collection and distribution break bulk operation and rail TOFC which performs line-haul operations.

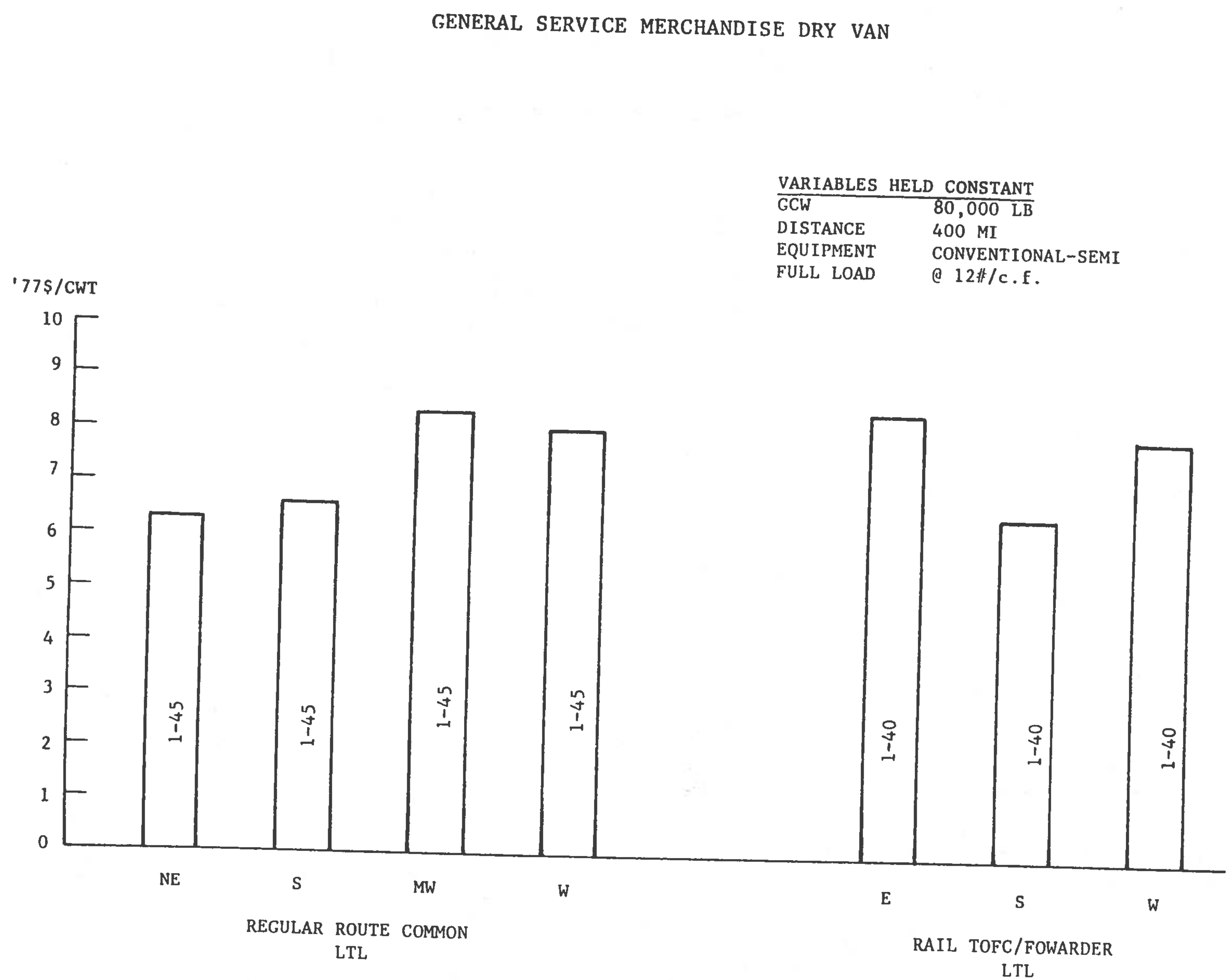

FIGURE 5-1. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE & REGION OF OPERATION

GENERAL SERVICE MERCHANDISE DRY VAN

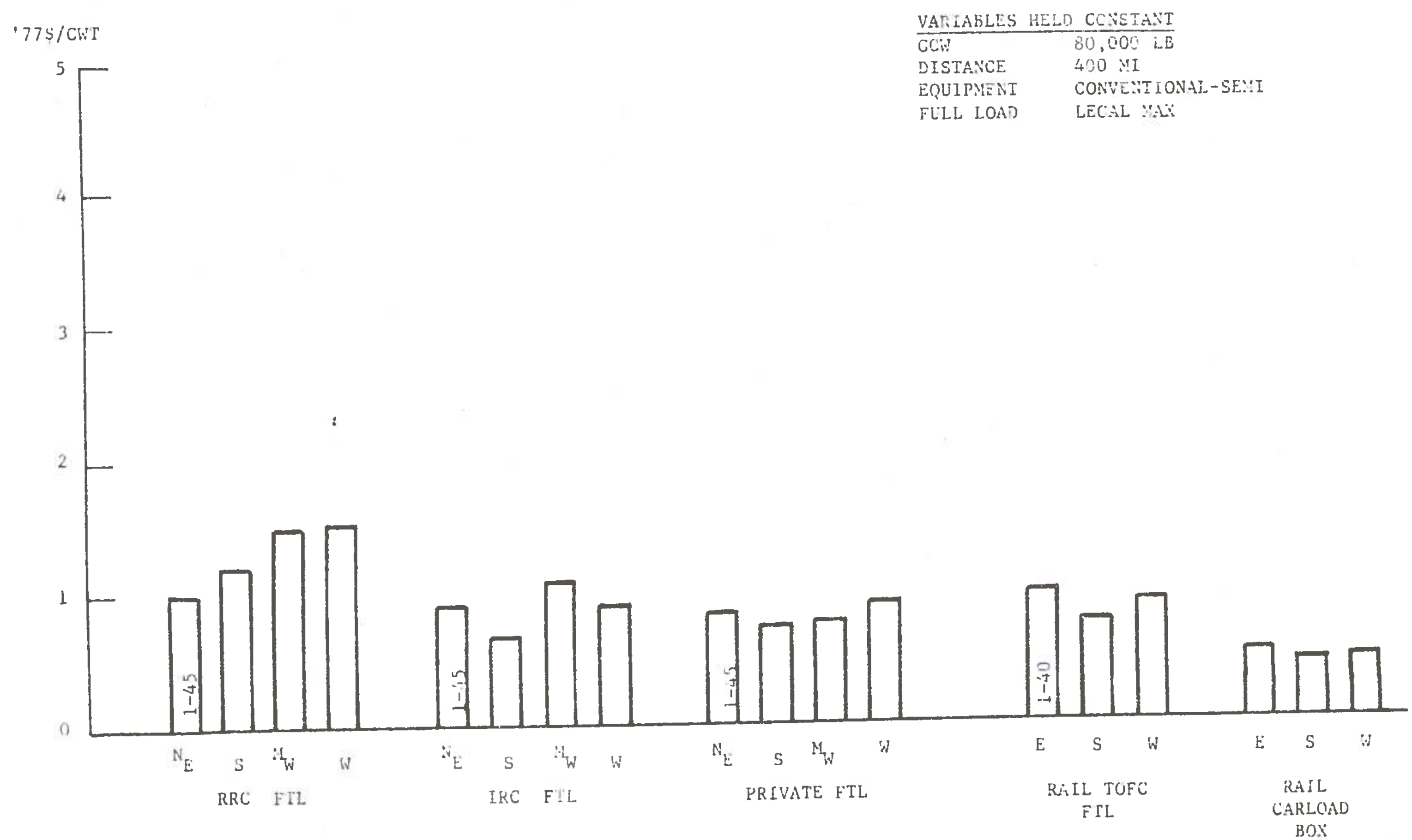

FIGURE 5-2. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE & REGION OF OPERATION

TABLE 5-1. SHIPMENT SIZE AND CARRIER SERVICE

CARRIERS \ SHIPMENTS	LTL	PTL	FTL	Single Car	Multi Car	Average Carload	Unit Train
Highway							
RRC	X	X	X	–	–	–	–
IRC	–	–	X	–	–	–	–
Private	–	–	X	–	–	–	–
Specialized Equipment	–	–	X	–	–	–	–
Rail							
TOFC	–	–	X	–	–	–	–
*TOFC/Forwarder	X	X	X	–	–	–	–
Box Carload	–	–	–	X	X	X	X
Specialized Equipment	–	–	–	X	X	X	X

* TOFC/Forwarder represents a rail mode in which LTL shipments are transported via freight forwarder on TOFC.

as possible and still capture the major differences in the price/service packaged offered to shippers, the following categories are defined. Regular route common carriers of general merchandise freight will reflect the movements of LTL, FTL and PTL shipments. Line-haul costs for each of these common carrier services are essentially equal, but terminal area costs for each will reflect handling differences associated with their respective distribution of shipment sizes. Irregular route/contract carriers, special commodity carriers, as well as private carriage, provide predominantly FTL services and have been costed to reflect their respective door-to-door operations. Comparison of motor carrier services to rail services is made for each of the various shipment sizes. Dedicated TOFC/COFC trains for dry vans and reefer trailers are assumed to be the only rail service truly competitive to truck and are costed for LTL and PTL as well as the more common FTL shipments. Carload service in mixed consist trains is represented and costed on the basis of single car and multi car shipments as well as an average of the two. Bulk movements in hopper/gondola cars are represented and costed in multi car and unit train shipments. Line-haul costs are estimated first on the basis of dollars per trailerload or dollars per carload, while terminal area costs are presented on a dollar per shipment ton basis.

The appropriate truck configurations, volume and weight capacities and payloads are associated with the predominant shipment sizes and carrier services. The trailer payloads do vary significantly with capacity limits, therefore payloads associated with each set of limits are needed to compute each shipment cost/rate. A previous TSC Staff Study[29]

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29 "Analysis of Truck Payloads Under Various Limits of Size, Weight and Configuration," by J. Mergel, May 1980, TSC # 321-10-9B.

outlines vehicle payloads under various truck size and weight limits, and is the source for these loads. Movements of LTL and PTL shipments are represented by light density loads and usually "cube-out" before reaching the legal maximum gross combination weight limit. An average design density of 12 pounds per cubic foot is used here to compute truck payloads for LTL and PTL shipments. A maximum legal weight load for FTL shipments is also computed to reflect the other end of the spectrum of loads. Factors controlling FTL payloads of high density freight include equipment types, tare weights and legal weight limits. Table 5-2 presents a matrix associating trailer loading conditions to the three shipment sizes, while Tables 5-3 and 5-4 list trailer payloads used for LTL, FTL and PTL shipments under the constraints of the various truck size and weight limits. Trailers on flat car (TOFC) will also be constrained by highway limits for access/egress portions of the total trip which utilize the Federal Aid Road System. Rail carloads for the dominant equipment types are shown in Table 5-4.

5.1.3 Operational, Functional and Cost Elements

A distribution of major cost categories which represents the total door-to-door shipment cost/rate for general service merchandise freight[30] is presented in Figures 5-3 and 5-4. LTL and FTL charges are apportioned among the operating functions of line-haul, pick-up and delivery and terminal area to reveal the potential for affecting total cost by changing the

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30 TSC's best estimation of the average charge to the shipper for a particular category of shipment. Appendix I shows how closely these cost/rates approximate actual charges.

TABLE 5-2. SHIPMENT SIZE AND TRAILER LOADING

SHIPMENTS / FULL VEHICLES	LTL	PTL	FTL
Cubed Out	X	X	-
Weighted Out	-	-	X

TABLE 5-3. VEHICLE PAYLOAD AND TRUCK SIZE AND WEIGHT LIMITS -- DRY VANS

FULL VEHICLES / EQUIPMENT TYPES	TRUCK		RAIL TOFC*	
	Max Weight Load	Cubed Out @ 12#/CF	Max Weight Load	Cubed Out @ 12#/CF
Conventional Semi (1-45'trailer)				
73/18/32 Limit	22.70	17.45	21.80	15.50
80/20/34 Limit	25.05	17.45	22.30	15.50
Bridge/18/32 Limit	23.05	17.45	21.80	15.50
Bridge/20/34 Limit	25.05	17.45	22.30	15.50
Bridge/22.4/36 Limit	25.95	17.45	24.40	15.50
Western Double (2-27'trailers)				
73/18/32 Limit	21.00	20.80	20.00	20.00
80/20/34 Limit	24.30	20.80	23.30	20.00
Bridge/18/32 Limit	24.30	20.80	23.30	20.00
Bridge/20/34 Limit	24.30	20.80	23.30	20.00
Bridge/22.4/36 Limit	24.30	20.80	24.35	20.00
Triple 27's (3-27' trailers)				
73/18/32 Limit	15.50	15.50	N/A	N/A
80/20/34 Limit	19.00	19.00		
Bridge/18/32 Limit	36.00	31.20		
Bridge/20/34 Limit	37.00	31.20		
Bridge/22.4/36 Limit	38.00	31.20		
Turnpike Doubles (2-45' trailers)				
73/18/32 Limit	--	--	N/A	N/A
80/20/34 Limit	--	--		
Bridge/18/32 Limit	32.74	32.74		
Bridge/20/34 Limit	34.79	34.74		
Bridge/22.4/36 Limit	37.25	34.93		

NOTE: Payloads reported for both truck and rail are listed in tons.

* The conventional semi-trailer used for rail TOFC operation is a single 40-foot trailer, while the 27-foot trailer is used for consistency with the truck mode.

TABLE 5-4. VEHICLE PAYLOAD AND TRUCK SIZE AND WEIGHT LIMITS -- OTHER EQUIPMENT TYPES

EQUIPMENT TYPES \ FULL VEHICLES	Max. Weight Convent. Semi	TRUCK Max. Weight Turnpike Double	Max. Weigh. Straight Truck	RAIL CARLOAD & TOFC Ave. Weight Load*
Auto Transport			N/A	23.70
73/18/32 Limit	18.64	--		
80/20/34 Limit	21.00	--		
Bridge/18/32 Limit	19.00	26.70		
Bridge/20/34 Limit	21.00	28.70		
Bridge/22.4/36 Limit	21.90	31.20		
Dump				100.00
73/18/32 Limit	19.25	--	15.55	
80/20/34 Limit	19.75	--	16.55	
Bridge/18/32 Limit	19.25	28.00	15.55	
Bridge/20/34 Limit	19.75	29.50	16.55	
Bridge/22.4/36 Limit	21.35	32.00	17.55	
Rack/Platform			N/A	50.13
73/18/32 Limit	23.79	--		
80/20/34 Limit	26.15	--		
Bridge/18/32 Limit	24.15	34.55		
Bridge/20/34 Limit	26.15	36.55		
Bridge/22.4/36 Limit	27.05	39.05		
Refrigerated Van			N/A	47.30 - reefer car 21.20 - TOFC van
73/18/32 Limit	21.20	--		
80/20/34 Limit	23.55	--		
Bridge/18/32 Limit	21.55	29.45		
Bridge/20/34 Limit	23.55	31.45		
Bridge/22.4/36 Limit	24.45	33.95		
Tank			N/A	61.13
73/18/32 Limit	23.70	--		
80/20/34 Limit	25.00	--		
Bridge/18/32 Limit	24.00	35.20		
Bridge/20/34 Limit	25.00	37.20		
Bridge/22.4/36 Limit	26.00	39.20		
Rail Box Car				48.00

Note: Payloads reported for both truck and rail are listed in tons.

* Reported average payloads for rail equipment types were obtained by matching predominate equipment types to commodity types and observing reported payloads from the Carload Waybill Statistics for 1977

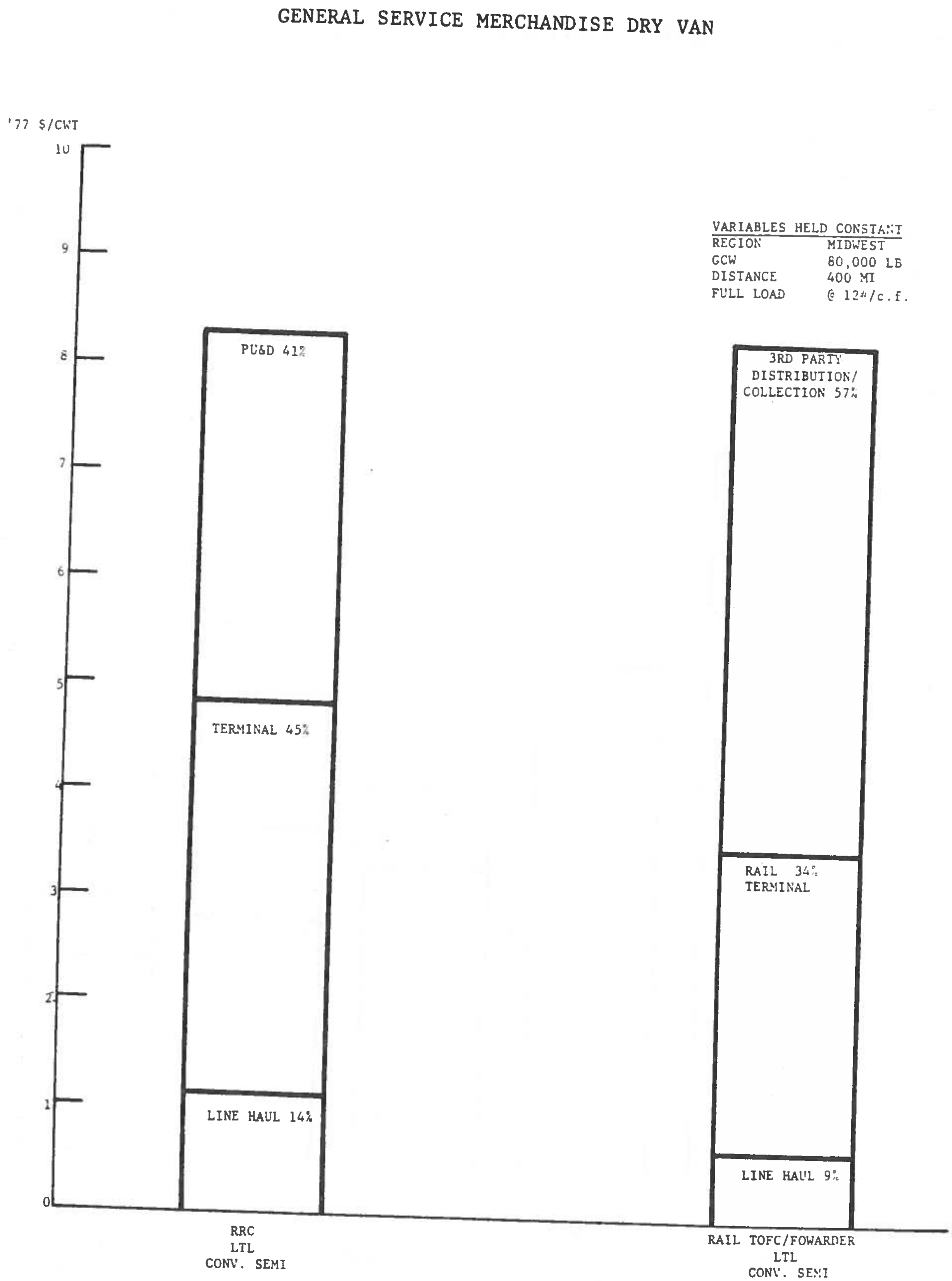


FIGURE 5-3. TOTAL SHIPMENT CHARGE & MAJOR COST CATEGORIES

GENERAL SERVICE MERCHANDISE DRY VAN

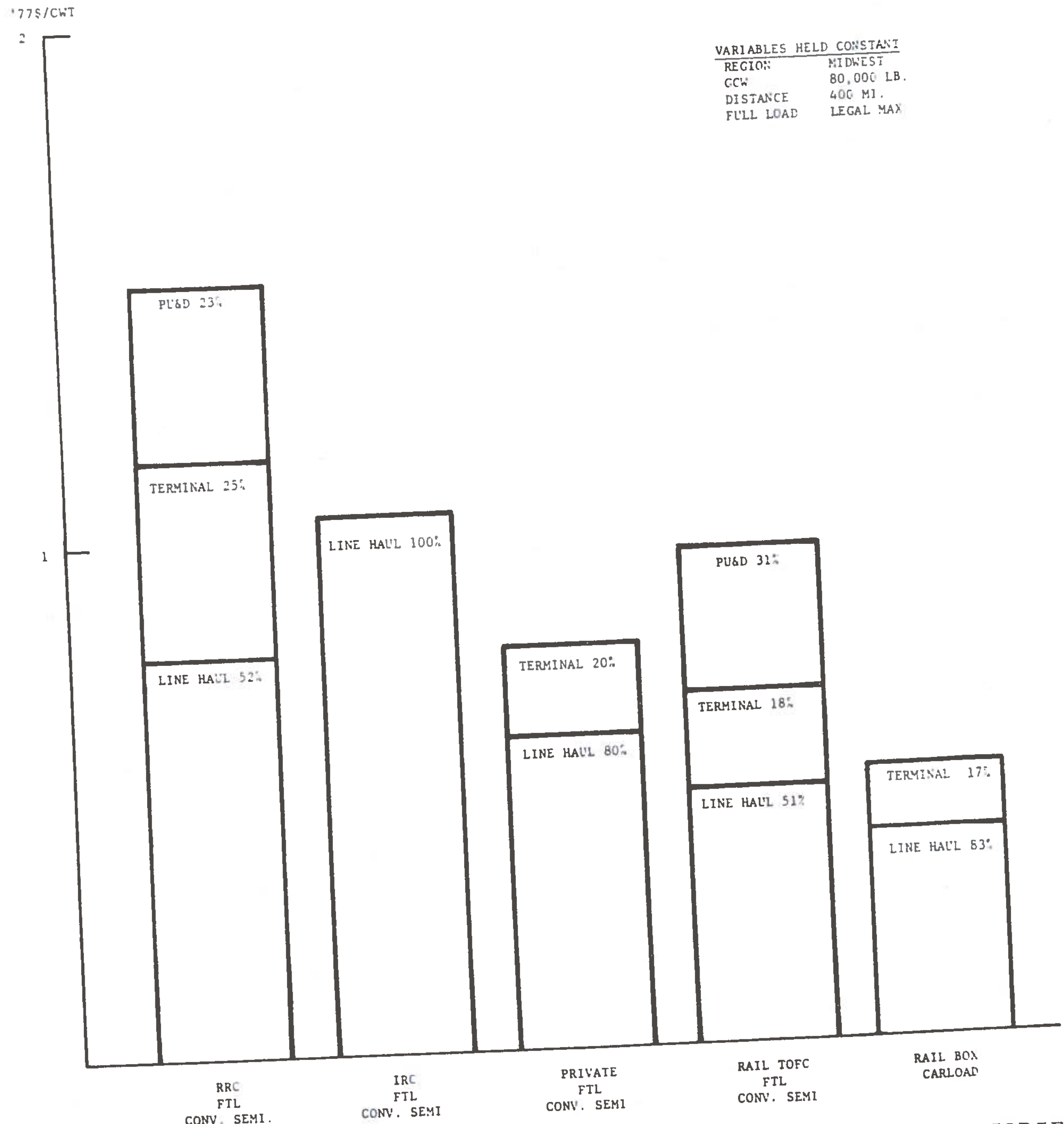


FIGURE 5-4. TOTAL SHIPMENT CHARGE & MAJOR COST CATEGORIES

vehicle capacity. Rail TOFC/Freight Forwarder (TOFC/FF) represents the only rail alternative to LTL shipments by regular route highway carriers. TOFC's third party distribution/collection activity is derived from the appropriate functions for highway carriers. There is no evidence that the activity would be different from the PU&D and dock loading of highway carriers.

Figure 5-3 shows that the line-haul component of LTL general freight services represents a very small percentage of the total cost/rates for all LTL services. Axle and gross weight limit changes are unlikely to substantially affect any of the competitive relationships among the available LTL carrier services because line-haul cost is such a small percentage of the total. However, availability of western doubles for motor carrier LTL service significantly reduces the cost of terminal handling and pick-up and delivery, thus changing the highway and rail competitive relationships.(see Section 5.2.1.). Axle and gross weight changes are likely to have a significant effect on cost/rates of FTL general freight services by all highway carrier groups because line-haul costs are a major portion of total cost/rates as shown in Figure 5-4. Irregular route and private carriers will be the major beneficiaries since line-haul represents over 80 percent of total cost/rates. Irregular route and private carriers appear very price competitive with rail TOFC which is consistent with current industry knowledge. Weight limit changes will significantly affect this competitive relationship.

Figure 5-5 isolates the line-haul portion of the total cost/rates for FTL general freight shipments and distributes appropriate costs among the major components of the line-haul function. Since line-haul costs are those most affected by truck capacity regulation as well as user taxes and fuel prices, Figure 5-5 provides an insight into the potential magnitude of the effects of and user taxes have as great an effect as potential effects from truck size and weight changes?

- Will this combined increase change the competitive relationship among motor carriers and between highway and rail?

These questions and the relative sensitivity of motor carrier cost/rates to other parameters are addressed in the following sections.

5.2 Parametric Analyses of General Service Merchandise Shipment Cost/Rates

This section presents a preliminary perspective of highway/rail market sensitivities to potential exogenous alterations to the individual cost factors and to total shipment cost/rates of general service merchandise services. Other services are treated in Section 5.3. Potential market sensitivity is examined by estimating the magnitude of change to shipment cost/rates which would result in a change in the competitive relationships for a particular service. Cost variables that are isolated in this analysis include truck size and weight limits, distance, highway user tax, and fuel cost for each carrier service category.

5.2.1 Sensitivity to Carrier Service and Truck Size

Figures 5-6 and 5-7 examine the effects on general freight cost/rates of altering truck size limits. One means of changing truck size limits would be to permit the use of western doubles. The use of western doubles provides approximately 20 percent more cubic capacity which can be translated into average unit cost savings in line-haul and in terminal area costs. Western doubles provide competitive advantages to specific shipment movements in which particular carrier groups specialize.

Western doubles have a cost/rate advantage over conventional semi-trailers of 11 percent for LTL shipments, and an advantage of between 10 and 16 percent for low density FTL and PTL shipments by regular route

GENERAL SERVICE MERCHANDISE DRY VAN

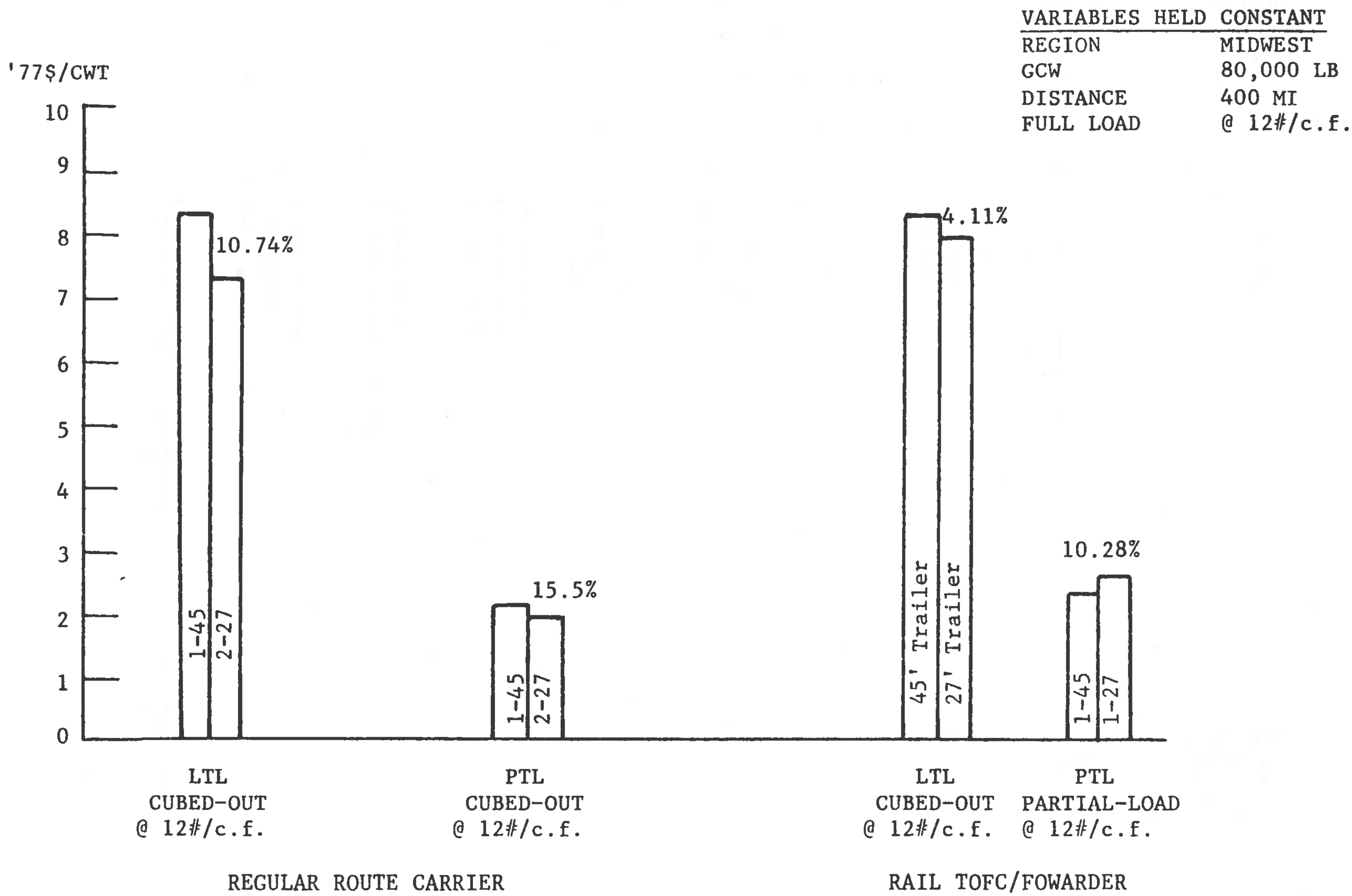


FIGURE 5-6. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE & TRUCK SIZE

5.2.2 Sensitivity to Carrier Service and Truck Weight Limits

Increasing a truck's gross combination weight (GCW) limit from 73,280 to 80,000 pounds provides an additional 10 percent in revenue payload capacity. Figures 5-8 and 5-9 illustrate potential cost/rate reductions resulting from increases in payload. Light density LTL shipments receive a minimal benefit from weight limit changes since most of the shipments "cube-out" before reaching the maximum weight. For legal weight loads, weight limit changes reduce cost/rates between 5 and 10 percent for conventional service. Rail TOFC's cost/rate reduction due to highway limit changes (assuming the new limits will ultimately affect TOFC trailers as well) is only about 1 percent, therefore, highway's competitive advantage is increased. Private truck and irregular route carriers increase their advantage the most (i.e., 7 and 9 percent, respectively). By utilizing weight restrictions of 22.4/36/Bridge, western doubles movements of FTL shipments are greatly enhanced. Payloads are increased 14 percent from the original GCW of 73,280 pounds, resulting in cost/rate reductions between 28 and 50 percent from conventional service.

5.2.3 Sensitivity to Carrier Service, Truck Size and Distance

The cost/rate models developed by TSC for highway and rail reflect a positive linear relationship with distance. Examination of the magnitude of changes in cost/rates at various lengths of haul will provide estimates of effects of limit changes on the competitive relationships. Figures 5-10 and 5-11 illustrate the sensitivity of carriers' shipment charges to truck size limits at short and long haul distances.

GENERAL SERVICE MERCHANDISE DRY VAN

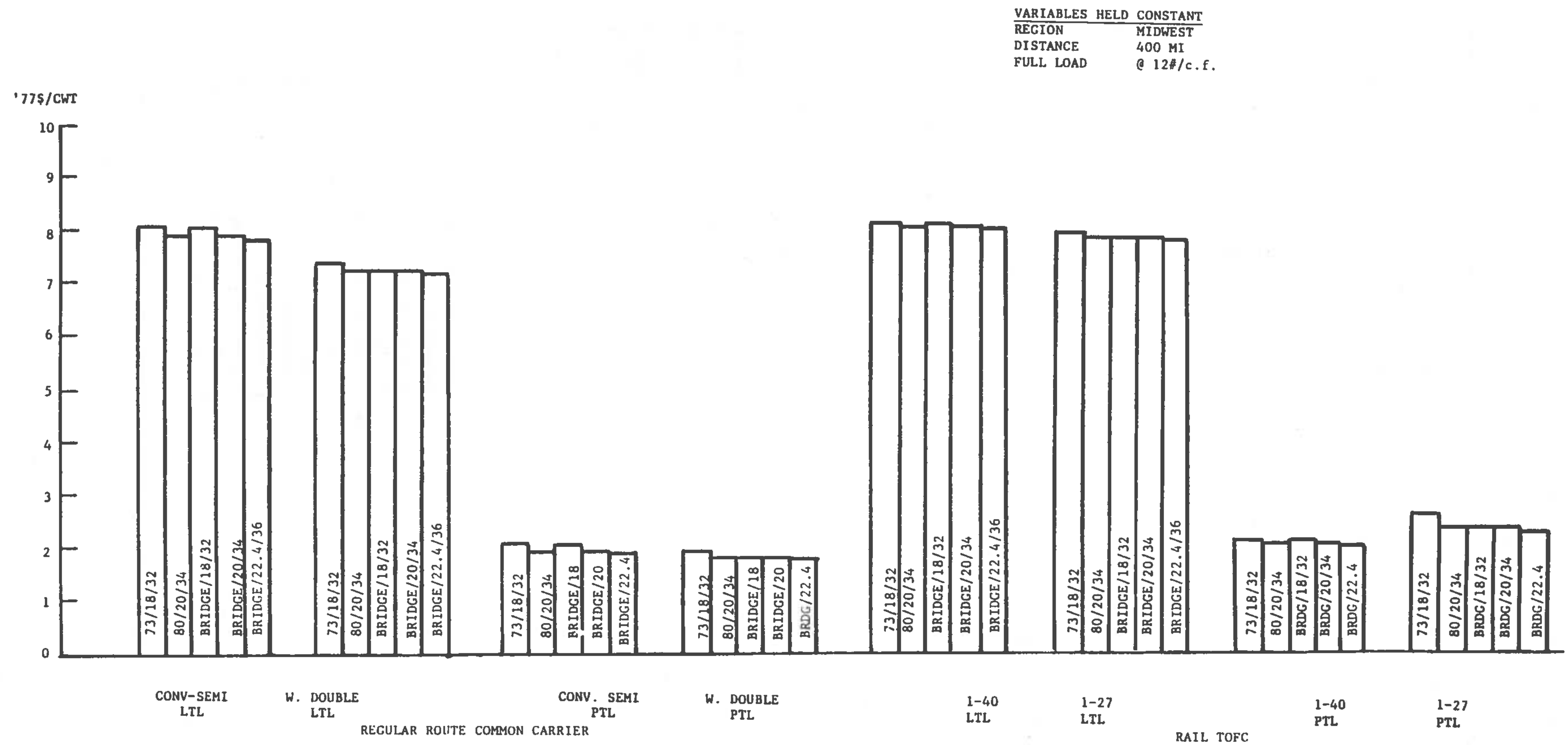


FIGURE 5-8. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE & TRUCK WEIGHT LIMITS

GENERAL SERVICE MERCHANDISE DRY VAN

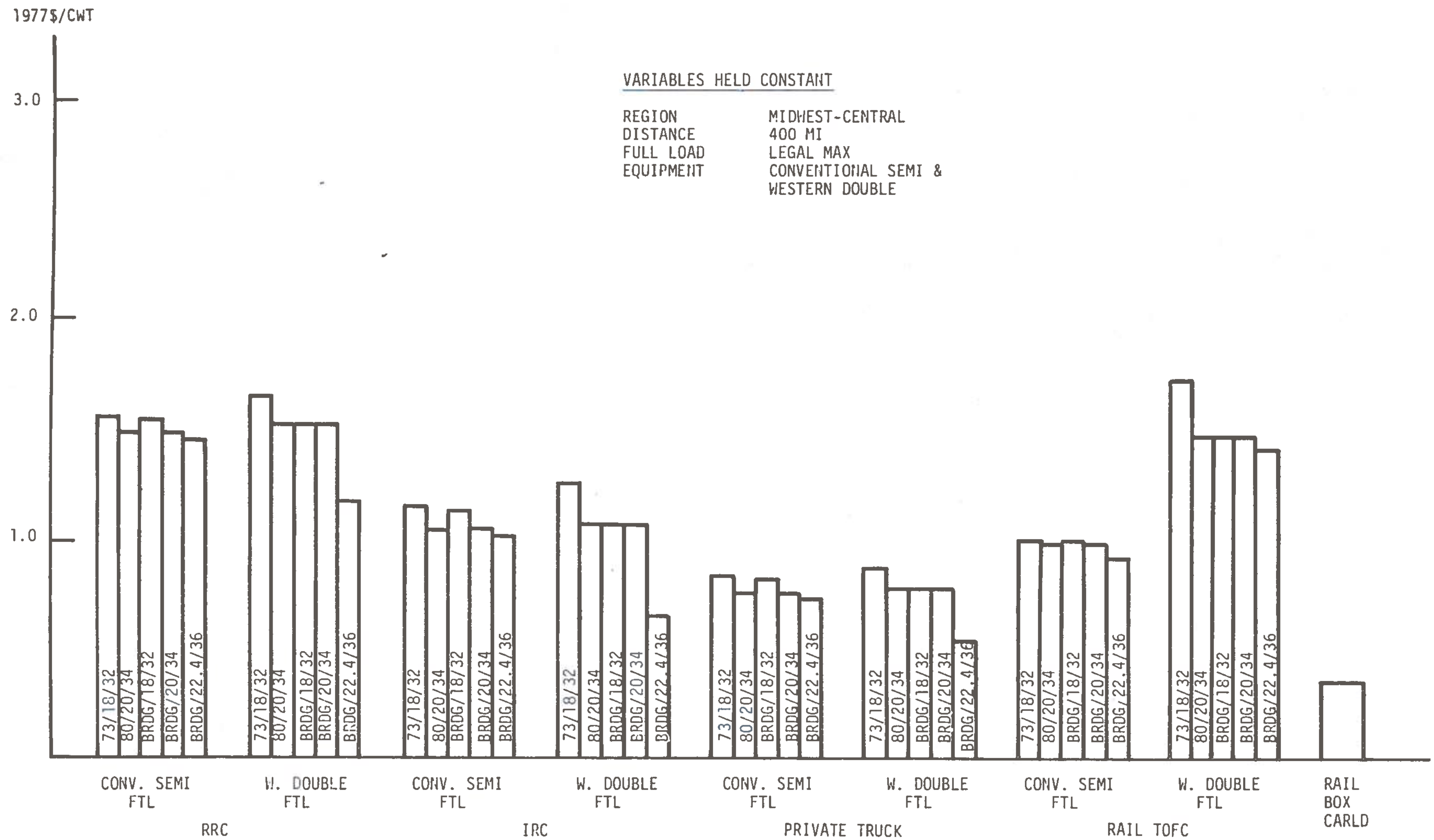


FIGURE 5-9. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE & TRUCK WEIGHT LIMITS

For general freight LTL shipments (Figure 5-10) the rail TOFC/FF cost/rate is competitive with motor carriers using conventional semi-trailers at distances greater than 400 miles. With the availability of western doubles, motor carriers show a cost/rate advantage at all haul distances up to about 1900 miles. Partial truckload shipments via rail TOFC/FF are competitive with motor carriers at distances greater than 400 miles using conventional semi-trailers. Availability of western doubles increases motor carriers' cost/rate advantage for PTL shipments. Rail's competitive advantage over highway is reduced to distances greater than 900 miles.

For full legal weight truckload shipments, irregular route carriers using conventional semi-trailers show the greatest effect to changes with distance. For them, line-haul costs represent essentially 100 percent of the total cost/rate. Rail has the competitive advantage for full truckload shipments beyond 350 miles for all highway carriers except private truck. Private carriage is the only truck service that remains competitive with rail TOFC at distances up to 1200 miles.

5.2.4 Sensitivity to Highway User Tax, Distance and Truck Weight Limits

At this time, there is no Department of Transportation (DOT) estimate of appropriate user tax levels to associate with each set of size and weight limits. In the absence of such, parametric treatment of user taxes using 1977 as a base year can be informative. This section has arbitrarily selected a range of values. If highway user taxes are increased from the 1977 levels (i.e., 1.6 percent for regular route FLT cost/rate and 3 percent for irregular route carriers) by as much as a factor of 5, then the motor carrier cost/rates would increase by 6 percent and 10.5 percent respectively. Comparable increases for cubed-out FTL cost/rates for regular and irregular route carriers are

GENERAL SERVICE MERCHANDISE DRY VAN

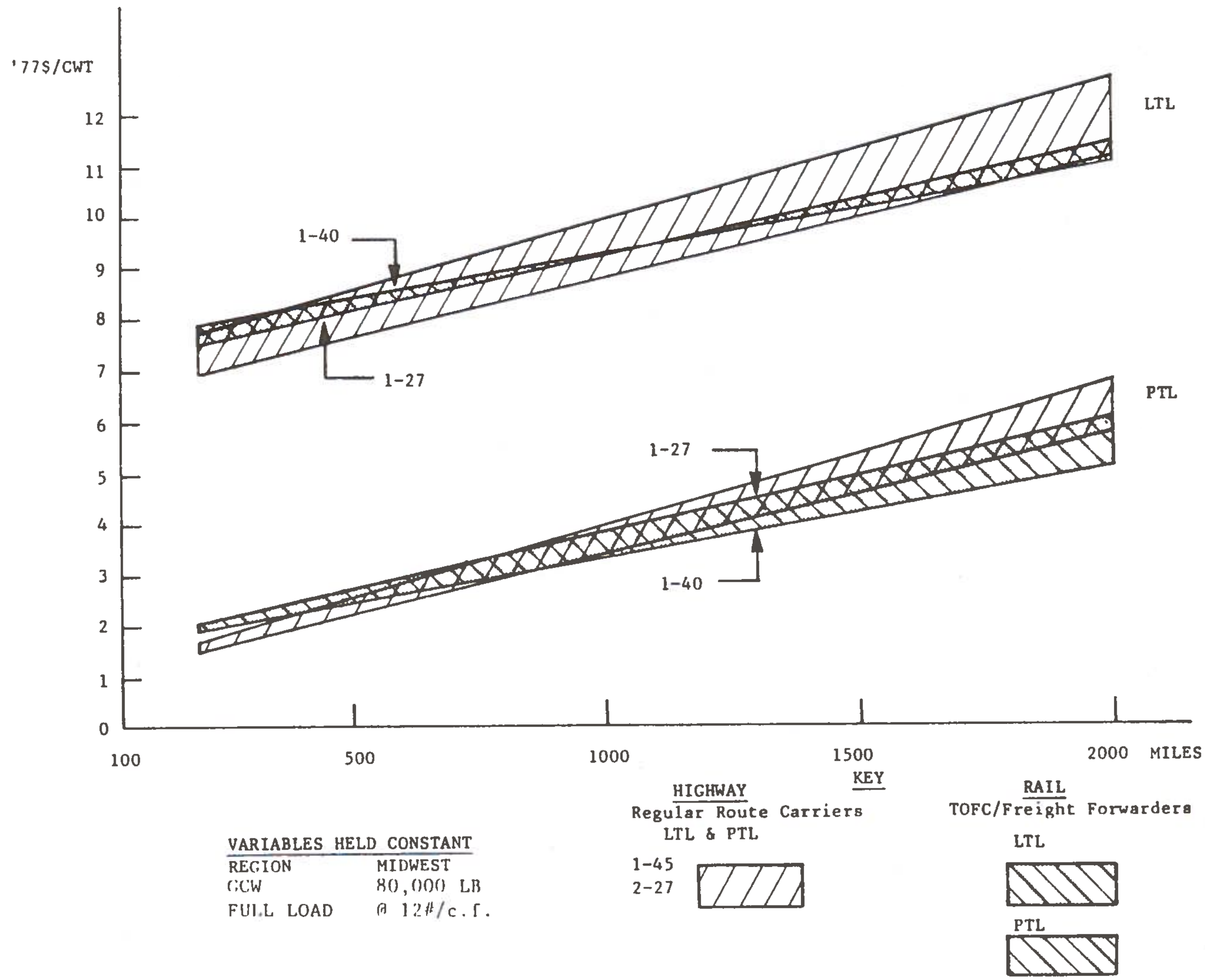
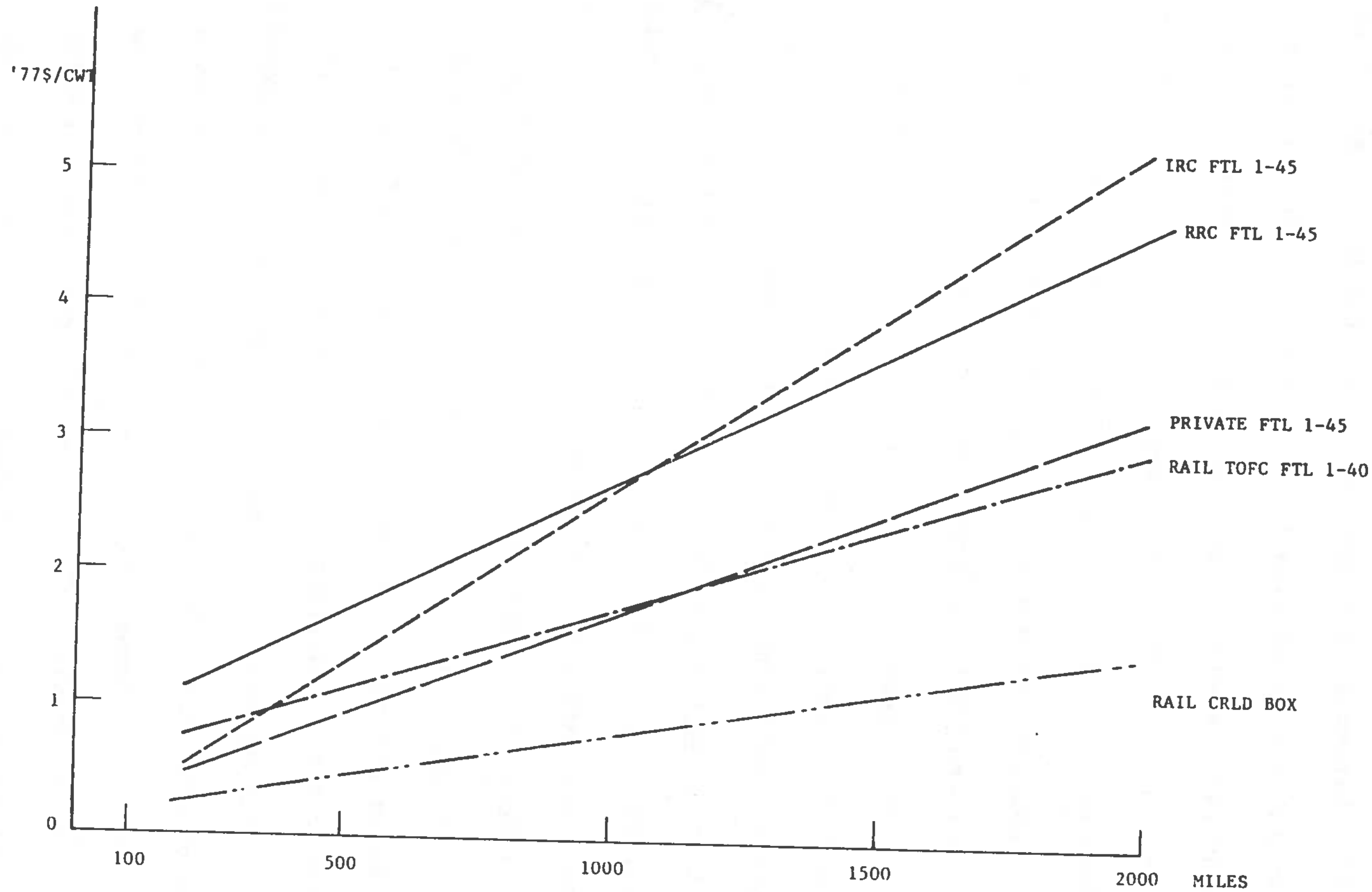


FIGURE 5-10. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE TRUCK, SIZE, & DISTANCE

GENERAL SERVICE MERCHANDISE DRY VAN



VARIABLES HELD CONSTANT	
REGION	MIDWEST
GCW	80,000 LB
FULL LOAD	LEGAL MAX

FIGURE 5-11. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE, TRUCK SIZE, & DISTANCE

7 percent and 11 percent respectively. Such an increase in user tax levels would equal cost/rate reductions associated with increased capacity for weighted-out FTL shipments, but would be only about 60 percent of the cost/rate reduction for increased capacity for cubed-out FTL shipments. Increases in highway user taxes will tend to move the competitive haul distance between irregular route carriers and rail TOFC (using a conventional semi-trailer) down to about 250 and 325 miles for cubed-out and weighted-out FTL shipments, respectively. A 10 percent increase in payload capacity will negate TOFC's apparent advantage from a fivefold increase in highway user taxes. Figures 5-12 and 5-12.1 illustrate irregular route carriers' shipment charge, sensitivity to highway user tax, distance, truck weight limits, and competitiveness with rail TOFC.

5.2.5 Sensitivity to Carrier Service, Truck Size and Fuel Cost

At this time, there is no DOT forecast of average fuel cost levels. In the absence of such, parametric treatment of fuel costs using 1977 as base year can be informative. This chapter has arbitrarily selected a range of values. If fuel costs (i.e., fuel price and fuel efficiency combined) increase in real dollar terms by as much as five times the 1977 levels, motor carrier cost/rates will increase between 12.5 percent (LTL shipments by regular route carriers) and 29 percent (FTL shipments by irregular route carriers). The use of western doubles can alleviate the cost/rate impact of increased fuel costs. For PTL shipments, the availability of western doubles reduces the fuel cost impact on cost/rates from a potential increase of 23 percent to a potential increase of only 7 percent, while LTL cost/rates experience a 12.3 percent net reduction at the higher fuel level.

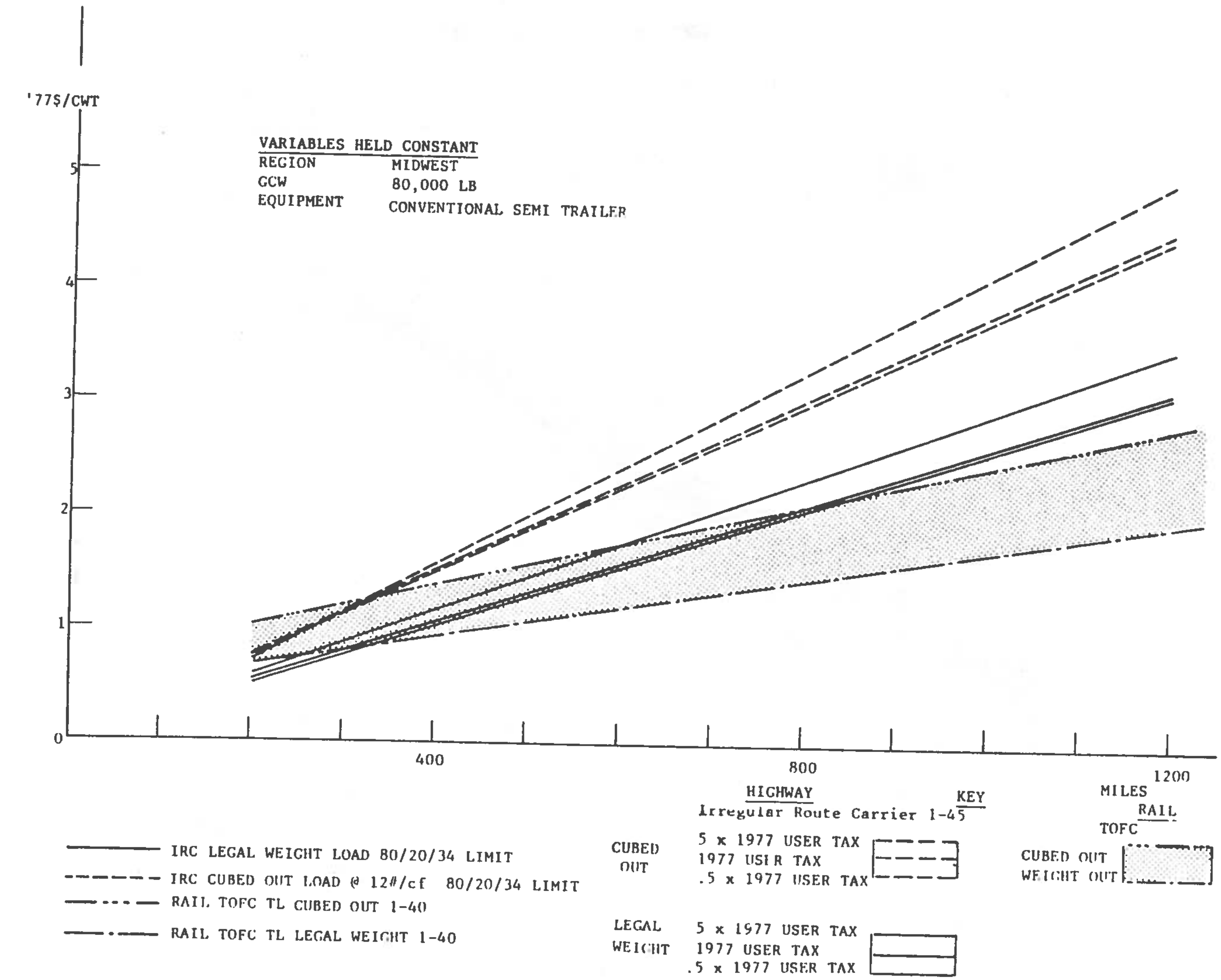


FIGURE 5-12. TOTAL SHIPMENT CHARGE: SENSITIVITY TO HIGHWAY USER CHARGE & DISTANCE

GENERAL SERVICE MERCHANDISE DRY VAN

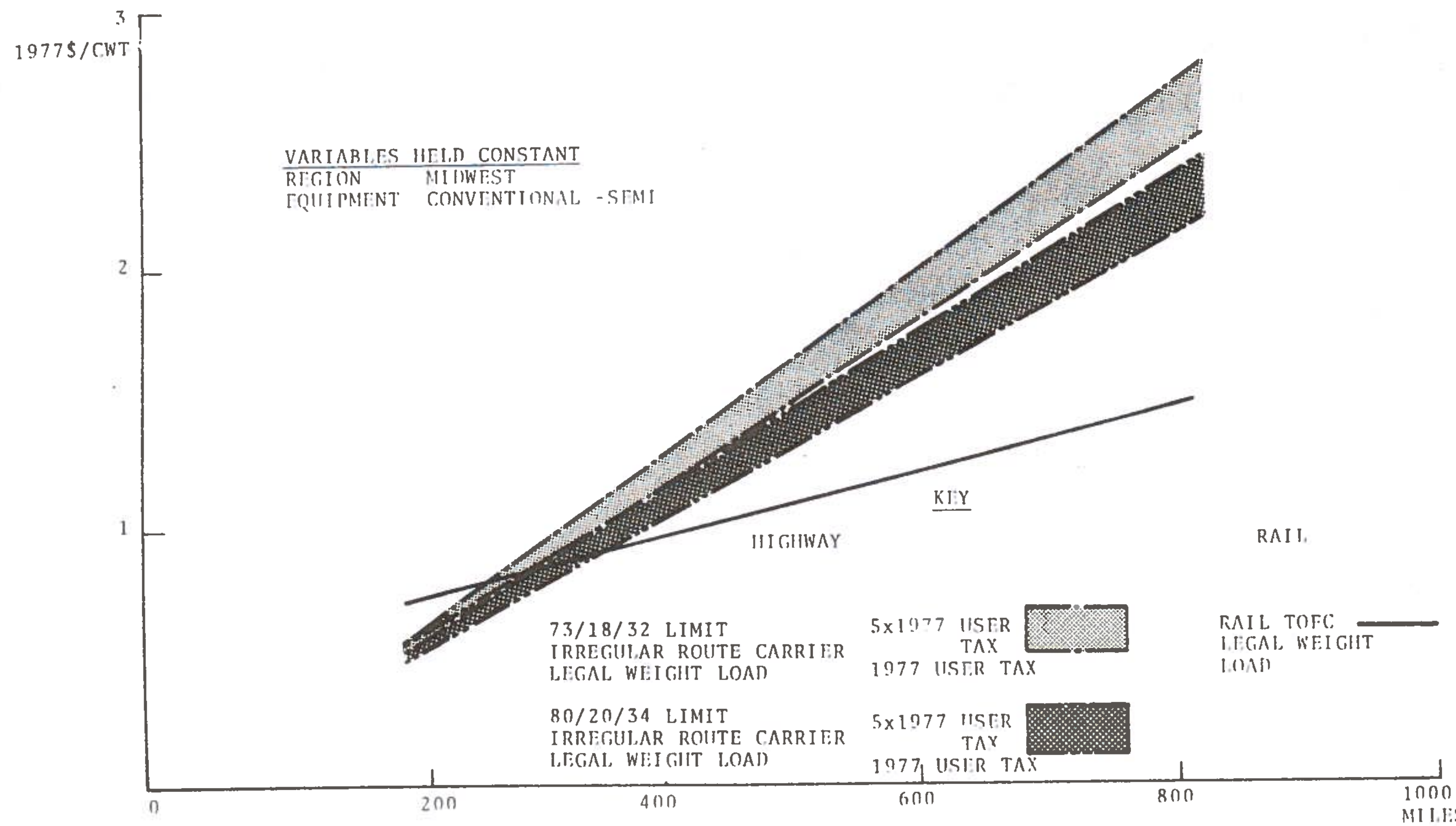


FIGURE 5-12.1 TOTAL SHIPMENT CHARGE: SENSITIVITY TO HIGHWAY USER CHARGE, DISTANCE, & TRUCK WEIGHT LIMITS

The competitive relationship between highway and rail TOFC/FF for LTL and PTL shipments remains essentially unchanged for the range of fuel cost increases at a 400 mile haul distance as shown in Figures 5-13 and 5-14. With the higher fuel cost level, rail TOFC (with conventional semi-trailers) movements of FTL shipments will experience a cost/rate increase of 22 percent, while the competitive highway service (RRC) increases by 29 percent at 400 miles. If western doubles are used by regular route carriers for LTL shipments, rail TOFC/FF (with conventional semi-trailers) will have a 10.4 percent higher cost/rate at the higher fuel cost level at 400 miles. For PTL shipments, rail TOFC/FF will have a 3 percent lower cost/rate than motor carriers with western doubles at the higher fuel cost level at 400 miles.

5.2.6 Sensitivity to Carrier Service, Distance and Fuel Cost

Figures 5-15 and 5-16 present LTL and FTL shipment charges and their relative sensitivity to fuel cost changes and the effect of haul distances. Examining the relationships, one can infer that fuel cost (i.e., fuel price and fuel efficiency combined) increases will have a greater cost/rate impact at the longer haul distances for all shipments because line-haul represents a larger percentage of the total cost at the longer distances. The combined effects of fuel cost increases along with increasing lengths of haul will have a greater impact on highway than for rail. At 1200 miles the rail TOFC/FF LTL cost/rate advantage is 16 percent, compared with a 4 percent difference at 400 miles and at the higher fuel cost levels. For PTL shipments, TOFC/FF cost/rate advantage increases from 16 percent at 400 miles to 26 percent at 1200 miles.

GENERAL SERVICE MERCHANDISE DRY VAN

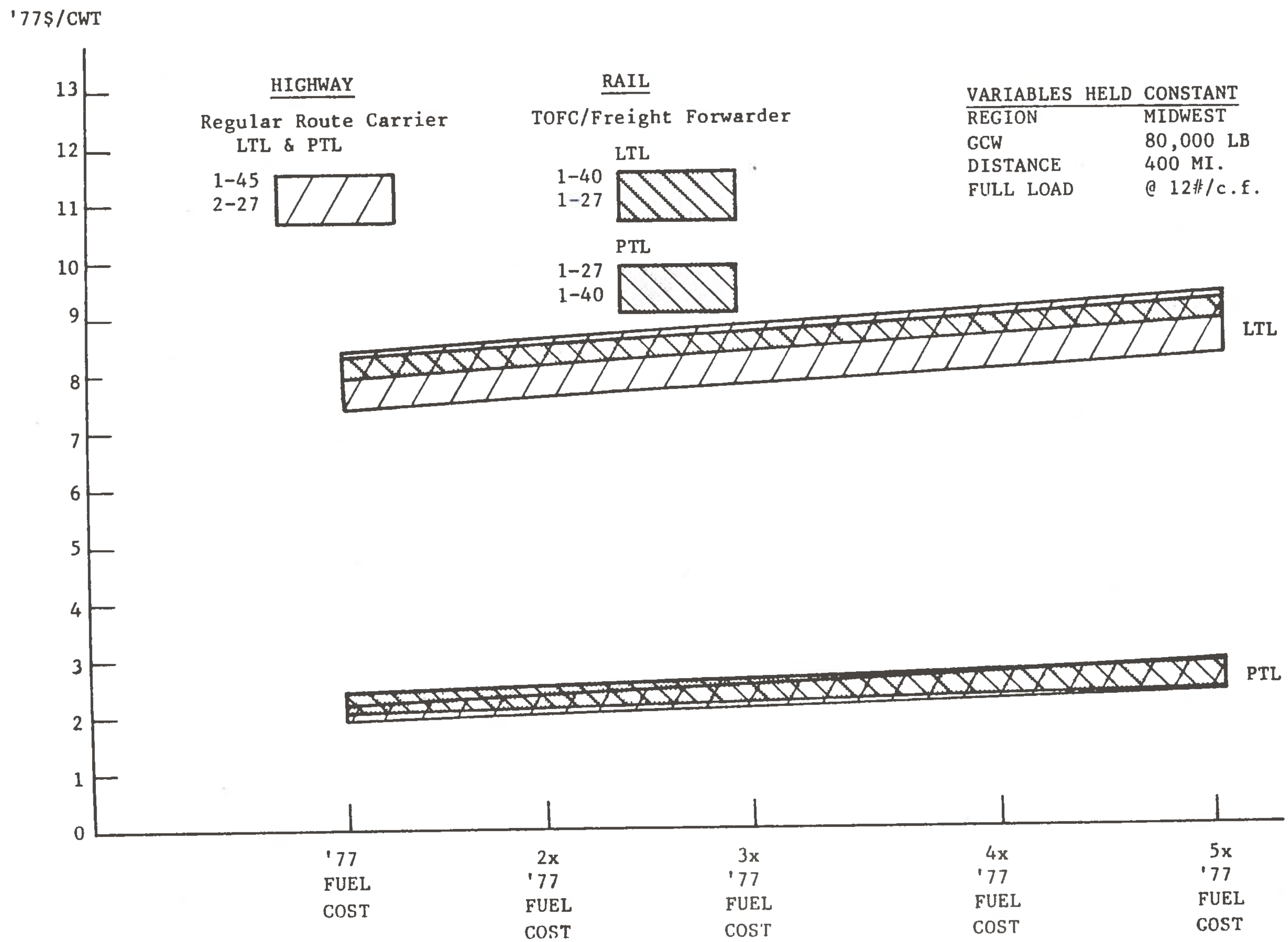


FIGURE 5-13. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE, TRUCK SIZE, & FUEL COST

GENERAL SERVICE MERCHANDISE DRY VAN

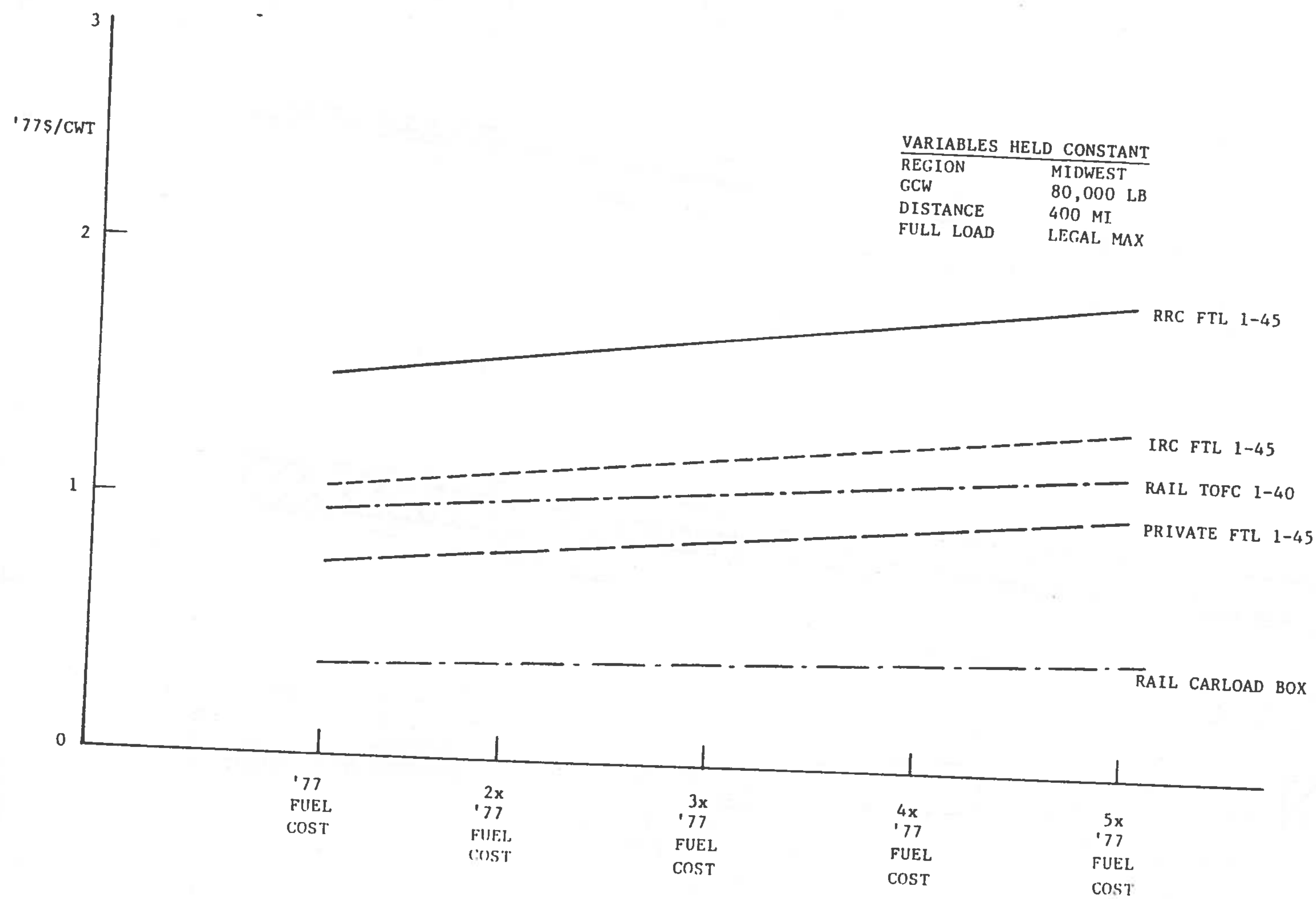


FIGURE 5-14. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE, HAUL DISTANCE, & FUEL COST

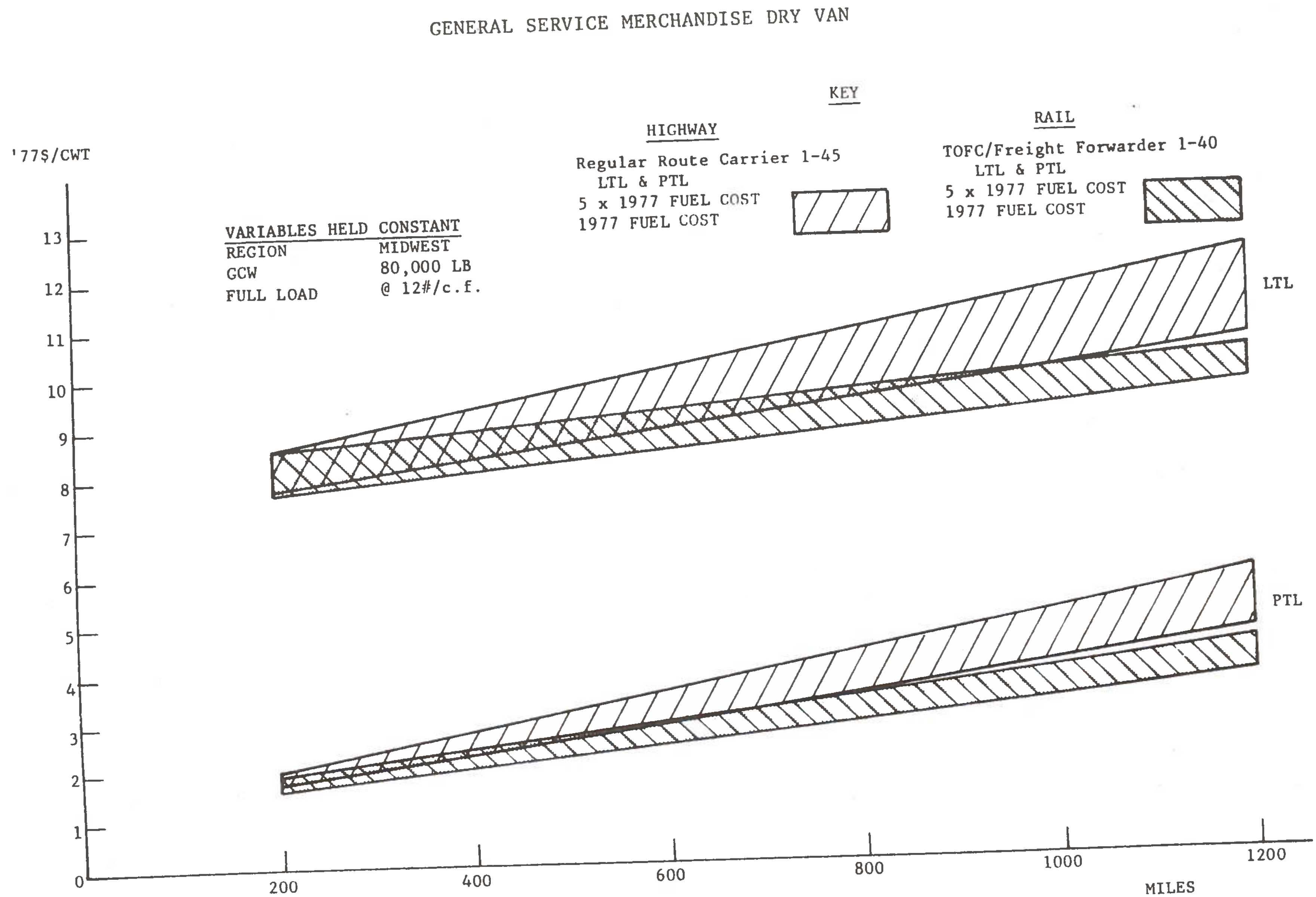


FIGURE 5-15. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE, HAUL DISTANCE, & FUEL COST

GENERAL SERVICE MERCHANDISE DRY VAN

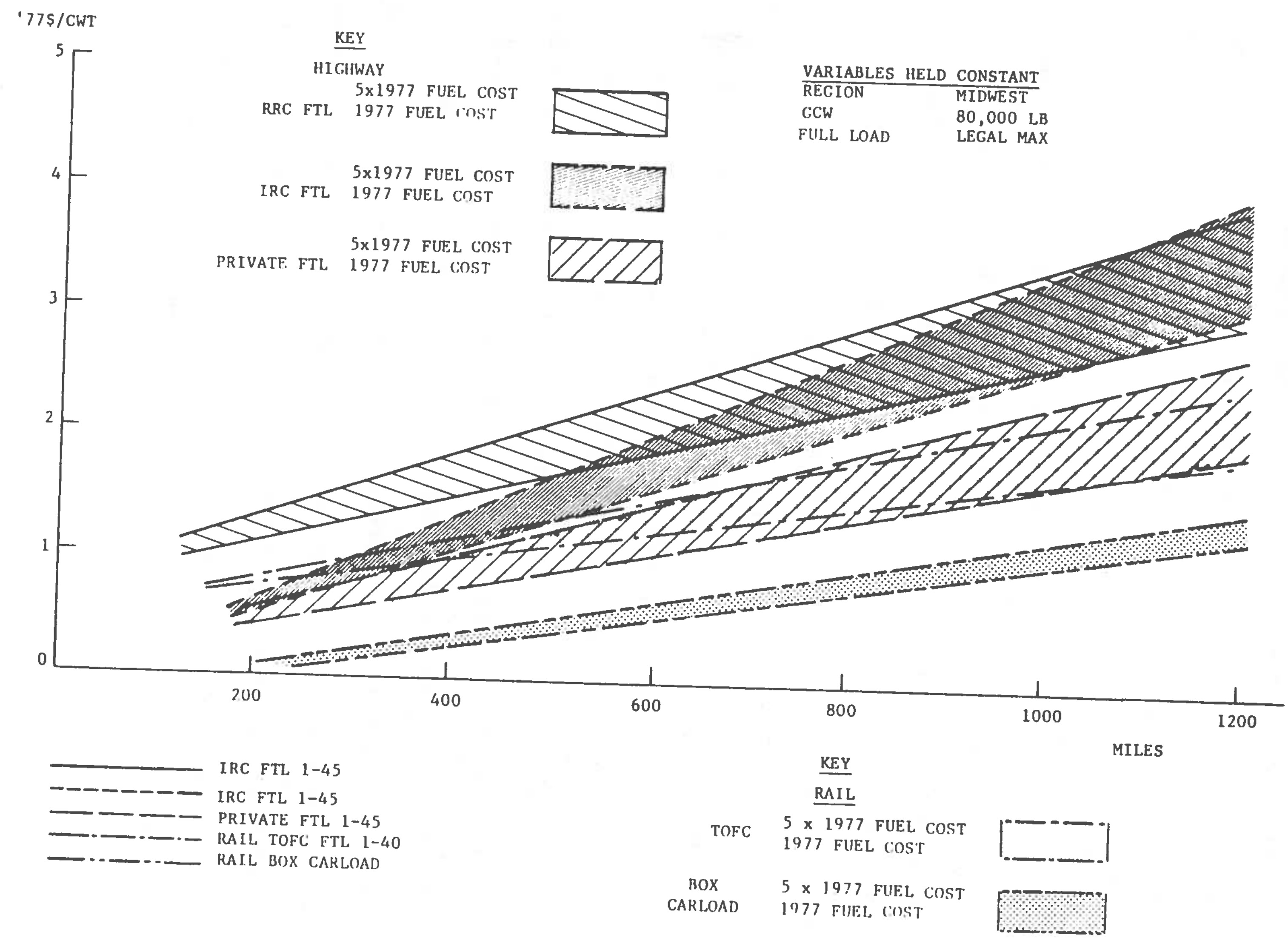


FIGURE 5-16. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE, HAUL DISTANCE & FUEL COST

At the higher fuel cost levels, availability of western doubles for highway carriers reduces the TOFC/FF LTL cost/rate advantage to 5 percent at 1200 miles and at 400 miles to a negative 8 percent. For PTL shipments, the advantage remains with rail, although it reduces to 14 percent at 1200 miles and 3 percent for 400 miles.

For TL shipments, rail TOFC (with conventional semi-trailers) improves its competitive advantage over all highway carriers. Haul distance cross overs for equal cost/rates reduce for private truck from 1100 miles to 700 miles and for irregular route carriers from 300 to 255 miles. TOFC increases its competitive advantage over regular route carriers over all distances to 57 percent at 400 miles and 61 percent at 1200 miles.

5.3 Parametric Analysis of Specialized Commodity Shipment Cost/Rates

This section attempts to complete the representation of all major categories of freight services. Sections 5-1 and 5-2 concentrated on representing cost/rates for general service merchandise dry van operations as well as the competitive rail side of the picture. Other specialized equipment types for truck and rail are examined here in terms of major cost categories and regional differences, and the effects of various TS&W limits are isolated. The specialized services and equipment types covered are auto transporters, dumps, platform/racks, refrigerated vans, and tanks. Rail costs are developed for services which are competitive with these truck services.

The specialized commodity truck services represent movements of full truck load shipments. Different truck configurations have inherent advantages for different shipment sizes. A single specific conventional semi trailer is presented here as the typical truck configuration for each specialized service. Obviously, there are many variations in equipment used in specific markets by various carriers for various services. This paper attempts to present the most typical services for the greatest volume of present truck activities.

The pricing effects of different truck size and weight limits on these conventional rigs are estimated. Three major axle weight limits ranging from about 10 percent below to about 10 percent above the current federal standard are examined. The extreme example of increased size limits which would permit the use of large double trailer rigs is represented by examination of the price effects of 45-foot doubles or "Turnpike Doubles" as they are referred to here.

5.3.1 Sensitivity To Carrier Service and Region of Operation

For a typical 400-mile trip utilizing conventional semi trailers loaded to their legal maximum with an 80,000-pound GCW limit, Figure 5-17 presents a regional breakdown of shipment cost/rates for special commodity truck services. Platform/rack and refrigerated van costs all show similar relationships to dry van movements by irregular route common carriers. Cost/rates within the southern region register the lowest, primarily because of low labor wages, while the northeast and midwest regions experience the highest levels of cost/rates. Auto transporters register the highest shipment cost/rate per hundred weight of all special commodity services. Correspondingly,

SPECIAL COMMODITY TRUCK SERVICES

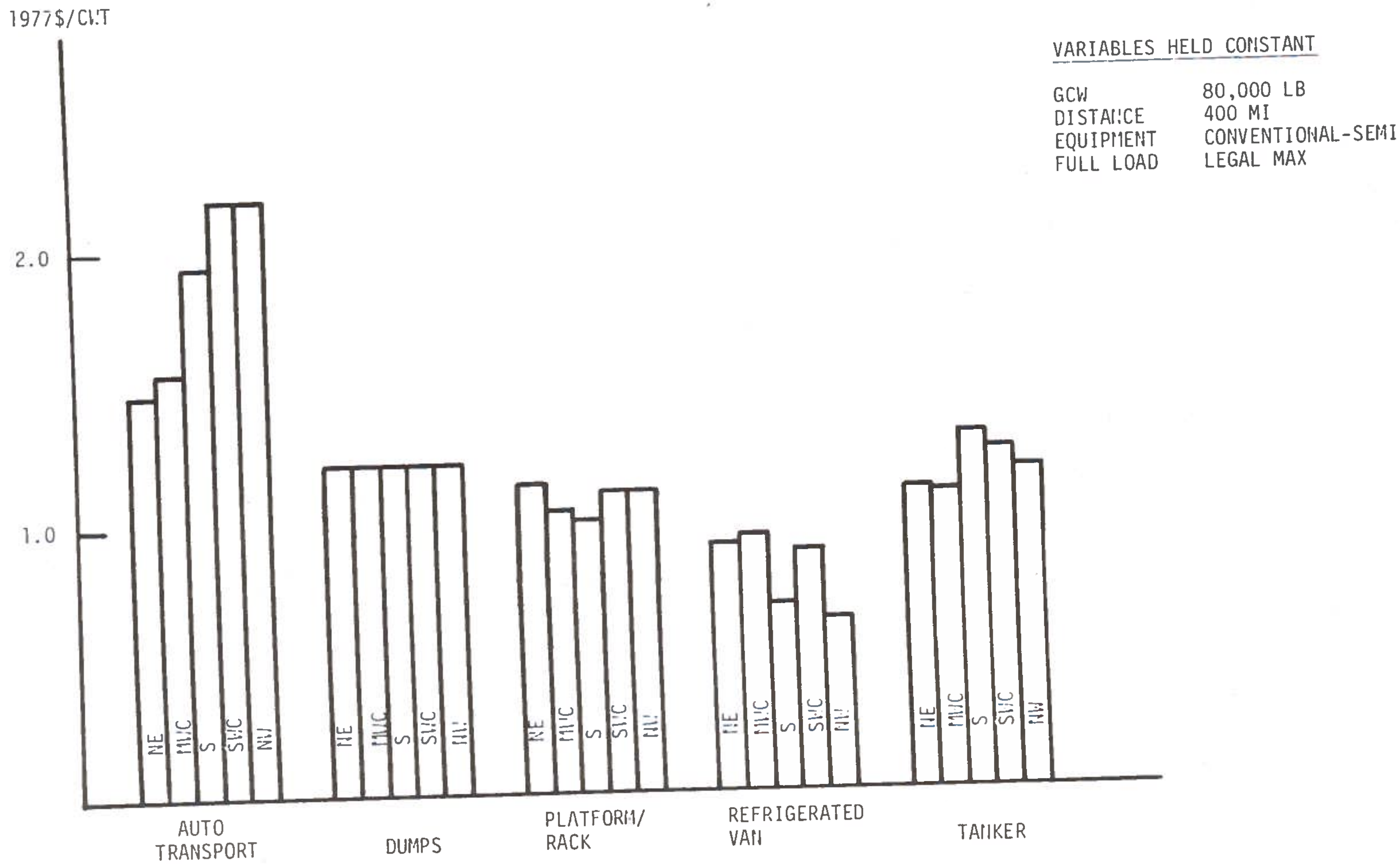


FIGURE 5-17. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE, & REGION OF OPERATION

auto transporters have the lowest average payload and commodity density compared to the other truck services. Heavy bulk movements in dump trucks reveal that single unit vehicles are more expensive to operate than tractor trailer combinations. Higher costs for maintenance, fuel, and labor are the primary reasons for the cost differences.

Figure 5-18 presents rail cost/rates for special commodity services which are comparable and competitive with truck services. Rail refrigerated car service appears to be competitive with truck refrigerated van service in all regions, while dedicated TOFC refrigerated vans' cost/rate is competitive in the south only. Platform/rack and tank cars are clearly price competitive with the alternative truck services.

5.3.2 Operational, Functional, and Cost Elements

Axle and gross weight limit changes are likely to have a greater effect on cost/rates of special commodity services than on general commodity services because line haul costs represent the major portion of total cost/rates for special commodity services. Figure 5-19 isolates the total cost/rate for special commodity FTL shipments and distributes appropriate costs among the components of line haul function.[34]

Fuel costs for auto transporters, racks and tanks all run about 6-9 percent of total cost/rate, while heavy weight payloads and additional fuel

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34 Special commodity truck services are generally irregular route carriers, operating non-scheduled movements. If they operate at all, IRC will only operate and maintain terminals in their base area.

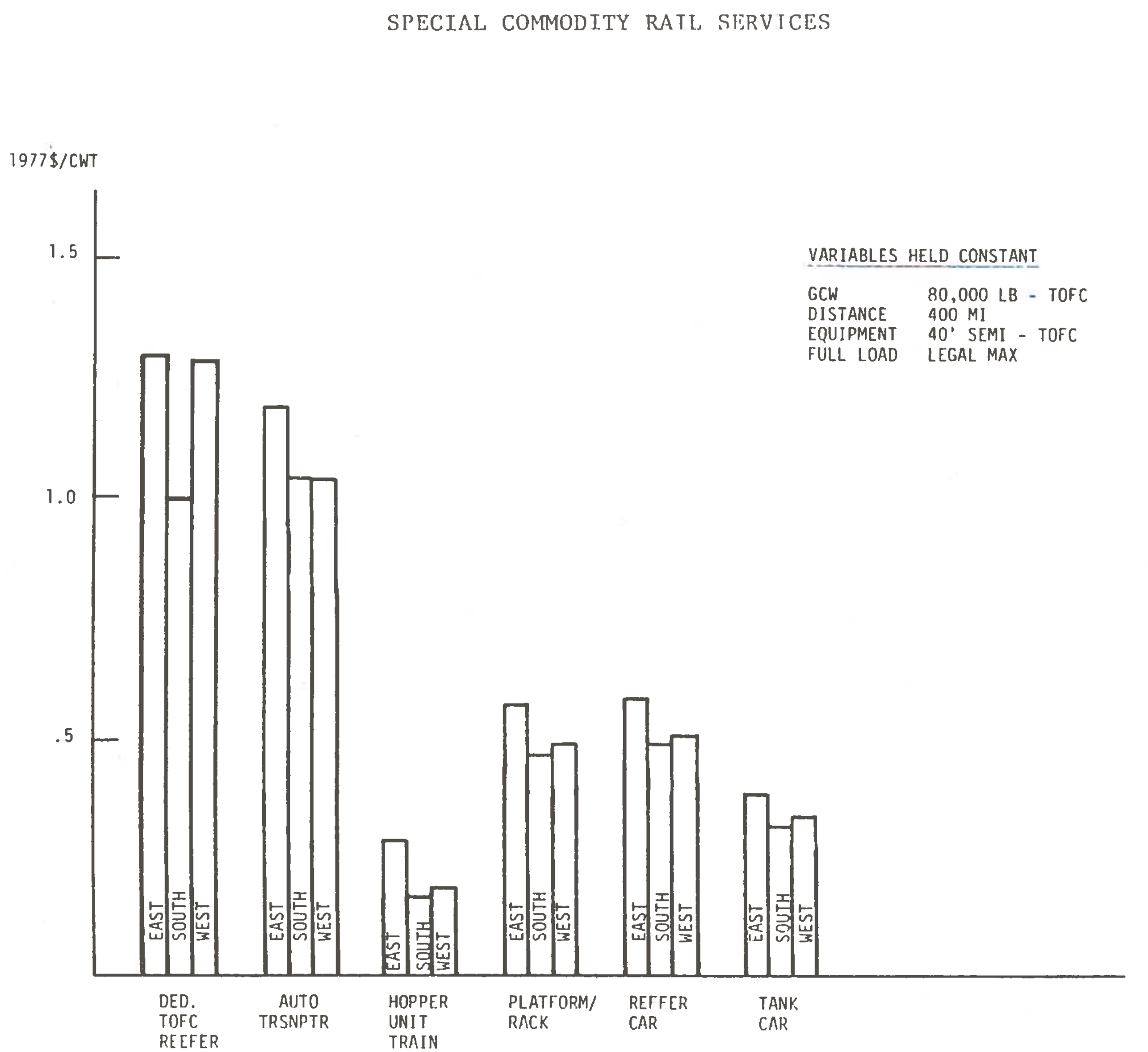

FIGURE 5-18. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE, REGION OF OPERATION

SPECIAL COMMODITY TRUCK SERVICES

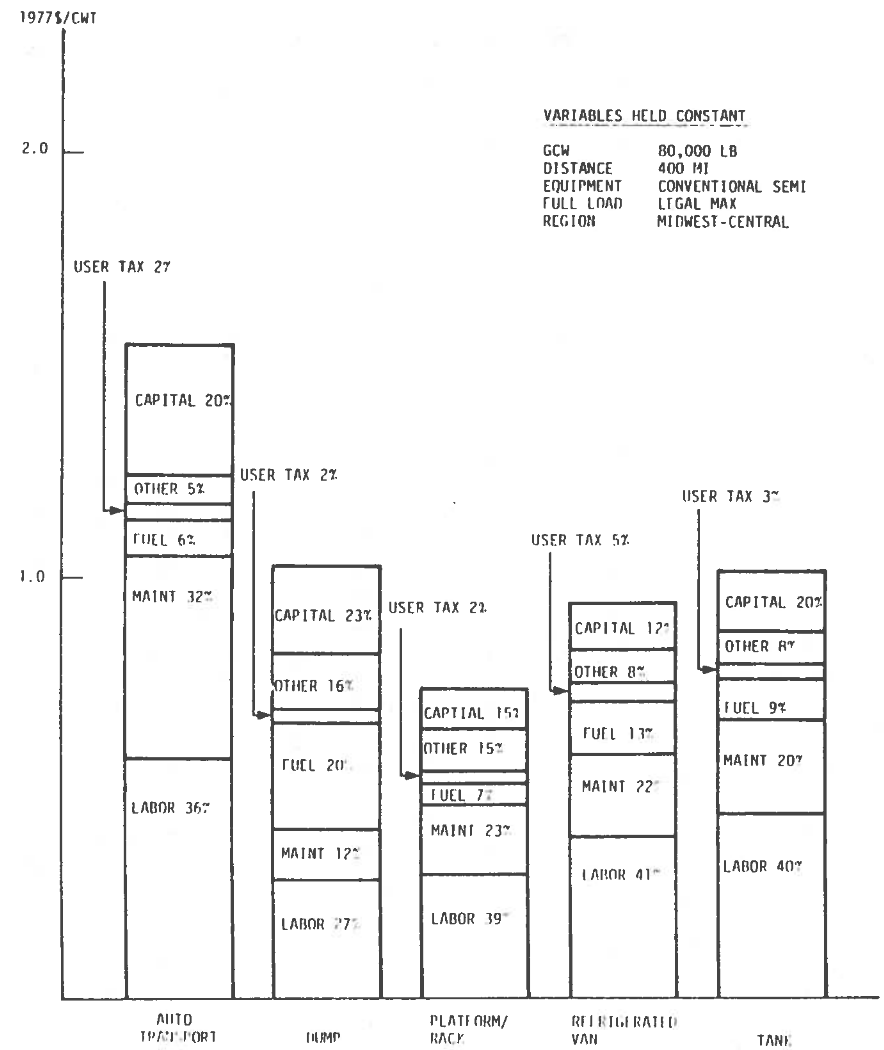

FIGURE 5-19. TOTAL SHIPMENT CHARGE: MAJOR COST CATEGORIES SPECIAL COMMODITY TRUCK SERVICES

usage for cooling units escalate fuel costs for dumps and refrigerated vans up to 20 percent and 13 percent, respectively. Fuel costs combined with road user taxes represent 8 to 22 percent of the total cost/rate. Increase in these two costs above the general level of inflation could negate any potential savings generated from increasing GCW limits from 73/18/32k to 80/20/34k or to 22.4/36k axles and gross weight via the Bridge Formula.

5.3.3 Sensitivity To Carrier Service and Truck Size

Figure 5-20 examines the potential savings on cost/rates of special commodity truck services which would result from substantially more liberal truck size limits, which would, in turn, permit the use of turnpike doubles on the Interstate System. Turnpike doubles provide twice the amount of cubic capacity than conventional semis, which can be translated into a 40-44 percent increase in payload tonnage, depending on which axle weight limits are used. This presumes that the gross weight limit is established by use of the Bridge Formula. An arbitrary gross weight limit of 73k or 80k negates the economic advantage of the turnpike double.

The potential savings in cost/rate reductions from utilizing turnpike doubles over conventional semis for special commodity services range from 9 to 23 percent. This broad impact range can be directly correlated to the average payloads of the services. The largest savings occur to those services which can attain the higher payloads, while a lesser reduction is realized by movements of lower commodity density.

5.3.4 Sensitivity To Carrier Service and Truck Weight Limits

Figure 5-21 presents potential cost/rate reductions for dry van and special commodity services resulting from altering gross weight as well as

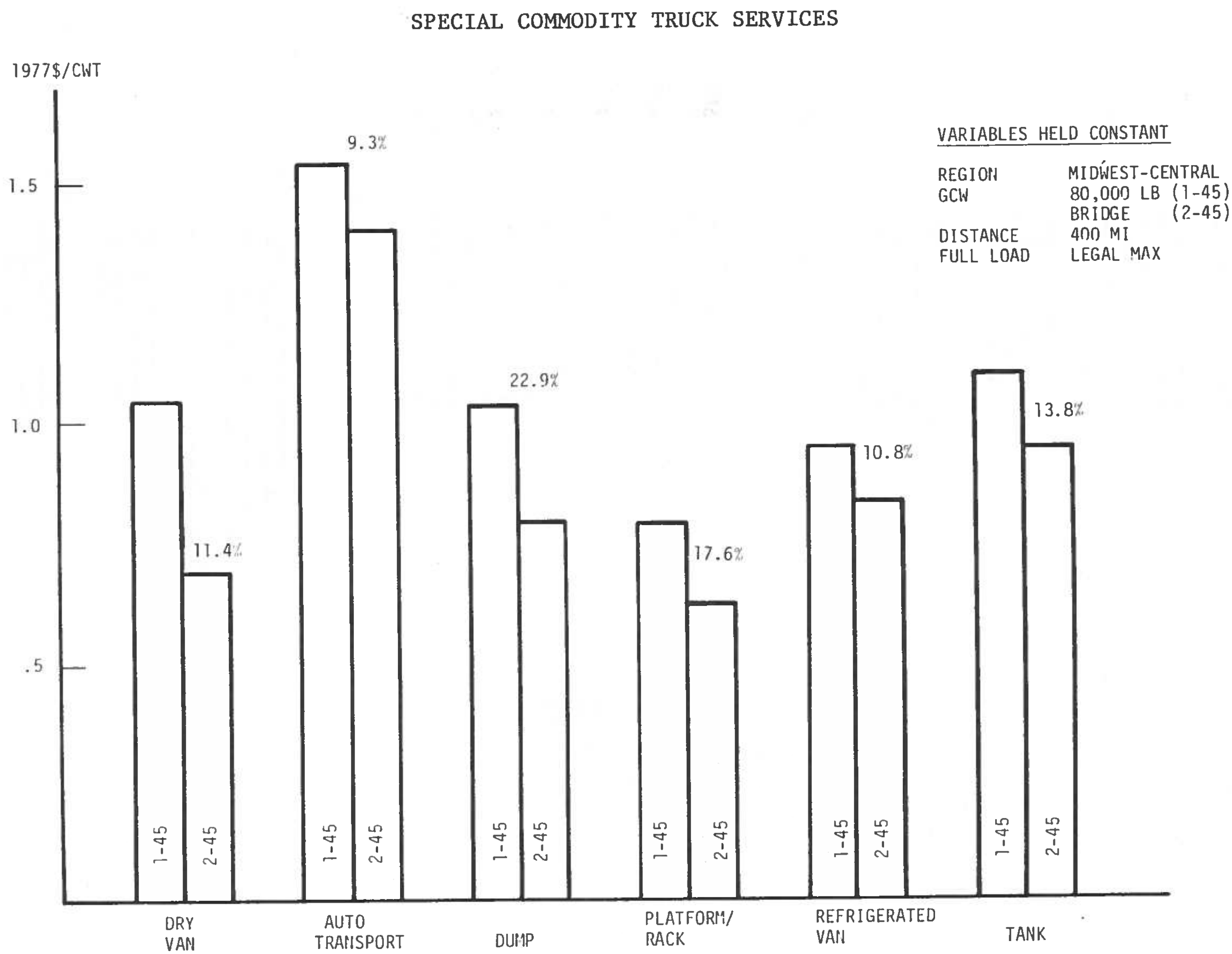

FIGURE 5-20. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE, & TRUCK SIZE

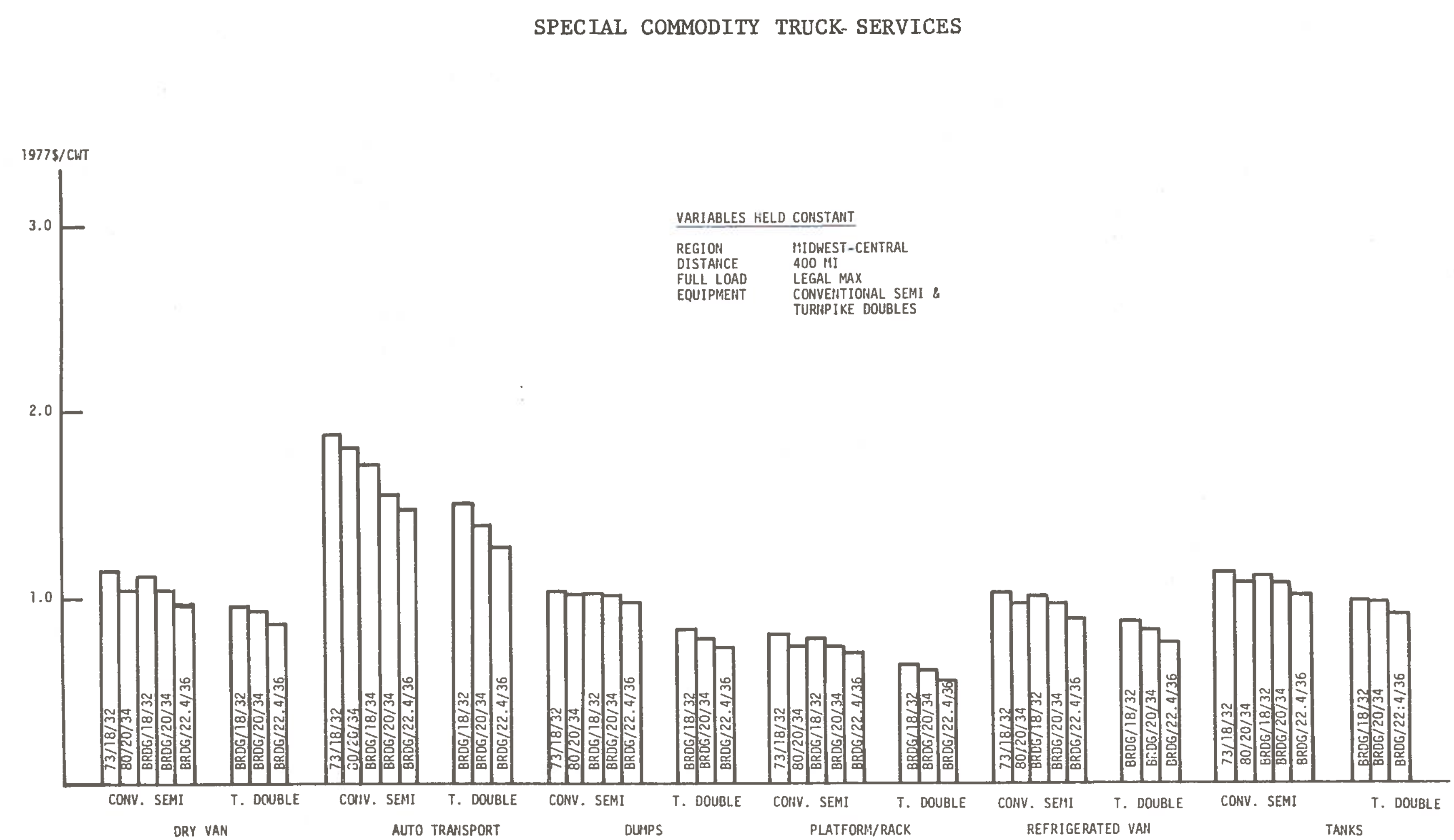

FIGURE 5-21. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE, & TRUCK WEIGHT LIMITS

individual axle limits. Conventional semitrailers and turnpike doubles represent the current dominant rig and the largest likely rig that could be used for these services on the Interstate System.

Three truck weight limits will be addressed in this section: 80/20/34k is the current Federal Standard on the Interstate System, 73/18/32k is the pre-1974 Federal Standard and the current low limit in several states, and 22.4/36k and the Bridge Formula determined gross weight which approximates the highest levels in effect in several states. These three sets of weight limits will be examined as follows:

1. Services using conventional semis at the low and high axle limits in relation to the current Federal Standard (20/34k).
2. Services using turnpike doubles at the 20/34k axle limits in relation to conventional semis at the 20/34k axle limits.
3. Services using turnpike doubles at the 18/32k axle limits in relation to conventional semis at the 20/34k axle limits.

If the federal GCW limits are rolled back from the current level (80/20/34k) to the 1956 level (73/18/32k), cost/rates of special commodity carriers using conventional semis will increase around 10 percent for all services except for tanks, whose increase is about 6 percent. Extending GCW limits to the heavy axle limits (i.e., 22.4/36k), will only produce about a 4 percent decrease in cost/rates for all special commodity carriers using conventional semis.

Dry van and refrigerated van services, utilizing conventional semis (at 20/34k axle limit), can lower their cost/rates 11 percent if turnpike doubles are substituted at the 20/34k axle limit. Only a 4 percent cost/rate reduction can be realized for these two services if the lower axle limit (18/32k) is implemented for turnpike doubles relative to conventional semis at 20/34k limits. Potential savings are more than doubled if turnpike doubles are used at the 20/34k limit instead of 18/32k relative to conventional semis at 20/34k axle limit. Other commodity services, utilizing turnpike doubles, can realize potential savings 1.5 times (14-16 percent vs. 9-12 percent) greater if 20/34k axle limits are applied instead of 18/32k limits in relation to conventional semis at 20/34k limit.

One additional possibility for maintaining or improving truck productivity while reducing adverse impacts on pavement and bridges might be to permit the use of combinations with a broader distribution of axle loads such as 27-foot triples. Three 27-foot trailers, loaded to their legal maximums provides 7 percent more payload than turnpike doubles at 18/32k axle limits.[35] But on a per-truck-mile cost basis, triple 27s are 14 percent more costly to operate relative to turnpike doubles. Higher labor premiums, capital, and maintenance costs are the primary categories causing triples higher operating cost. Therefore, triples do not provide a favorable tradeoff between truck productivity and pavement wear for movements of full truckload shipments. Table 5-4 presents irregular route carrier cost/rates for distances of 400 and 2000 miles and three truck weight limits. Conventional semis, turnpike doubles and triple 27s are the three truck configurations presented.

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35 "Analysis of Truck Payloads Under Various Limits of Size, Weight and Configuration," by J. Mergel, June 1979.

TABLE 5-5. TOTAL SHIPMENT CHARGE: SENSITIVITY TO CARRIER SERVICE, TRUCK WEIGHT LIMITS AND DISTANCE

	General Service Merchandise Dry Van Irregular Route Carriers			
	Conv. Semi	Turnpike Double*	Western Doubles	Triple 27s*
400 Miles				
18/32/73	$1.15	$1.07	$1.33	$1.10
20/34/80	1.05	1.00	1.15	1.07
22.4/36/Bridge	1.01	.94	1.14	1.04
2000 Miles				
18/32/73	$5.77	$5.06	$6.67	$5.23
20/34/80	5.23	4.71	5.75	5.09
22.4/36/Bridge	5.05	4.45	5.74	4.95

* GCW limits for turnpike doubles and triple 27s are determined through the use of the Bridge Formula.

NOTE: Total shipment cost/rates are presented in 1977 $/cwt. Cost/rates represent the Midwest region.

5.3.5 Sensitivity To Truck Size, Weight Limits and Distance -- General Service Merchandise Dry Vans

Figure 5-22 shows that for full truckload shipments loaded to the legal maximum with limits of 73/18/32k, rail TOFC is price competitive with motor carriers using conventional semi trailers at distances greater than 400 miles. Increasing limits to the Bridge Formula with single/tandem axle loadings of 22.4k and 36k pounds, truck's cost/rate advantage is increased to 500 miles. This could mean a significant increase in market penetration.

With the availability of turnpike doubles at the higher GCW limits, motor carriers are able to receive 44 percent more net payload if trailers are loaded to the legal maximum. This can be translated into increasing truck's competitive position with rail TOFC up to 650 miles.

From a truck productivity viewpoint, increasing the truck limits from 20/34k to 22.4/36k will not have a major impact on reducing motor carrier's cost/rate. For a 400-mile trip, dry van conventional semi's and turnpike doubles' cost/rates will reduce by 4 to 6 percent, respectively. If the base weight limit is 18/32k, conversion to 22.4/36k weight limit will provide a potential 14 percent reduction in cost/rates for both conventional semis and turnpike doubles.

5.3.6 Sensitivity To Truck Size, Weight Limits and Distance -- Special Commodity Truck Services

For other equipment types (refrigerated van, rack/platform and tank), Figures 5-23, 5-24, and 5-25, respectively examine the competitive relationships between truck and rail by altering truck weight limits and the availability of turnpike doubles for FTL shipments.

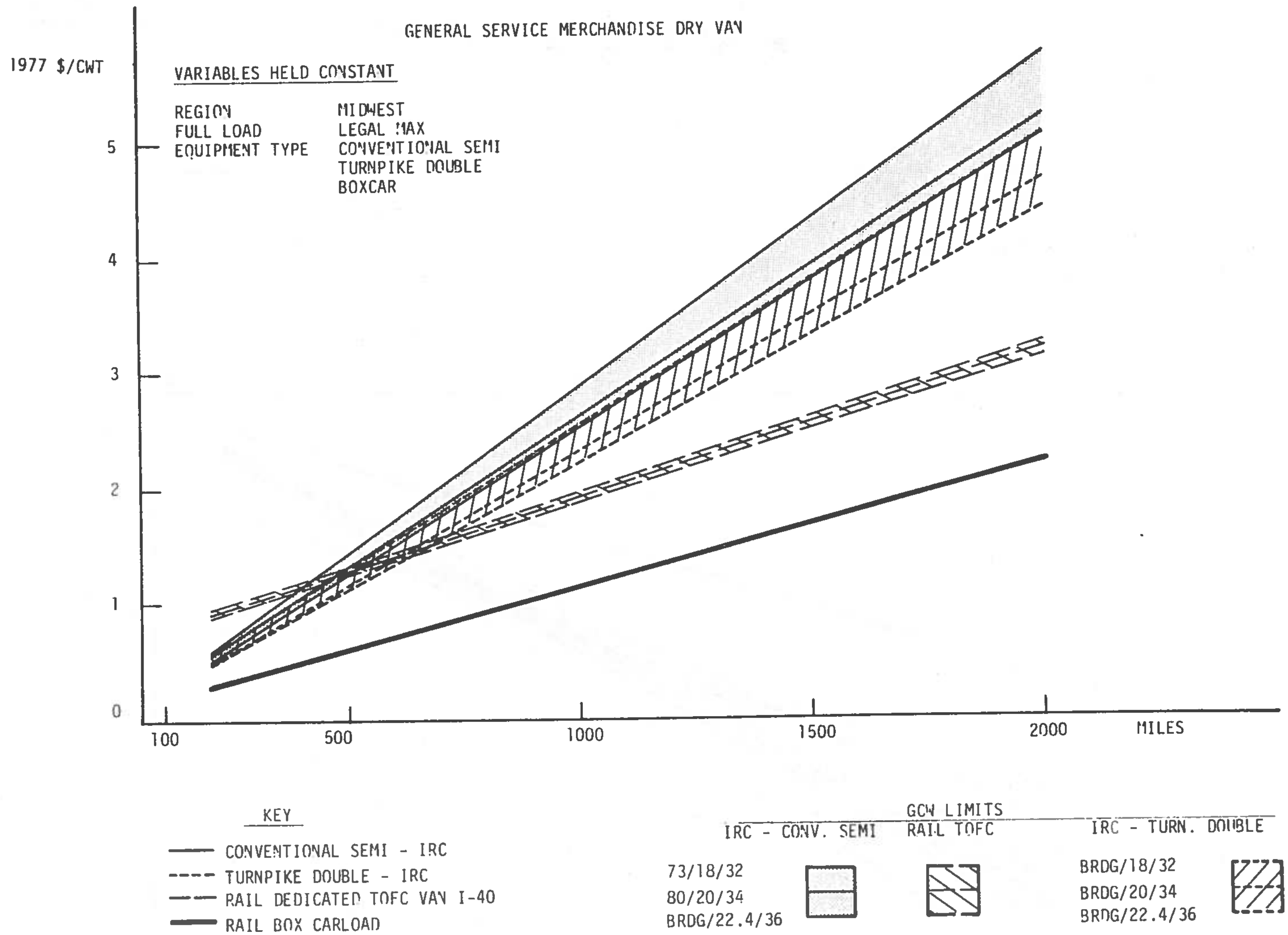


FIGURE 5-22. TOTAL SHIPMENT CHARGE: SENSITIVITY TO TRUCK SIZE, WEIGHT LIMITS AND DISTANCE

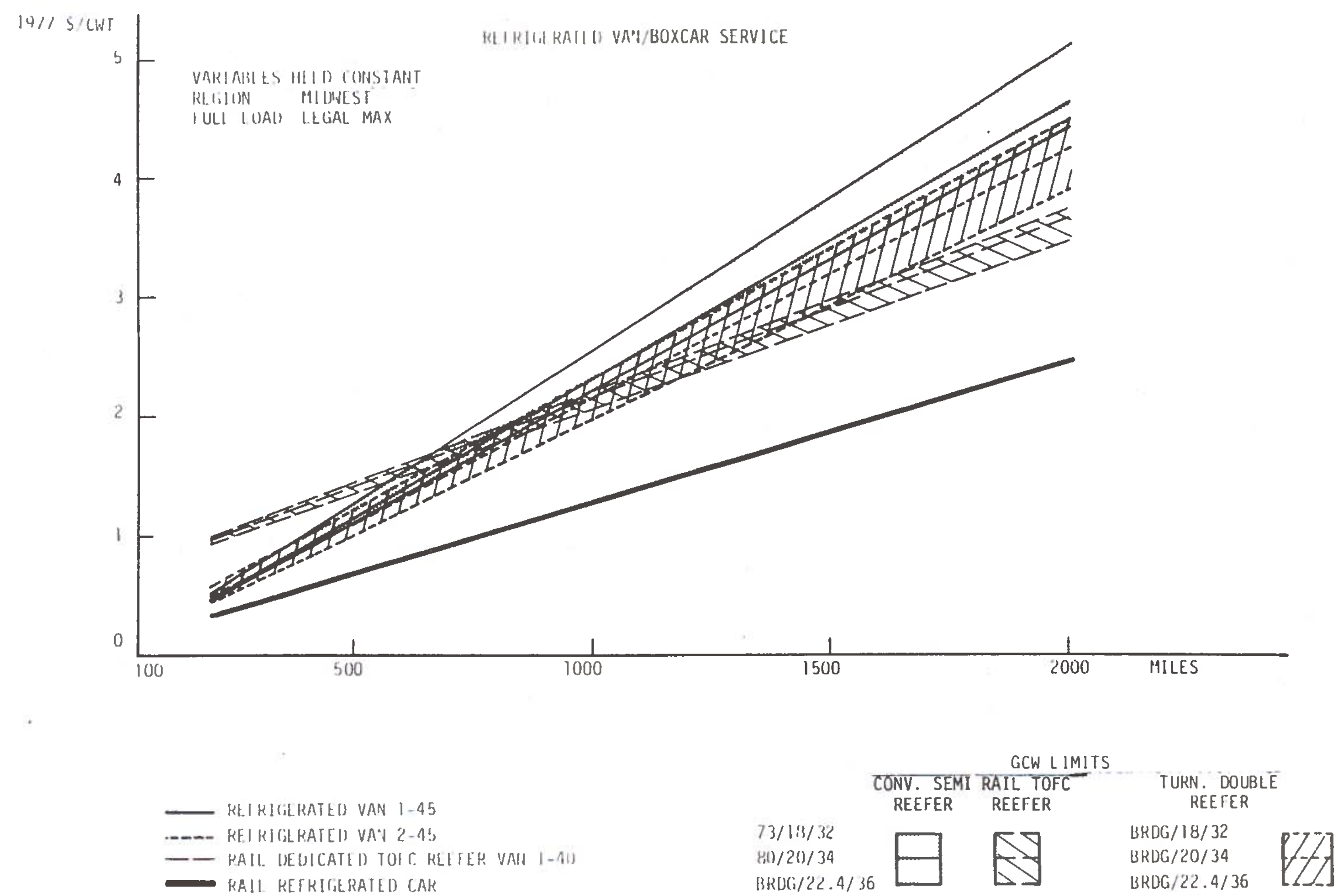


FIGURE 5-23. TOTAL SHIPMENT CHARGE: SENSITIVITY TO TRUCK SIZE, WEIGHT LIMITS AND DISTANCE

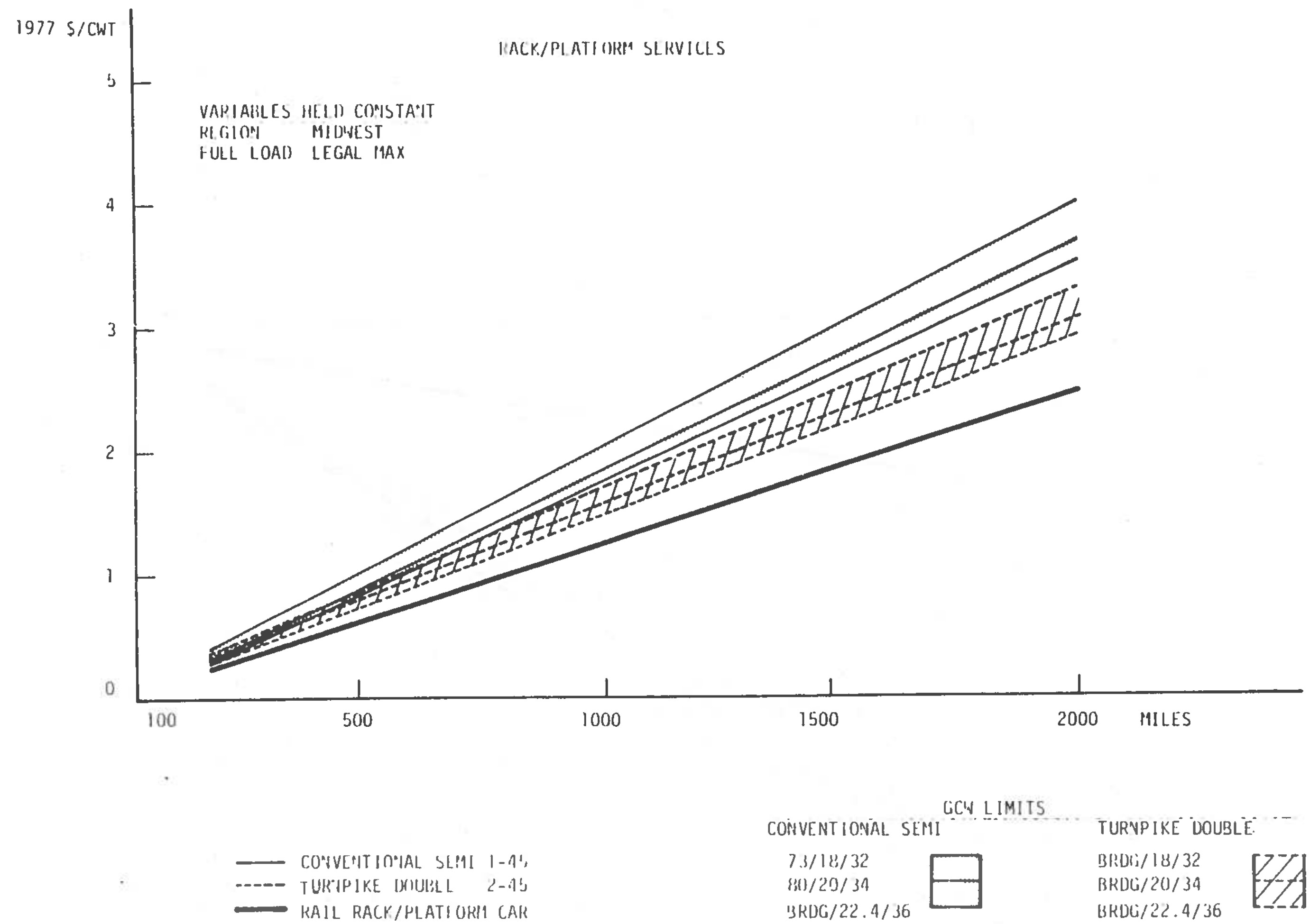


FIGURE 5-24. TOTAL SHIPMENT CHARGE: SENSITIVITY TO TRUCK SIZE, WEIGHT LIMITS AND DISTANCE

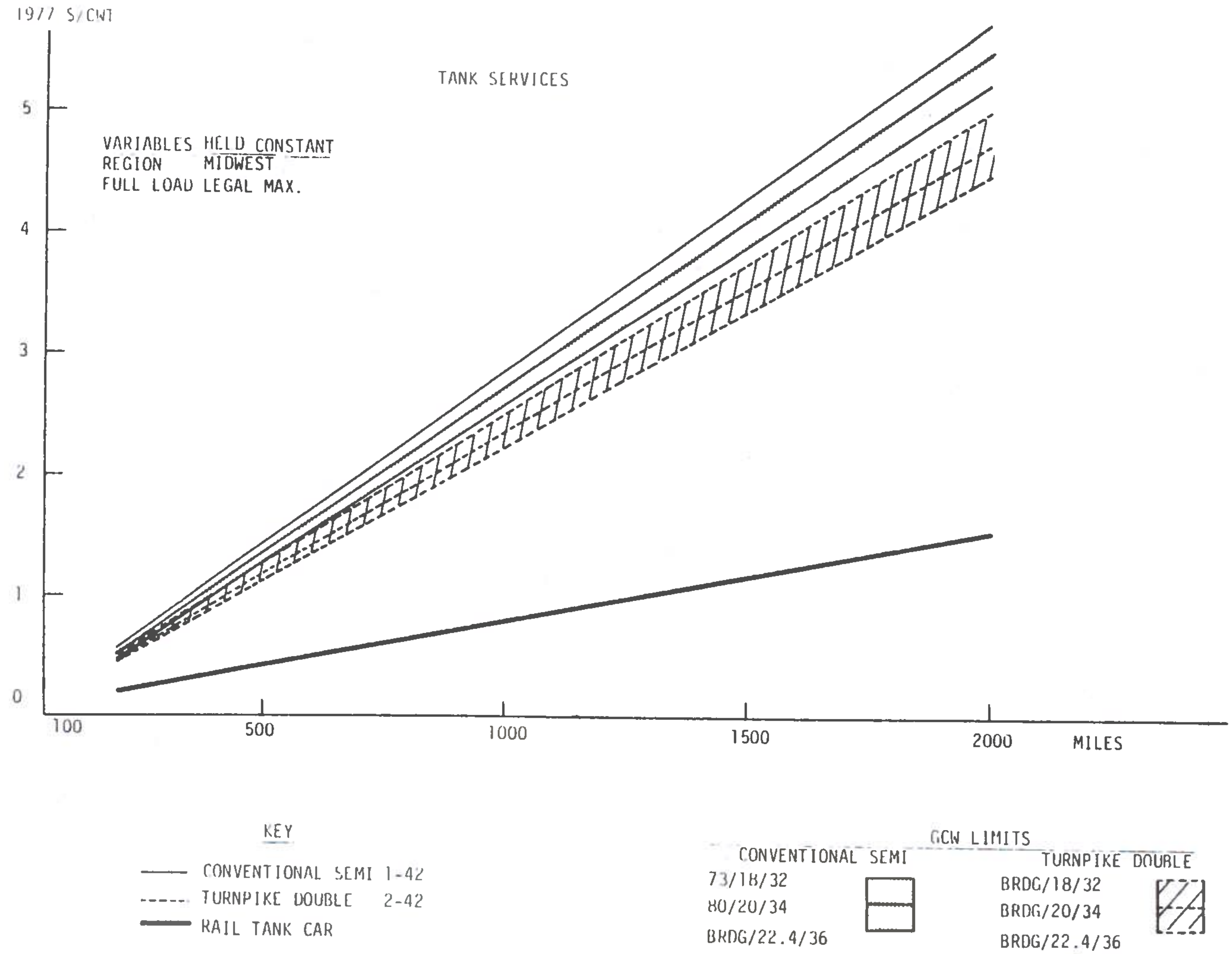


FIGURE 5-25. TOTAL SHIPMENT CHARGE: SENSITIVITY TO TRUCK SIZE, WEIGHT LIMITS AND DISTANCE

Dedicated TOFC refrigerated vans is the only other rail service which is competitive with the truck service. Trucks are competitive with TOFC at distances up to 650 miles under weight limits of 73/18/32k. Truck refrigerated vans' competitive advantage is increased to 800 miles with 80/20/34k and 825 miles if GCW limits are increased to Bridge/22.4/36k. Turnpike doubles make the truck service even more attractive. Motor carriers are able to compete with TOFC refrigerated vans up to distances of 1150 miles if doubles are permitted at the highest weight limit and 800 miles at the lowest limit.

For an average haul distance of 1000 miles, turnpike doubles provide an 11% reduction in cost/rates over conventional semis at any axle limit. Altering axle limits from 20/34k to 22.4/36k will reduce refrigerated van cost/rates 4 to 8 percent for either conventional semis or turnpike doubles, respectively. Reducing limits from 20/34k to 18/32k will increase cost/rates 11 percent for conventional semis and 7 percent for tunrpike doubles.

Rack/platform and tank truck services also display the inherent economic attractiveness of turnpike doubles. Racks can increase payload by 42 percent, while tank's net gain is 51 percent by utilizing turnpike doubles instead of conventional semis. This gain in net payload will have a positive effect on reducing the cost/rates of these truck services. Turnpike doubles used in rack/platform services will yield 8 to 11 percent reduction in cost/rates for a 400 mile trip over conventional semis at any weight limit. An increase in axle limits from 20/34k to 22.4/36k will produce a net cost/rate reduction of 3 percent for singles and 7 percent for turnpike doubles. Platform cost/

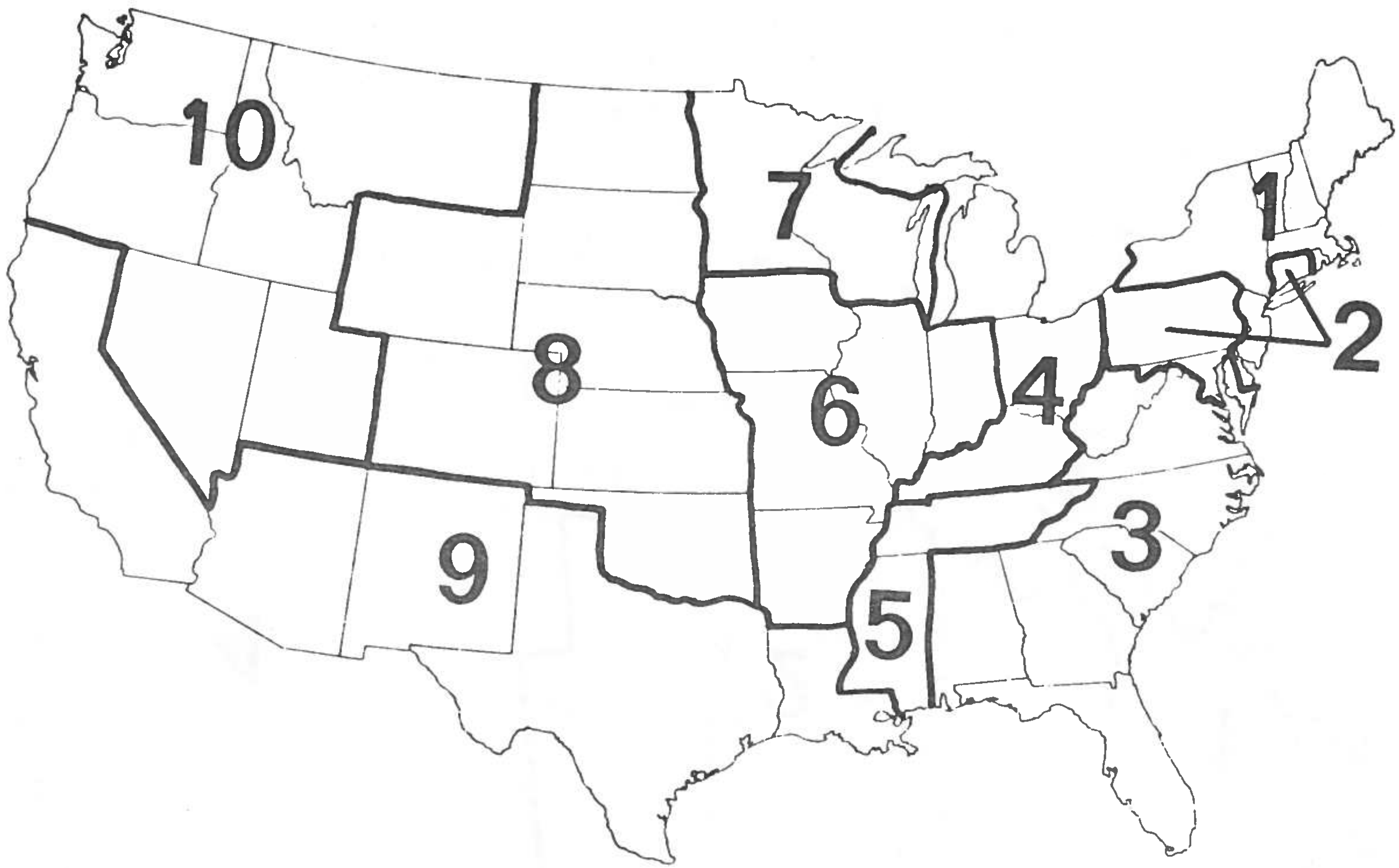
rates increase 6 to 10 percent if the current federal standard is rolled back to the 1956 level for turnpike doubles and conventional semis, respectively. Figure 5-24 shows that for higher truck size and weight limits, platform/rack carriers will be price competitive with rail services.

Tank truck services can obtain a cost/rate reduction of 7 to 10 percent at 400 miles if doubles are substituted for singles at any weight bracket. Increasing axle limits from the federal standard to the highest level will yield a 4 to 5 percent reduction in cost/rates for conventional semis and turnpike doubles, respectively. Utilizing the low axle limits will increase cost/rates 6 percent for both singles and doubles. Figure 5-25 illustrates that changing either size or weight limits will not result in any clear competitive change between truck and rail for tank services if price is the determining factor for mode choice.

APPENDIX A

TABLE A-1. MATRIX OF COMPATIBLE TRUCK AND RAIL COST REGIONS TO BE APPLIED TO THE TEN TRUCK SIZE AND WEIGHT STUDY REGIONS

TRUCK SIZE AND WEIGHT STUDY REGIONS	DRY VAN COSTING REGIONS	OTHER EQUIPMENT COSTING REGIONS	RAIL COSTING REGIONS
(1) Northeast	(1) Northeast	(1) Northeast	(1) East
(2) East	(1) Northeast	(1) Northeast	(1) East
(3) Southeast	(3) South	(3) South	(2) South
(4) Middle-East	(2) Midwest	(2) Midwest-Central	(3) West
(5) South-Central	(3) South	(3) South	(2) South
(6) Central	(2) Midwest	(2) Midwest-Central	(3) West
(7) North-Central	(2) Midwest	(2) Midwest-Central	(3) West
(8) West-Central	(4) West	(4) Southwest-Central	(3) West
(9) Southwest	(4) West	(4) Southwest-Central	(3) West
(10) Northwest	(4) West	(5) Northwest	(3) West



Source: "Truck Size and Weight Study Work Plan for Phase II," System Design Concepts, December 1979, page 34.

FIGURE A-1. REGIONS TO BE USED IN THE REPORTING OF TS&W RESULTS

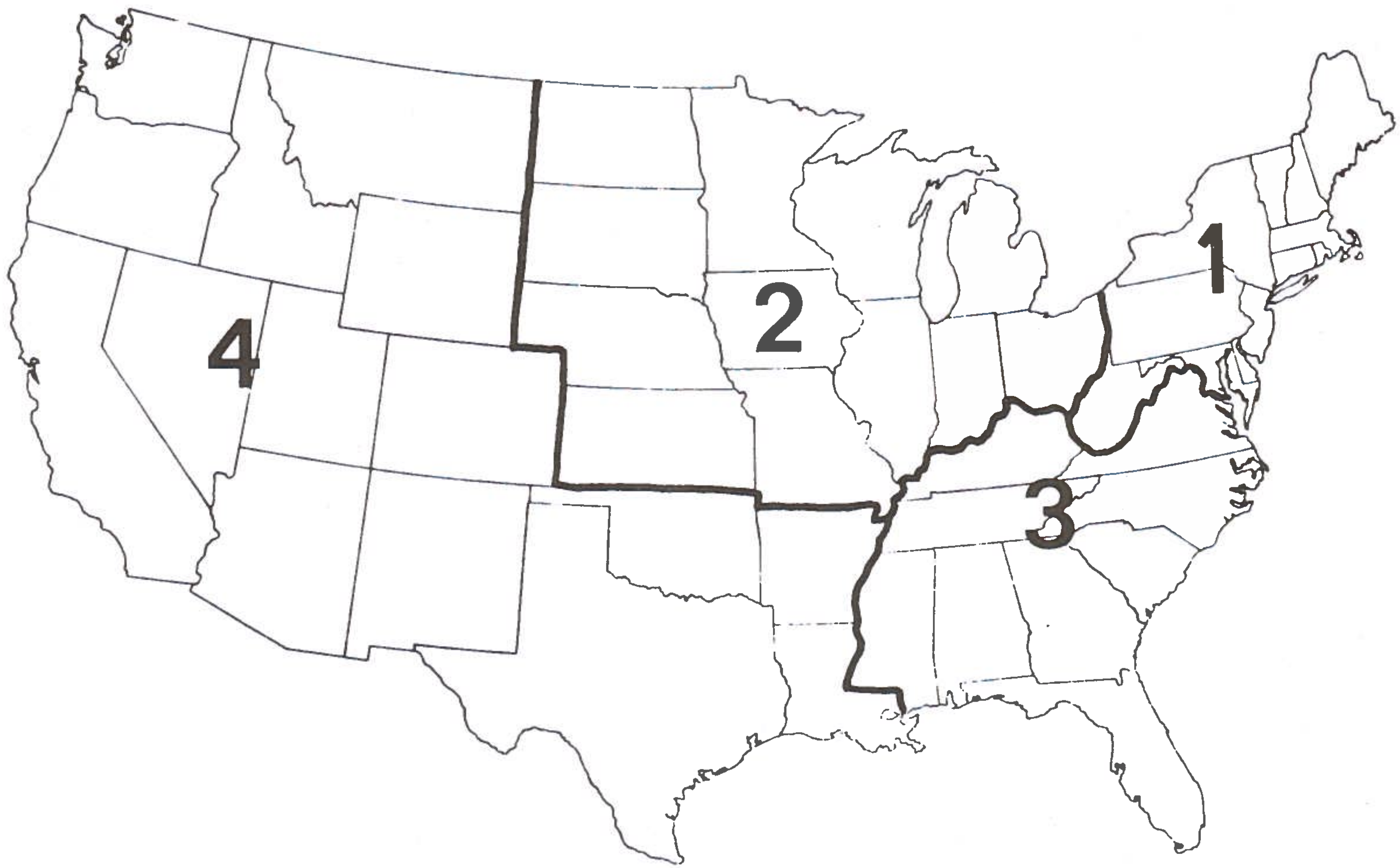


FIGURE A-2. GENERAL SERVICE MERCHANDISE DRY VAN STUDY COST AREAS DEVELOPED FROM ICC RATE REPORTING REGIONS

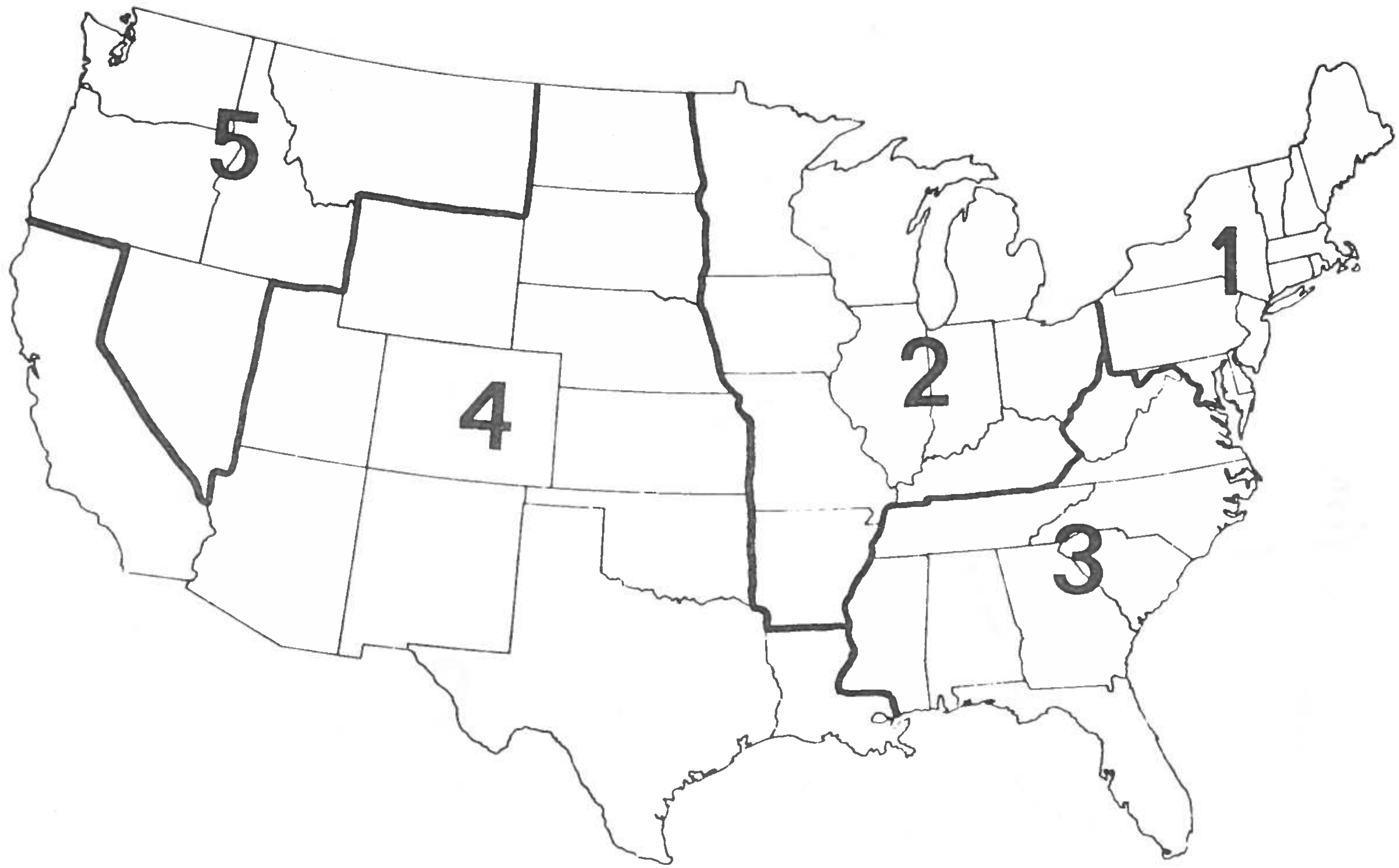


FIGURE A-3. TRUCK STUDY COST REGIONS FOR OTHER HIGHWAY EQUIPMENT TYPES

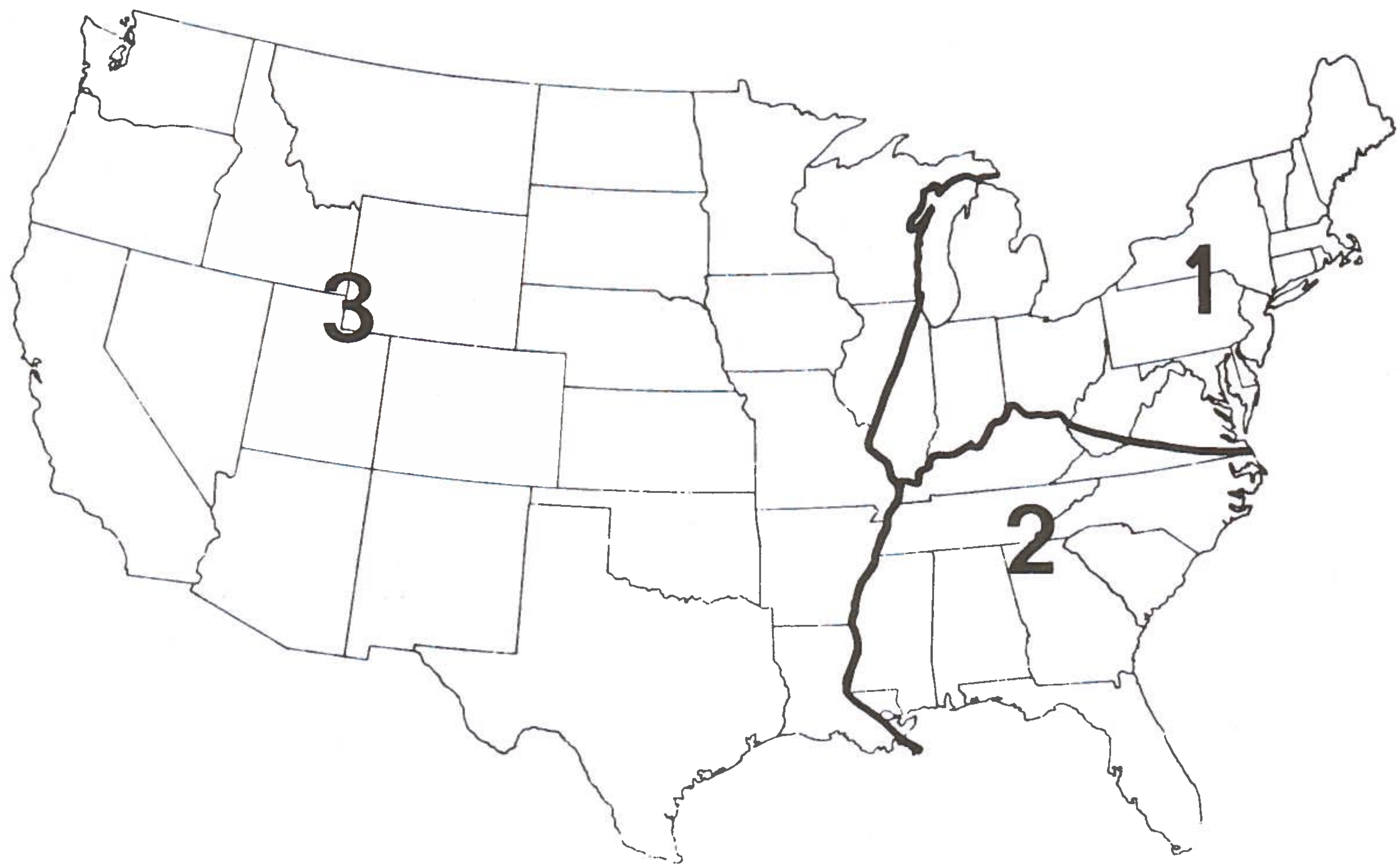


FIGURE A-4. RAIL STUDY COST AREAS DEVELOPED FROM ICC COST REGIONS

APPENDIX B

TABLE B-1. CARRIERS SELECTED BY CLASS AND REGION OF OPERATION FOR TSC TRUCK COST MODEL

Regular Route Common

	North Eastern	Southern	Midwestern	Western
1.	Sanborns Motor Express Portland, ME	AAA-Cooper Trans. Dethan, AL	Yellow Freight Sahwnee Mission, KS	Time DC Lubbock, TX
2.	Holmes Transport. Framingham, MA	Georgia Hwy. Expr. Atlanta, GA	Dohrn Transfer Rock Island, IL	Pacific Int'l Expr. Oakland, CA
3.	APA Transport Corp. Bergen, NJ	Carolina Frt. Carriers Cherryville, NC	Mid-Amer. Lines Kansas City, MO	IML Frt. Salt Lake City, UT
4.	Preston Trkg. Co. Preston, MD	McLean Trucking Winston-Salem, NC	Werner Continental St. Paul, MN	Consolidated Frt. Menlo Park, CA
5.		So. East. Frt. Lines Columbia, SC		Garrett Frt. Lines Pocatello, ID
6.		Great Coastal Expr. Richmond, VA		Redball Motor Frt. Dallas, TX

Irregular Route/Contract Carriers

Food Hanlets Elizabeth, NJ	A.G. Boone Charlotte, NC	Fast Motor Serv. Inc. Palos Heights, IL	U&R Express Inc. White City, OR
C-Line Chepachet, RI	C.T. Hertzsch Louisville, KY	Standard Fwdg Co. Inc. E. Moline, IL	Continental Cont. Carts City-Industry, CA
Gross & Hecht Trkg. Inc. Edison, NJ		Cresco Lines Crestwood, IL	Jo/Kel Inc. City-Industry, CA
D.J. McNichol Co. Philadelphia, PA		Chip Carriers Inc. Omaha, NE	
Pacific Trptn. Lns. Inc. Buffalo,NY		Truckaway Serv. Inc. Detroit, MI	
		Signal Delv. Serv. Inc. Hinsdale, IL	

Private Carriers

Stop & Shop Boston, MA	Burlington Ind. Inc. Burlington, NC	SCM Corp. Cleveland, OH	Johns Manville Sales Corp. Denver Co.
General Electric Co. Schenactady, NY	R.J. Reynolds Tobacco Co. Winston Salem, NC	The CECO Corp. Chicago, IL	Certified Grocers of Calif. Ltd. Los Angeles, CA

TABLE B-2. CARRIERS SELECTED BY EQUIPMENT TYPE, CLASS AND REGION OF OPERATION FOR TSC TRUCK COST MODEL

NORTHEAST	MIDWEST-CENTRAL	SOUTH	SOUTHWEST-CENTRAL	NORTHWEST
		AUTO TRANSPORT CARRIERS		
1. M&G Convoy, Inc. Buffalo, NY 2. Nu-Car Carriers Inc. Bryn Mawr, PA 3. Glabern Corporation Penndel, PA	1. Automobile Transport Inc. Wayne, MI 2. Arco Auto Carriers Inc. Chicago, IL 3. Anchor Motor Frt Inc. Cleveland, OH 4. C&J Commercial Drvawy Lansing, MI	1. Dealers Transport Co. Memphis, TN 2. Motor Convoy Inc. Atlanta, GA. 3. Dixie Transport Co. Jacksonville, FL.	1. Insured Transporters, Inc. Freemont, CA 2. Auto Convoy Co. Dallas, TX 3. Dealers Auto Trpt Inc. Rosemead, CA.	1. Convoy, Co Kirkland, WA 2. Transport Stg & Dist Co. Seattle, WA
		PLATFORM/RACK CARRIERS		
1. Materials Trpt Service Inc. Northampton, PA 2. L.J. Kennedy Trkg Co. Kearny, NJ 3. Freeport Transport Inc. Freeport, PA	1. Smeester Bros. Trkg Iron Mountain, MI 2. Russell Trucking Line Inc. Sandusky, OH 3. D. Lodesky Trucking, Inc. Gurnee, IL	1. Poole Truck Line Inc. Evergreen, AL 2. Osborne Truck Line, Inc. Birmingham, AL 3. Moss Trucking Co. Inc Charlotte, NC	1. Don Ward Inc. Denver, CO 2. Melton Truck Lines Inc. Shreveport, LA 3. Brazos Transport Co. Lubbock, TX.	1. System Transport Inc. Spokane, WA 2. Builder Transport Inc. Great Falls, MT 3. West Coast Truck Lines Inc. Eugene, OR
		REFRIGERATED VAN CARRIERS		
1. Refrigerated Food Exp. Boston, MA 2. H.F. Campbell & Son Inc. Millerstown, PA 3. Hendries, Inc. Milton, MA	1. Coldway Carriers Inc. Clarksville, IN 2. Best Refrigerated Exp. Inc. Council Bluffs, IA 3. Bray Lines Inc. Cushing, OK	1. Alterman Transport Lines Inc. Opa Loca, FL 2. Colonial Refrigerated Trpt Inc. Knoxville, TN 3. Redwing Refrigerated Inc. Taft, FL	1. Trans-Cold Express, Inc. Irving, TX 2. W.J. Digby, Inc. Denver, CO 3. Midwest Coast Trpt Inc. Sioux Falls, SD	1. Dunkley Refrg. Trpt Inc. Salt Lake City, UT 2. IDA-CAL Frt Lines Inc. Nampa, ID 3. Inc Express Inc. Seattle, WA
		TANK CARRIERS		
1. Chemical Leaman Tank Lns Downington, PA 2. Baltimore Tank Lines Inc. Glen Burnie, MD 3. Roy Brothers Inc. Pinehurst, MA	1. A&C Carriers Inc. Muskegon, MI 2. Buck Transport Co. Pleasant Prairie, WI 3. Commercial Transport Inc. Belleville, IL	1. Bralley-Willett Tank Lines Inc. Richmond, VA 2. Fleet Transport Co. Inc. Nashville, TN 3. Infinger Transportation Co. Charleston, SC	1. Bray Transports Inc. Cushing, OK 2. Acme Transportation Inc. San Pablo, CA 3. Ellex Transportation Inc. Tulsa, OK	1. Arrow Trans-portation, Inc. Portland, OR 2. Inland Trans-portation Co. Seattle, WA 3. Northern Tank Line Co. Miles City, MT

Note: Data for cost estimates of Dump Truck Services was obtained from TSC Staff Study, "Determining the Productivity of Improved Coal Haul Roads," D.P. Sullivan & J.S. Yarmus, September 1979.

TABLE B-3. CARRIERS SELECTED BY REGION OF OPERATION FOR TSC RAIL COST MODEL

North Eastern	Southern	Western
Baltimore and Ohio Railroad Co.*	Southern Railway Co.	Atchison Topeka and Santa Fe Railway Co.
Chesapeake and Ohio Railroad Co.*	Seaboard Coast Line Railroad Co.	Burlington Northern, Inc. St. Paul, MN
Norfolk and Western Railway Co.		Missouri Pacific Railroad Co.
		Southern Pacific Transportation Co.
		Union Pacific Railroad Co.

*Unconsolidated from Chessie System

APPENDIX C

TABLE C-1. EQUIPMENT AND CARRIER SERVICES WHICH CAN BE ESTIMATED FROM THE AVAILABLE I.C.C. DATA FILES[4]

TRUCK - GENERALLY CLASS I

BY REGION

- General Service Dry Van
- Dumps[1]
- Reefer Van
- Tankers
- Auto Transports
- Platform/Racks
- Household Goods[2]

RAIL[3] - BY REGION

- General Service Boxcar and TOFC
- Bulk Car Movements
- High Cube - Car Parts[2]
- High Cube - Auto Transports
- Reefer
- Tank Cars
- Platform/Racks

Note:

(1) Dump truck cost information was gathered from a TSC Staff Study, "Determining the Productivity of Improved Coal Haul Roads." D.P. Sullivan & J.S. Yasmus, September 1979.

(2) Costs for these services were not completed for this exercise.

(3) All of the above in single car, multicar or unit train shipments.

(4) Appendices D, E and F, which follow come from ICC data files.

APPENDIX D

TABLE D-1. 1977 AVERAGE COSTS: BY REGION AND BY CARRIER SERVICE - REGULAR ROUTE COMMON CARRIER LTL SERVICE - CONVENTIONAL SEMIS AND WESTERN DOUBLES

	NORTHEASTERN CONV. SEMI	NORTHEASTERN W. DOUBLE*	SOUTHERN CONV. SEMI	SOUTHERN W. DOUBLE*	MIDWESTERN CONV. SEMI	MIDWESTERN W. DOUBLE*	WESTERN CONV. SEMI	WESTERN W. DOUBLE*
Line-Haul ($/Truck-Mile)								
Labor	.340	.357	.317	.333	.347	.364	.381	.381
Maint. & Tires & Tubes	.227	.263	.186	.216	.181	.210	.171	.198
Fuel, Oil & Lube	.092	.095	.084	.087	.092	.095	.086	.089
Road User Taxes	.017	.018	.028	.029	.028	.029	.027	.028
Other L.H.	.071	.071	.045	.045	.049	.049	.060	.060
Total Operating	.747	.804	.660	.710	.697	.747	.725	.756
** Capital (Equip.)								
a) Reported Actuals	.208		.076		.100			.084
b) NPV, Replace, Ind. % RTN	.557	.564	.162	.164	.279	.282	.325	.329
c) NPV, Replace, 15% RTN	.380	.383	.111	.112	.190	.192	.222	.224
Total L.H. ($/Truck-Mile)								
a)	.955	---	.736	---	.797	---	---	.840
b)	1.304	1.368	.822	.874	.976	1.029	1.050	1.085
c)	1.127	1.187	.771	.822	.887	.939	.947	.980
Terminal Area (incl. PU&D)($/TON)								
Labor	61.309	55.178	72.668	65.401	84.714	76.243	86.296	78.451
Maint. (Eq.&Fac.), Tires & Tubes	10.921	9.829	13.979	12.581	21.334	19.201	17.540	15.945
Fuel, Oil & Lub.	2.231	2.008	2.831	2.548	3.092	2.783	3.003	2.730
Road User Taxes	1.327	1.194	.809	0.728	.891	.802	.868	.789
Other	14.980	13.482	16.214	14.593	24.114	21.703	22.947	20.861
Total Term. Operations	90.768	81.691	106.501	95.851	134.145	120.730	130.654	118.776
Capital (Eq. & Fac.) Reported Actuals	4.912	4.421	6.123	5.511	9.300	8.370	6.987	6.352
***Total Term ($/TON)	95.680	86.112	112.624	101.362	143.445	129.100	137.641	125.128

Note: Western truck costs can be applied to the Southwest-Central and Northwest regions to be compatible with the other truck body types.

Computations for Western Doubles:
(1) Labor costs (drivers and helpers) are increased at a premium of 5%. Source: "Western Doubles Corridor and Rate Study: A Rate Analysis," Gordan Fay Assoc. with TDS Inc.
(2) Maintenance costs are 16% higher for Western Doubles. Source: Same as (1).
(3) Fuel costs and highway user taxes are 3% higher for Western Doubles. Source: "Truck and Rail Fuel Consumption," D.A. Knapton and D.J. Maio, TSC Project Memo #TSC 321-OP-040-4-0
(4) Other costs or unclassified categories will experience no change from conventional Semi to Western Double.
(5) Capital costs were estimated from net present value analysis.

**Reported actual capital costs were estimated by isolating individual carrier's annual debt and equity cost and apply that cost to the line haul investment, thus reducing it to an annual cost basis. Net present value analysis incorporated both an industry average percent return to insure the debt cost as well as the level of profits and equity for 1977 are recovered, as well as a uniform 15% return be recovered, through the unit cost over the life of the equipment financed.

***10% reduction in Total Term $/TON for Doubles versus Conv. Singles for reduced Handlings Estimated from: "Western Doubles Corridor and Rate Study: A Rate Analysis," Gordan Fay Assoc. with TDS Inc.

TABLE D-2. 1977 AVERAGE COSTS: BY REGION AND BY CARRIER SERVICE - REGULAR ROUTE COMMON CARRIER PARTIAL TL SERVICE - CONVENTIONAL SEMIS AND WESTERN DOUBLES

	NORTHEASTERN CONV. SEMI	NORTHEASTERN W. DOUBLES	SOUTHERN CONV. SEMI	SOUTHERN W. DOUBLES	MIDWESTERN CONV. SEMI	MIDWESTERN W. DOUBLES	WESTERN CONV. SEMI.	WESTERN W. DOUBLES
Line-Haul	($/Mile)							
Labor	.340	.357	.317	.333	.347	.364	.381	.381
Maint. & Tires & Tubes	.227	.263	.186	.216	.181	.210	.171	.198
Fuel, Oil & Lube	.092	.095	.084	.087	.092	.095	.086	.089
Road User Taxes	.017	.018	.028	.029	.028	.029	.027	.028
Other L.H.	.071	.071	.045	.045	.049	.049	.060	.060
Total Operating	.747	.804	.660	.710	.697	.747	.725	.756
Capital (Equip.)								
a) Reported Actuals	.208	---	.076	---	.100	---	---	.084
b) NPV, Replace, Ind. % RTN	.557	.564	.162	.164	.279	.282	.325	.329
c) NPV, Replace, 15% RTN	.380	.383	.111	.112	.190	.192	.222	.224
Total L.H. ($/Truck-Mile)								
a)	.955	---	.736	---	.797	---	---	.840
b)	1.304	1.368	.822	.874	.976	1.029	1.050	1.085
c)	1.127	1.187	.771	.822	.887	.939	.947	.980
Terminal Area (Incl. PU&D)	($/Ton)							
Labor	9.843	8.859	11.478	10.330	13.743	12.369	13.649	12.408
Maint. (Eq.&Fac.), Tires & Tubes	1.753	1.578	2.208	1.987	3.460	3.114	2.773	2.521
Fuel, Oil & Lub.	.358	.322	.446	.401	.503	.453	.474	0.431
Road User Taxes	.214	.193	.128	.115	.144	.130	.138	.125
Other	2.405	2.164	2.562	2.306	3.912	3.521	3.629	3.299
Total Term. Operations	14.573	13.116	16.822	15.140	21.762	19.586	20.662	18.784
Capital (Equip. & Fac.)								
Reported Actuals	.788	.709	.968	.871	1.508	1.357	1.106	1.005
*Total Term ($/TON)	15.360	13.824	17.790	16.011	23.270	20.943	21.769	19.790

*TOTAL TERM $/TON FROM ICC COST SCALES ADJUSTED TO LTL SERVICE AVERAGE SHIPMENT SIZE & COST, SEE APPENDIX F.
TOTAL TERM $/TON ALLOCATED AMONG COST ACCOUNTS PER % DISTRIBUTION FOR LTL SERVICE
10% REDUCTION IN TOTAL TERM $/TON FOUR DOUBLES VS. CONV. SINGLES FOR REDUCED HANDLINGS ESTIMATED FROM EARLY INPUTS FROM FAY/TDS

WESTERN TRUCK COSTS CAN BE APPLIED TO THE SOUTHWEST-CENTRAL AND NORTHWEST REGIONS TO BE COMPATIBLE WITH THE OTHER TRUCK BODY TYPES.

COMPUTATIONS FOR WESTERN DOUBLES:

(1) Labor costs (drivers and helpers) are increased at a premium of 5%. Source: "Western Doubles Corridor and Rate Study: A Rate Analysis," Gordon Fay Assoc. with TDS Inc.
(2) Maintenance costs are 16% higher for Western Doubles. Source: Same as (1).
(3) Fuel costs and highway user taxes are 3% higher for Western Doubles. Source: "Truck and Rail Fuel Consumption," D.A. Knapton and D.J. Maio, TSC Project Memo #TSC 321-OP-040-4-0.
(4) Other costs or unclassified categories will experience no change from Conventional Semi to Western Double.
(5) Capital costs were estimated from net present value analysis.

TABLE D-3. 1977 AVERAGE COSTS: BY REGION AND BY CARRIER SERVICE - REGULAR ROUTE COMMON CARRIER FULL TRUCK LOAD SERVICE - CONVENTIONAL SEMIS AND WESTERN DOUBLES

	NORTHEASTERN CONV. SEMI	NORTHEASTERN W. DOUBLES	SOUTHERN CONV. SEMI.	SOUTHERN W. DOUBLES	MIDWESTERN CONV. SEMI	MIDWESTERN W. DOUBLES	WESTERN CONV. SEMI.	WESTERN W. DOUBLES
Line-Haul ($/Truck-Mile)								
Labor	.340	.357	.317	.333	.347	.364	.381	.381
Maint. & Tires & Tubes	.227	.263	.186	.216	.181	.210	.171	.198
Fuel, Oil & Lube	.092	.095	.084	.087	.092	.095	.086	.089
Road User Taxes	.017	.018	.028	.029	.028	.029	.027	.028
Other L.H.	.071	.071	.045	.045	.049	.049	.060	.060
Total Operating	.747	.804	.660	.710	.697	.747	.725	.756
Capital (Equip.)								
a) Reported Actuals	.208	---	.076	---	.100	---	---	.084
b) NPV, Replace, Ind.% RTN	.557	.564	.152	.164	.279	.282	.325	.329
c) NPV, Replace, 15% RTN	.380	.383	.111	.112	.190	.192	.222	.224
Total L.H. ($/Truck-Mile)								
a)	.955	---	.736	---	.797	---	1.050	.840
b)	1.304	1.368	.822	.874	.976	1.029	.947	1.085
c)	1.127	1.187	.771	.822	.887	.939		.980
Terminal Area (inc. PU&D)	$/TON							
Labor	6.190		7.097		8.446			8.309
Maint. (Eq.&Fac.) Tires & Tubes	1.102		1.365		2.126			1.688
Fuel, Oil & Lub.	.225		.276		.309			.280
Road User Taxes	.134		.079		.089			.081
Other	1.513		1.584		2.404			2.277
Total Term. Operations	9.164		10.401		13.374			12.635
Capital (Equip & Fac.) Reported Actuals	.496		.598		.927			.694
*Total Term ($/TON)	9.66	9.660	11.000	11.000	14.300	14.300	13.329	13.329

*Total Term ($/TON) from ICC Cost Scales indexed T6 TSC 1977 Costs
Total Term $/TON Allocated Among Cost Accounts per % Distribution for LTL Service
No Reduction in Total Term ($/TON) for Doubles vs. Conv. Singles for Full Truck Load Handling

Western truck costs can be applied to the Southwest-Central and Northwest regions to be compatible with the other truck body types.

Computations for Western Doubles:

(1) Labor costs (drivers and helpers) are increased at a premium of 5%. Source: "Western Doubles Corridor and Rate Study: A Rate Analysis," Gordon Fay Assoc. with TDS Inc.

(2) Maintenance costs are 16% higher for Western Doubles. Source: Same as (1).

(3) Fuel costs and highway user taxes are 3% higher for Western Doubles. Source: "Truck and Rail Fuel Consumption," D.A. Knapton and D.J. Maio, TSC Project Memo #TSC 321-08-040-4-0.

(4) Other cost or unclassified categories will experience no change from conventional semi to Western Double

(5) Capital costs were estimated from net present value analysis.

TABLE D-4. 1977 AVERAGE COSTS BY REGION AND BY CARRIER SERVICE - IRREGULAR ROUTE COMMON/ CONTRACT CARRIAGE AND PRIVATE CARRIAGE FULL TRUCK LOAD SERVICE - CONVENTIONAL SEMIS AND WESTERN DOUBLES

	NORTHEASTERN		SOUTHERN		MIDWESTERN		WESTERN	
	CONV. SEMI	W. DOUBLE	CONV. SEMI	W. DOUBLE	CONV. SEMI	W. DOUBLE	CONV. SEMI	W. DOUBLE
Line-Haul ($/Truck-Mile)								
Labor	.403	.423	.329	.345	.514	.540	.432	.454
Maint. & Tires & Tubes	.280	.325	.163	.189	.339	.393	.323	.375
Fuel, Oil & Lub	.069	.071	.088	.091	.096	.099	.146	.150
Road User Taxes	.017	.018	.027	.028	.035	.036	.048	.049
Other L.H.	.076	.076	.069	.069	.098	.098	.070	.070
Total Operating	.845	.913	.676	.722	1.082	1.166	1.019	1.098
Capital								
a) Reported Actuals	.092	---	.071	---	.056	---	.051	---
b) NPV, Replace, Ind. % RTN	.291	.294	.148	.143	.228	.229	.089	.090
c) NPV, Replace, 15% RTN	.310	.312	.157	.158	.242	.244	.094	.095
Total L.H. ($/Truck-Mile)								
a) w/Region Actuals	.937	---	.747	---	1.138	---	1.070	---
b)	1.136	1.207	.824	.870	1.310	1.395	1.108	1.138
c)	1.155	1.225	.833	.880	1.324	1.410	1.113	1.193
TOTAL TERM ($/TON)	---	---	---	---	---	---	---	---

PRIVATE CARRIAGE

	NORTHEASTERN		SOUTHERN		MIDWESTERN		WESTERN	
	CONV. SEMI	W. DOUBLE	CONV. SEMI	W. DOUBLE	CONV. SEMI	W. DOUBLE	CONV. SEMI	W. DOUBLE
Line-Haul ($/Truck-Mile)								
Labor	.390	.410	.317	.333	.391	.411	.420	.441
Maint. & Tires & Tubes	.228	.265	.187	.217	.182	.211	.198	.230
Fuel, Oil & Lube	.122	.126	.112	.115	.080	.083	.136	.140
Road User Taxes								
Other L.H.	---		---		---		---	
Total Operating	.730	.801	.616	.665	.653	.705	.754	.811
Capital								
a) Reported Actuals	---	---	---	---	---	---	---	---
b) NPV, Replace, Ind. % RTN	.129	.130	.153	.154	.115	.115	.198	.199
c) NPV, Replace, 15% RTN	.150	.151	.178	.179	.133	.134	.230	.231
TOTAL L.H. ($/Truck-Mile)								
a)								
b)	.859	.931	.769	.819	.768	.820	.952	1.010
c)	.880	.952	.794	.844	.786	.839	.994	1.042
TOTAL TERM ($/TON)	2.42	2.42	2.32	2.32	2.83	2.83	2.21	2.21

NOTE: Western truck costs can be applied to the Southwest-Central and Northwest regions to be compatible with the other truck body types.

Computations for Western Doubles:

(1) Labor costs (drivers and helpers) are increased at a premium of 5%. Source: "Western Doubles Corridor and Rate Study: A Rate Analysis," Gordon Fay Assoc. with TDS Inc.

(2) Maintenance costs are 16% higher for Western Doubles. Source: Same as (1).

(3) Fuel costs and highway user taxes are 3% higher for Western Doubles. Source: "Truck and Rail Fuel Consumption," D.A. Knapton and D.J. Maio, TSC Project Memo #TSC 321-OP-040-4-0.

(4) Other costs or unclassified caterogies will experience no change from Conventional Semi to Western Doubles.

(5) Capital costs were estimated from net present value analysis.

TABLE D-5. 1977 AVERAGE COSTS: BY REGION AND BY CARRIER SERVICE REGULAR ROUTE COMMON CARRIER LTL, PTL & FTL SERVICE - CONVENTIONAL SEMIS & TURNPIKE DOUBLES

	NORTHEAST		MIDWEST-CENTRAL		SOUTH		SOUTHWEST-CENTRAL		NORTHWEST	
	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE
Line-Haul ($/Truck Mile)										
Labor	$ .340	$ .381	$ .347	$ .389	$ .317	$ .355	$ .381	$ .427	$ .381	$ .427
Maint & Tires & Tubes	.227	.291	.181	.232	.186	.238	.171	.219	.171	.219
Fuel, Oil & Lube	.092	.109	.092	.110	.084	.100	.086	.102	.086	.102
Road User Taxes	.017	.020	.028	.033	.028	.033	.027	.032	.027	.032
Other L.H.	.071	.071	.049	.049	.045	.045	.060	.060	.060	.060
Total Operating	.747	.872	.697	.813	.660	.771	.725	.840	.725	.840
Capital										
a.) Reported Actuals	.208	---	.100	------	.076	------	------	------	------	------
b.) NPV Replace, Ind % RTN	.557	.798	.279	.367	.162	.178	.325	.416	.325	.416
c.) NPV Replace, 15% RTN	.380	.489	.190	.244	.111	.143	.222	.285	.222	.285
Total Line Haul($/Truck Mile)										
a.)	.955	------	.797	------	.736	------	------	------	------	
b.)	1.304	1.670	.976	1.180	.822	.949	1.081	1.256	1.081	1.256
c.)	1.127	1.361	.887	1.057	.771	.914	.978	1.125	.978	1.125

Computations for turnpike doubles

(1) Labor costs (drivers & helpers) are increased at a premium of 12% — Source: "Western Doubles Corridor and Rate Study: A Rate Analysis," Gordon Fay Assoc. with TDS Inc.

(2) Maintenance costs are 28% higher for turnpike doubles — Source: Same as (1).

(3) Fuel cost and highway user taxes are 19% higher for turnpike doubles — Source: "Truck and Rail Fuel Consumption," D.A. Knapton & D.J. Maio TSC Proj. Memo #TSC 321-OP-040-4-0.

(4) Other costs or unclassified categories will experience no change from conventional semis to turnpike doubles

(5) TSC has estimated an additional cost of $50/trip to turnpike doubles for access to /egress from the Interstate system. This cost penalty should be added to total terminal costs.

(6) Capital costs were estimated from net present value analysis.

TABLE D-6. 1977 AVERAGE COSTS: BY REGION AND BY CARRIER SERVICE REGULAR ROUTE COMMON CARRIER LTL SERVICE - WESTERN DOUBLES & TRIPLE 27'S

	NORTHEAST		MIDWEST-CENTRAL		SOUTH		SOUTHWEST-CENTRAL		NORTH-WEST	
	W. DOUBLE	TRIPLE 27's	W. DOUBLE	TRIPLE 27's	W. DOUBLE	TRIPLE 27's	W. DOUBLE	TRIPLE 27's	W. DOUBLE	TRIPLE 27's
Line-Haul ($/Truck Mile)										
Labor	$ .357	$ .386	$ .364	$ .393	$ .333	$ .360	$ .381	$ .412	$.381	$ .412
Maint & Tires & Tubes	.263	.418	.210	.334	.216	.343	.198	.315	.198	.315
Fuel, Oil & Lube	.095	.118	.095	.118	.087	.108	.089	.110	.089	.110
Road User Taxes	.018	.022	.029	.036	.029	.036	.028	.035	.028	.035
Other L.H.	.071	.071	.049	.049	.045	.045	.060	.060	.060	.060
Total Operating	.804	1.015	.747	.930	.710	.892	.756	.932	.756	.932
Capital										
a) Reported Actuals	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
b) NPV Replace, Ind % RTN	.564	.831	.282	.383	.164	.186	.329	.433	.329	.433
c) NPV Replace, 15% RTN	.383	.509	.192	.254	.112	.148	.224	.297	.224	.297
Total Line-Haul ($/Truck Mile)										
a)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
b)	1.368	1.846	1.029	1.313	.874	1.078	1.085	1.365	1.085	1.365
c)	1.187	1.516	.939	1.184	.822	1.040	.980	1.229	.980	1.229

Computations for Triple 27's

(1) Drivers are paid 8% more for driving triples than western doubles

(2) Maintenance costs are 59% higher for triple 27's

(3) Fuel costs and road user taxes for triple 27's are 24% more costly on a vehicle mile basis than western doubles

(4) Other or unclassified category experience no change in costs from western doubles to triple 27's

(5) TSC has estimated an additional cost of $50/trip to triple 27's for access to /egress from the Interstate system. This cost penalty should be added to total terminal costs.

(6) Capital costs were estimated from net present value analysis.

Source: "Western Doubles Corridor and Rate Study: A Rate Analysis," Gordon Fay Associates with Traffic Distribution Services

TABLE D-7. 1977 AVERAGE COSTS: BY REGION AND CARRIER SERVICE AUTO TRANSPORT CARRIERS - CONVENTIONAL SEMIS & TURNPIKE DOUBLES

	NORTHEAST		MIDWEST-CENTRAL		SOUTH		SOUTHWEST-CENTRAL		NORTHWEST	
	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE
Line-Haul ($/Truck Mile)										
Labor	$ .604	$ .676	$ .587	$ .657	$ .886	$ .992	$ .917	$1.027	$ .917	$1.027
Maint. & Tires & Tubes	.434	.555	.521	.667	.578	.740	.630	.806	.630	.806
Fuel, Oil & Lube	.111	.132	.092	.109	.156	.186	.169	.201	.169	.201
Road User Taxes	.031	.037	.028	.033	.056	.067	.038	.045	.038	.045
Other L.H.	.095	.095	.073	.073	.122	.122	.101	.101	.101	.101
Total Operating	1.275	1.458	1.301	1.539	1.798	2.107	1.855	2.180	1.855	2.180
Capital										
a.) Reported Actuals	.071	-----	.074	-----	.043	-----	.092	-----	.092	-----
b.) NPV Replace, Ind % RTN	.281	.410	.320	.469	.227	.330	.432	.633	.432	.633
c.) NPV Replace, 15% RTN	.320	.469	.160	.422	.271	.396	.339	.496	.339	.496
Total Line Haul ($/Truck Mile)										
a)	1.346	------	1.375	-----	1.841	-----	1.947	-----	1.947	-----
b)	1.556	1.868	1.621	2.008	2.025	2.437	2.287	2.813	2.287	2.813
c)	1.595	1.927	1.461	1.961	2.069	2.503	2.194	2.676	2.194	2.676

Computations for turnpike doubles:

(1) Labor costs (driver & helper) are increased at a premium of 12% — Source: "Western Doubles Corridor and Rate Study: A Rate Analysis," Gordon Fay Assoc. w/TDS, Inc.

(2) Maintenance costs are 28% higher for turnpike doubles — Source: Same as (1)

(3) Fuel cost and highway user taxes are 19% higher for turnpike doubles — Source: "Truck and Rail Fuel Consumption," D.A. Knapton & D.J. Maio TSC Proj. Memo #%SC 321-OP-040-4-0

(4) Other costs or unclassified categories will experience no change from conventional semis to turnpike doubles.

(5) Capital costs were estimated from net present value analysis.

(6) TSC has estimated an additional cost of $50/trip to turnpike doubles for access to /egress from the Interstate system. This cost penalty should be added to total terminal costs.

TABLE D-8. 1977 AVERAGE COSTS: BY REGION AND CARRIER SERVICE DUMP CARRIERS - STRAIGHT TRUCKS, CONVENTIONAL SEMITRAILERS & TURNPIKE DOUBLES

	NORTHEAST			MIDWEST-CENTRAL			SOUTH			SOUTHWEST-CENTRAL			NORTHWEST		
	STRT. TRUCK	CONV. SEMI	TURNPIKE DOUBLE	STRT. TRUCK	CONV. SEMI	TURNPIKE DOUBLE	STRT. TRUCK	CONV. SEMI	TURNPIKE DOUBLE	STRT. TRUCK	CONV. SEMI	TURNPIKE DOUBLE	STRT. TRUCK	CONV. SEMI	TURNPIKE DOUBLE
Line-Haul ($/Truck Mile)															
Labor	(*)	$ .276	$ .309	(*)	$ .276	$ .309	$ .437	(*)	(*)	$ .437	(*)	(*)	$ .437	(*)	(*)
Maint & Tires & Tubes		.117	.150		.117	.150	.216			.216			.216		
Fuel, Oil & Lube		.199	.237		.199	.237	.228			.228			.228		
Road User Taxes		.022	.026		.022	.026	.054			.054			.054		
Other L.H.		.167	.167		.167	.167	.163			.163			.163		
Total Operating		.781	.889		.781	.889	1.098			1.098			1.098		
Capital															
a) Reported Actuals		-----	-----		-----	-----	-----			-----			-----		
b) NPV, Replace, Ind % RTN		.235	.276		.235	.276	.462			.462			.462		
c) NPV, Replace, 15% RTN		.213	.258		.213	.258	.539			.539			.539		
Total Line-Haul ($/Truck Mile)															
a)		-----			-----	-----	-----								
b)		1.016	1.165		1.016	1.165	1.560			-----			-----		
c)		.994	1.147		.994	1.147	1.637			1.560			1.560		
										1.637			1.637		

Computations for turnpike doubles

(1) Labor costs (driver & Helpers) are increased at a premium of 12% — Source: "Western Doubles Corridor and Rate Study: A Rate Analysis, Gordon Fay Assoc. with TDS Inc.

(2) Maintenance costs are 28% higher for turnpike doubles — Source: Same as (1)

(3) Fuel cost and highway user taxes are 19% higher for turnpike doubles — Source: "Truck and Rail Fuel Consumption, D.A. Knapton & D.J. Main TSC Proj. Memo # TSC 321-OP-040-4-0

(4) Other costs or unclassified categories will experience no change from conventional semis to turnpike doubles

(5) Capital costs were estimated from net present value analysis.

(*)Note: Dump Truck Costs represent truck movements of heavy bulk materials such as coal, minerals, sand and gravel. Specific equipment types should be matched according to region of operation. Straight trucks (10-wheeler dumps) are predominately found in the South, Southwest and Northwest regions. While, conventional semis will be predominately in the Northeast and Midwest-Central

(6) TSC has estimated an additional cost of $50/trip to turnpike doubles for access to /egress from the Interstate system. This cost penalty should be added to total terminal costs.

TABLE D-9. 1977 AVERAGE COSTS: BY REGION AND CARRIER SERVICE PLATFORM/FLATBED CARRIERS CONVENTIONAL SEMITRAILERS AND TURNPIKE DOUBLES

	NORTHEAST		MIDWEST-CENTRAL		SOUTH		SOUTHWEST-CENTRAL		NORTHWEST	
	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE
Line-Haul ($/Truck Mile)										
Labor	$ .397	$ .445	$ .371	$ .416	$ .229	$ .256	$ .227	$ .254	$ .227	$ .254
Maint. & Tires & Tubes	.237	.303	.218	.279	.223	.285	.470	.602	.470	.602
Fuel, Oil & Lube	.084	.100	.062	.074	.100	.119	.084	.100	.084	.100
Road User Taxes	.043	.051	.023	.027	.047	.056	.027	.032	.027	.032
Other L.H.	.088	.088	.142	.142	.061	.061	.038	.038	.038	.038
Total Operating	.849	.987	.816	.938	.660	.777	.846	1.026	.846	1.026
Capital										
a) Reported Actuals	.049	-----	.076	-----	.087	-----	.036	-----	.036	-----
b) NPV Replace, Ind % RTN	.213	.270	.145	.184	.206	.262	.219	.280	.219	.219
c) NPV Replace, 15% RTN	.142	.186	.087	.114	.126	.239	.132	.168	.132	.168
Total Line-Haul ($/Truck Mile)										
a)	.898	-----	.892	-----	.747	-----	.882	-----	.882	-----
b)	1.062	1.257	.961	1.122	.866	1.039	1.065	1.306	1.065	1.306
c)	.991	1.173	.903	1.052	.786	1.016	.978	1.194	.978	1.194

Computations for turnpike doubles

(1) Labor costs (drivers & helpers) are increased at a premium of 12% — Source: "Western Doubles Corridor and Rate Study: A Rate Analysis," Gordon Fay Assoc. with TDS INC.

(2) Maintenance costs are 28% higher for turnpike doubles — Source: Same as (1)

(3) Fuel cost and highway user taxes are 19% higher for turnpike doubles — Source: "Truck and Rail Fuel Consumption," D.A. Knapton & Div. Maio TSC Proj. Memo # TSC 321-OP-040-4-0

(4) Other costs or unclassified categories will experience no change from conventional semis to turnpike doubles

(5) Capital costs were estimated from net present value analysis.

Note: Due to time and labor constraints, no carriers were generated for the Northwest region. Truck costs for the Southwest-Central region were interpolated to the Northwest region.

Platform/Flatbed truck costs will also represent the cost of transporting grain by motor carriers.

(6) TSC has estimated an additional cost of $50/trip to turnpike doubles for access to /egress from the Interstate system. This cost penalty should be added to total terminal costs.

TABLE D-10. 1977 AVERAGE COSTS: BY REGION AND CARRIER SERVICE REFRIGERATED VAN CARRIERS - CONVENTIONAL SEMITRAILERS AND TURNPIKE DOUBLES

	NORTHEAST		MIDWEST-CENTRAL		SOUTH		SOUTHWEST-CENTRAL		NORTHWEST	
	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV.SEMI	TURNPIKE DOUBLE
Line-Haul ($/Truck Mile)										
Labor	$ .388	$ .435	$ .450	$ .504	$ .223	$ .250	$ .618	$ .692	$ .198	$ .222
Maint. & Tires & Tubes	.215	.316	.238	.305	.195	.250	.093	.119	.171	.219
Fuel, Oil & Lube	.129	.142	.138	.164	.110	.131	.131	.156	.073	.087
Road User Taxes	.046	.054	.053	.063	.041	.049	.011	.013	.043	.051
Other L.H.	.073	.073	.085	.085	.064	.064	.049	.049	.045	.045
Total Operating	.852	1.020	.964	1.121	.633	.744	.902	1.029	.530	.624
Capital										
a) Reported Actuals	.031	-----	.051	-----	.107	-----	.163	-----	.100	-----
b) NPV Replace, Ind % RTN	.227	.316	.132	.184	.185	.257	.155	.215	.223	.311
c) NPV Replace, 15% RTN	.200	.279	.107	.158	.163	.232	.157	.228	.188	.262
Total Line-Haul($/Truck Mile)										
a)	.883	-----	1.015	-----	.740	-----	1.065	-----	.630	-----
b)	1.079	1.336	1.096	1.305	.818	1.001	1.057	1.244	.753	.935
c)	1.052	1.299	1.071	1.279	.796	.176	1.059	1.257	.718	.886

Computations for turnpike doubles

(1) Labor costs (drivers & helpers) are increased at a premium of 12%. Source: "Western Doubles Corridor and Rate Study: A Rate Analysis," Gordan Fay Assoc. with TDS Inc.

(2) Maintenance costs are 28% higher for turnpike doubles Source: Same as (1)

(3) Fuel cost and highway user taxes are 19% higher for turnpike doubles Source: "Truck and Rail Fuel Consumption," D.A. Knapton & D.J. Maio TSC Proj. Memo # TSC 321-OP-040-4-0.

(4) Other costs or unclassified categories will experience no change from conventioanl semis to turnpike doubles

(5) Capital costs were estimated from net present value analysis,

(6) TSC has estimated an additional cost of $50/trip to turnpike doubles for access to /egress from the Interstate system. This cost penalty should be added to total terminal costs.

TABLE D-11. 1977 AVERAGE COSTS: BY REGION AND CARRIER SERVICE TANK CARRIERS - CONVENTIONAL SEMITRAILERS AND TURNPIKE DOUBLES

	NORTHEAST		MIDWEST-CENTRAL		SOUTH		SOUTHWEST-CENTRAL		NORTHWEST	
	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE	CONV. SEMI	TURNPIKE DOUBLE
Line-Haul ($/Truck Mile)										
Labor	$ .521	$ .584	$ .551	$ .705	$ .521	$ .584	$ .459	$ .514	$ .490	$ .549
Maint. & Tires & Tubes	.264	.338	.279	.357	.412	.527	.255	.326	.328	.420
Fuel, Oil & Lube	.113	.134	.119	.142	.103	.123	.096	.114	.098	.117
Road User Taxes	.035	.042	.037	.044	.061	.073	.044	.052	.044	.052
Other L.H.	.100	.100	.106	.106	.065	.065	.111	.111	.117	.117
Total Operating	1.033	1.198	1.092	1.354	1.162	1.372	.965	1.117	1.077	1.255
Capital										
a) Reported Actuals	.053	-----	.105	-----	.082	-----	-----	.142	.059	-----
b) NPV Replace, Ind % RTN	.341	.511	.270	.396	.463	.680	.421	.619	.384	.562
c) NPV Replace, 15% RTN	.257	.383	.252	.368	.293	.429	.263	.385	.351	.513
Total Line-Haul ($/Truck Mile)										
a)	1.086	-----	1.197	-----	1.244	-----	-----	1.259	1.136	-----
b)	1.374	1.709	1.362	1.750	1.625	2.052	1.386	1.736	1.461	1.817
c)	1.290	1.581	1.244	1.722	1.455	1.801	1.228	1.502	1.428	1.768

Computations for turnpike doubles

(1) Labor costs (drivers & helpers) are increased at a premium of 12% — Source: "Western Doubles Corridor and Rate Study: A Rate Analysis," Gordon Fay Assoc. with TDS Inc.

(2) Maintenance costs are 28% higher for turnpike doubles — Source: Same as (1).

(3) Fuel cost and highway user taxes are 19% higher for turnpike doubles — Source: "Truck and Rail Fuel Consumption," D.A. Knapton D.J. Maio, TSC Proj. Memo #TSC 321-OP-040-4-0

(4) Other costs or unclassified categories will experience no change from conventional semis to turnpike doubles

(5) Capital costs were estimated from net present value analysis.

(6) TSC has estimated an additional cost of $50/trip to turnpike doubles for access to /egress from the Interstate system. This cost penalty should be added to total terminal costs.

NOTE: Cost estimates for the Southwest-central region revealed that the current dominant truck configuration is the truck trailer double with tandem axles (see Table E-3.2.1, p. E-17). Conventional semi trailer cost estimates were constructed downward from the doubles cost.

TABLE D-12. 1977 AVERAGE COSTS: BY REGION AND BY CARRIER SERVICE
RAIL GENERAL SERVICE BOX CARLOAD

	EASTERN	SOUTHERN	WESTERN
Line-Haul ($/Box Car-Mile)			
Labor	.090	.096	.089
Maint. Rolling Stock	.174	.134	.140
Fuel, Oil & Lube	.104	.120	.117
Maint. of Way	.245	.158	.178
Other	.102	.062	.077
Total Operating	.715	.570	.601
Capital (Equip. & Fac.)			
a) Reported Actuals	.124	.124	.056
b) NPV, Replace, Ind. % RTN	.323	.305	.257
c) NPV, Replace, 15% RTN	.470	.482	.484
Total L.H. ($/Car-Mile)			
a)	.839	.694	.657
b)	1.038	.875	.858
c)	1.185	1.052	1.085
Terminal Area (incl. PU&D)	($/TON)		
Labor	1.464	1.149	1.639
Maint. (Equip & Fac.)	.155	.107	.114
Fuel, Oil & Lube	.103	.080	.152
Other	.001	.000	.000
Total Term Operating	1.723	1.336	1.905
Capital (Equip. & Fac.) Reported Actuals	.050	.018	.036
TOTAL TERM ($/TON)	1.773	1.354	1.941
AVER. LOAD PER CAR	57.0	65.0	62.0
Total Term ($/Car)	98.243	86.876	118.134

TABLE D-13. 1977 AVERAGE COSTS: BY REGION AND BY CARRIER SERVICE RAIL DEDICATED TOFC SERVICE

		EASTERN		SOUTHERN		WESTERN	
		1-40	1-27	1-40	1-27	1-40	1-27
Line-Haul ($/Trailer-Mile)							
Labor		.050	.033	.062	.041	.048	.032
Maint. Rolling Stock		.079	.053	.072	.098	.073	.049
Fuel, Oil, and Lube		.045	.030	.046	.031	.044	.029
Maint. of Way		.092	.061	.087	.058	.080	.053
Other		.059	.039	.037	.025	.050	.034
Total Operating		.326	.216	.304	.203	.295	.197
Capital (Eq. & Fac.)							
a) Reported		.124	---	.124	---	.056	---
b) NPV, Replace, Ind. % RTN		.223	.219	.195	.180	.181	.179
c) NPV, Replace, 15% RTN		.300	.294	.285	.279	.312	.305
Total L.H. ($/Trailer-Mile)							
a)		.450	---	.428	---	.351	---
b)		.549	.435	.499	.383	.476	.374
c)		.626	.510	.589	.482	.607	.502
Term. Handling (Excl.PU&D)	($/Trailer)	122.615	122.615	65.801	65.751	124.053	124.052
Reported Capital (Eq.& Fac.)	($/Trailer	.677	.677	.846	.846	1.182	1.182
Term. Hand & Capital	($/Trailer)	123.292	123.292	66.647	66.597	125.235	125.234
*Term. Hand. (Excl PU&D)	($/TON)	8.192	12.329	4.256	6.600	8.795	12.523
**PU&D (T.L.)	($/Trailer)	87.534	43.767	71.459	35.730	86.418	43.209
Aver. Load for PU&D	(TONS)	15.50	10.00	15.50	10.00	15.50	10.00
PU&D (T.L.)	($/TONS)	5.816	4.376	4.610	3.573	5.575	4.321
***LTL Handling (Incl. PU&D)	($/TON)	143.455	129.100	112.624	101.362	137.641	125.128
LTL Handling (Incl. PU&D)	($/Trailer)	2,223.397	1,291.000	1,745.672	1,013.620	2,133.436	1,251.280
****PTL Handling (Incl. PU&D)	($/TON)	23.270	20.943	17.790	16.011	21.769	19.790
PTL Handling (Incl. PU&D)	($/Trailer)	360.685	209.430	275.745	160.110	337.420	197.900
TOFC Highway Interchange	($/Trailer	122.706	61.353	47.625	23.812	57.484	23.742

*40' single TOFC trailer calculated using reported average load for TOFC operations, and single 27' calculated using 10.0 tons per trailer

**Assume 2-27's per PU&D trip

***LTL Terminal Handling and PU&D estimates are equal to Common Carrier LTL service. See Table D-1. Amounts shown represent the cost of a freight fowarder.

****PTL Terminal Handling and PU&D estimates are equal to Common Carrier PTL service. See Table D-2. Amounts shown represent the cost of a freight fowarder.

TABLE D-14. 1977 RAIL AVERAGE COSTS: BY REGION, CAR TYPE AND BY SHIPMENT SIZE RAIL GENERAL SERVICE BOX CARLOAD

	EAST			SOUTH			WEST		
	AVE. CAR	SINGLE CAR	MULTI-CAR	AVE. CAR	SINGLE CAR	MULTI-CAR	AVE. CAR	SINGLE CAR	MULTI-CAR
Line-Haul ($/Box Car Mile)									
Labor	$.090	$	$	$.096	$	$	$.089	$	$
Maint. Rolling Stock	.174			.134			.140		
Fuel, Oil & Lube	.104			.120			.117		
Maint. of Way	.245			.158			.178		
Other	.102			.062			.077		
Total Operating	.715	.715	.715	.570	.570	.570	.601	.601	.601
Capital									
a) Reported Actuals	.124	----	----	.124	----	----	.056	----	----
b) NPV, Replace Ind % RTN	.323	.323	.323	.305	.305	.305	.257	.257	.257
c) NPV, Replace 15% RTN	.470	.470	.470	.482	.482	.482	.484	.484	.484
Total L.H. ($/Car Mile)									
a)	.839	----	----	.694	----	----	.657	----	----
b)	1.038	1.038	1.038	.875	.875	.875	.858	.858	.858
c)	1.185	1.185	1.185	1.052	1.052	1.052	1.085	1.085	1.085
Terminal Area (Incl. PU&D)									
Labor	$1.464	$	$	$1.149	$	$	$1.639	$	$
Maint. (Equip. & Fac.)	.155			.107			.114		
Fuel, Oil & Lube	.103			.080			.152		
Other	.001			.000			.000		
Total Term Operating	1.723			1.336			1.905		
Capital (Equip. & Fac.) Reported Actuals	.050			.018			.036		
Total Terminal ($/Ton)	1.773	1.950	1.596	1.354	1.489	1.219	1.941	2.135	1.747

TABLE D-14.1 BASIC RAIL COST FACTORS USED TO DIFFERENTIATE VARIOUS SHIPMENT SIZES

Shipment Size	Line Haul*	Terminal Area**
Single Car Shipment	1.0	1.1
Average Car Shipment	1.0	1.0
Multiple Car Shipment	1.0	0.9
Unit Train Shipment	2.0	0.4

* Apply to average $/car-mile costs in Table D-]2.

** Apply to average $/ton costs in Table D-]2.

SOURCE: Derived by TSC from TSC Staff Study SS-223-U1-32, "Freight Market Sensitivity to Service Quality and Price," Fuertes, Maio, Nienhaus, December 1977, p. A-14.

TABLE D-15. 1977 RAIL AVERAGE COSTS: BY REGION, CAR TYPE AND BY SHIPMENT SIZE AUTO TRANSPORTER SERVICE

	EAST			SOUTH			WEST		
	AVE. CAR	SINGLE CAR	MULTI-CAR	AVE. CAR	SINGLE CAR	MULTI-CAR	AVE. CAR	SINGLE CAR	MULTI-CAR
Line-Haul ($/Box Car Mile)									
Labor	$.090	$	$	$.096	$	$	$.089	$	$
Maint. Rolling Stock	.284			.218			.228		
Fuel, Oil & Lube	.104			.120			.117		
Maint. of Way	.245			.158			.178		
Other	.102			.062			.077		
Total Operating	.825	.825	.825	.654	.654	.654	.689	.689	.689
Capital									
a) Reported Actuals	.124	----	----	.124	----	----	.056	----	----
b) NPV, Replace Ind % RTN	.519	.519	.519	.490	.490	.490	.413	.413	.413
c) NPV, Replace 15% RTN	.761	.761	.761	.761	.761	.761	.761	.761	.761
Total L.H.*($/Car Mile)									
a)	.949	----	----	.778	----	----	.745	----	----
b)	.344	1.344	1.344	1.144	1.144	1.144	1.102	1.102	1.102
c)	1.586	1.586	1.586	1.415	1.415	1.415	1.450	1.450	1.450
Terminal Area (Incl. PU&D)									
Labor	$1.464	$	$	$1.149	$	$	$1.639	$	$
Maint. (Equip. & Fac.)	.253			.174			.186		
Fuel, Oil & Lube	.103			.080			.152		
Other	.001			.000			.000		
Total Term Operating	1.821			1.403			1.977		
Capital (Equip. & Fac.) Reported Actuals	.050			.018			.036		
Total Terminal ($/Ton)	1.871	2.058	1.684	1.421	1.563	1.279	2.013	2.214	1.812

NOTE: Differentiation of cost/rates for auto transport car service from general service box carload is limited to the effects of ownership and maintenance costs for the specialized equipment used. Capital costs are estimated from net present value analysis, using 1977 manufacturer's price for transports. A cost factor of 1.63, derived from the ratio of purchase prices of both car types, was applied to the maintenance of rolling stock for box carload service.

TABLE D-16. 1977 RAIL AVERAGE COSTS: BY REGION, CAR TYPE AND BY SHIPMENT SIZE GONDOLA/HOPPER BULK CAR SERVICE

	EAST			SOUTH			WEST		
	AVE. CAR	MULTI-CAR	UNIT TRAIN*	AVE. CAR	MULTI-CAR	UNIT TRAIN*	AVE. CAR	MULTI-CAR	UNIT TRAIN*
Line-Haul ($/Box Car Mile)									
Labor	$.090	$	$	$.090	$	$	$.090	$	$
Maint. Rolling Stock	.132			.102			.106		
Fuel, Oil & Lube	.132			.102			.133		
Maint. of Way	.245			.158			.178		
Other	.100			.062			.077		
Total Operating	.701	.701	.785	.514	.514	.576	.584	.584	.666
Capital									
a) Reported Actuals	.124	----	----	.124	----	----	.056	----	----
b) NPV, Replace Ind % RTN	.078	.078	.078	.078	.078	.078	.062	.062	.062
c) NPV, Replace 15% RTN	.175	.175	.175	.175	.175	.175	.174	.174	.174
Total L.H. ($/Car Mile)									
a)	.825	----	----	.638	----	----	.640	----	----
b)	.779	.779	.863	.592	.592	.654	.646	.646	.728
c)	.876	.876	.960	.689	.689	.751	.758	.758	.840
Terminal Area (Incl. PU&D)									
Labor	$1.464	$	$	$1.149	$	$	$1.639	$	$
Maint. (Equip. & Fac.)	.155			.107			.114		
Fuel, Oil & Lube	.103			.080			.152		
Other	.001			.000			.000		
Total Term Operating	1.723			1.336			1.905		
Capital (Equip. & Fac.) Reported Actuals	.050			.018			.036		
Total Terminal ($/Ton)	1.773	1.596	.709	1.354	1.219	.542	1.941	1.747	.776

*Line haul cost estimates for unit train services were corrected by empty backhaul factors to differentiate from average and multiple car services. Empty backhaul factors were constructed by examining rail carriers loaded to total car mile statistics, and applying it to unit trains empty backhaul.

NOTE: Differentiation of cost/rates for gondola/hopper car service from general service box carload is limited to the effects of ownership and maintenance costs for the specialized equipment used. Capital costs are estimated from net present value analysis, using 1977 manufacturer's price for gondola/hoppers. A cost factor of 0.76, derived from the ratio of purchase prices of both car types, was applied to the maintenance of rolling stock for box carload service.

TABLE D-17. 1977 RAIL AVERAGE COSTS: BY REGION, CAR TYPE AND BY SHIPMENT SIZE RACK/FLAT CAR SERVICE

	EAST			SOUTH			WEST		
	AVE. CAR	SINGLE CAR	MULTI-CAR	AVE. CAR	SINGLE CAR	MULTI-CAR	AVE. CAR	SINGLE CAR	MULTI-CAR
Line-Haul ($/Box Car Mile)									
Labor	$.090	$	$	$.096	$	$	$.089	$	$
Maint. Rolling Stock	.230			.152			.185		
Fuel, Oil & Lube	.104			.120			.117		
Maint. of Way	.124			.158			.178		
Other	.102			.062			.077		
Total Operating	.771	.771	.771	.588	.588	.588	.646	.646	.646
Capital									
a) Reported Actuals	.124	----	----	.124	----	----	.056	----	----
b) NPV, Replace Ind % RTN	.423	.423	.423	.399	.399	.399	.337	.337	.337
c) NPV, Replace 15% RTN	.555	.555	.555	.555	.555	.555	.555	.555	.555
Total L.H. ($/Car Mile)									
a)	.895	----	----	.712	----	----	.702	----	----
b)	1.194	1.194	1.194	.987	.987	.987	.983	.983	.983
c)	1.326	1.326	1.326	1.143	1.143	1.143	1.201	1.201	1.201
Terminal Area (Incl. PU&D)									
Labor	$1.464	$	$	$1.149	$	$	$1.639	$	$
Maint. (Equip. & Fac.)	.205			.141			.151		
Fuel, Oil & Lube	.103			.080			.152		
Other	.001			.000			.000		
Total Term Operating	1.773			1.370			1.942		
Capital (Equip. & Fac.) Reported Actuals	.050			.018			.036		
Total Terminal ($/Ton)	1.823	2.005	1.641	1.388	1.527	1.249	1.978	2.176	1.780

NOTE: Differentiation of cost/rates for rack/flat car service from general service box carload is limited to the effects of ownership and maintenance costs for the specialized equipment used. Capital costs are estimated from net present value analysis, using 1977 manufacturer's price for rack/flats. A cost factor of 1.32, derived from the ratio of purchase prices of both car types, was applied to the maintenance of rolling stock for box carload service.

TABLE D-18. 1977 RAIL AVERAGE COSTS: BY REGION, CAR TYPE AND BY SHIPMENT SIZE REFRIGERATED CAR SERVICE

	EAST			SOUTH			WEST		
	AVE. CAR	SINGLE CAR	MULTI-CAR	AVE. CAR	SINGLE CAR	MULTI-CAR	AVE. CAR	SINGLE CAR	MULTI-CAR
Line-Haul ($/Box Car Mile)									
Labor	$.090	$	$	$.096	$	$	$.089	$	$
Maint. Rolling Stock	.204			.157			.164		
Fuel, Oil & Lube*	.112			.125			.125		
Maint. of Way	.245			.158			.178		
Other	.102			.062			.077		
Total Operating	.753	.753	.753	.598	.598	.598	.633	.633	.633
Capital									
a) Reported Actuals	.124	----	----	.124	----	----	.056	----	----
b) NPV, Replace Ind % RTN	.375	.375	.375	.354	.354	.354	.299	.299	.299
c) NPV, Replace 15% RTN	.554	.554	.554	.552	.552	.552	.544	.544	.544
Total L.H. ($/Car Mile)									
a)	.877	----	----	.722	----	----	.689	----	----
b)	1.128	1.128	1.128	.952	.952	.952	.932	.932	.932
c)	1.307	1.307	1.307	1.150	1.150	1.150	1.177	1.177	1.172
Terminal Area (Incl. PU&D)									
Labor	$1.464	$	$	$1.149	$	$	$1.639	$	$
Maint (Equip. & Fac.)	.181			.125			.133		
Fuel, Oil & Lube*	.413			.352			.437		
Other	.001			.000			.000		
Total Term Operating	2.059			1.626			2.209		
Capital (Equip. & Fac.) Reported Actuals	.050			.018			.036		
Total Terminal ($/Ton)	2.109	2.320	1.898	1.644	1.808	1.480	2.245	2.470	2.021

*Fuel cost represents the amount of fuel used by locomotives in linehaul and terminal operations plus the additional amount of fuel required to keep the refrigeration unit operating. Cooling units consume about .7 gal/hr when in operation.

NOTE: Differentiation of cost/rates for refrigerated car service from general service box carload is limited to the effects of ownership and maintenance costs for the specialized equipment used. Capital costs are estimated from net present value analysis, using 1977 manufacturer's price for refrigerated cars. A cost factor of 1.17, derived from the ratio of purchase prices of both car types, was applied to the maintenance of rolling stock for box carload service.

TABLE D-19. 1977 RAIL AVERAGE COSTS: BY REGION, CAR TYPE AND BY SHIPMENT SIZE TANKER CAR SERVICE

	EAST			SOUTH			WEST		
	AVE. CAR	SINGLE CAR	MULTI-CAR	AVE. CAR	SINGLE CAR	MULTI-CAR	AVE. CAR	SINGLE CAR	MULTI-CAR
Line-Haul ($/Box Car Mile)									
Labor	$.090	$	$	$.096	$	$	$.089	$	$
Maint. Rolling Stock	.117			.090			.094		
Fuel, Oil & Lube	.104			.120			.117		
Maint. of Way	.245			.158			.178		
Other	.102			.062			.077		
Total Operating	.658	.658	.658	.526	.526	.526	.555	.555	.555
Capital									
a) Reported Actuals	.124	----	----	.124	----	----	.056	----	----
b) NPV, Replace Ind % RTN	.221	.221	.221	.209	.209	.209	.176	.176	.176
c) NPV, Replace 15% RTN	.364	.364	.364	.365	.365	.365	.365	.365	.365
Total L.H. ($/Car Mile)									
a)	.782	----	----	.650	----	----	.611	----	----
b)	.879	.879	.679	.735	.735	.735	.731	.731	.731
c)	1.022	1.022	1.022	.891	.891	.891	.920	.920	.920
Terminal Area (Incl. PU&D)									
Labor	$1.464	$	$	$1.149	$	$	$1.639	$	$
Maint. (Equip. & Fac.)	.104			.072			.076		
Fuel, Oil & Lube	.103			.080			.152		
Other	.001			.000			.000		
Total Term Operating	1.672			1.301			1.867		
Capital (Equip. & Fac.) Reported Actuals	.050			.018			.036		
Total Terminal ($/Ton)	1.722	1.894	1.550	1.319	1.451	1.187	1.903	2.093	1.713

NOTE: Differentiation of cost/rates for tank car service from general service box carload is limited to the effects of ownership and maintenance costs for the specialized equipment used. Capital costs are estimated from net present value analysis, using 1977 manufacturer's price for tanks. A cost factor of 0.67, derived from the ratio of purchase prices of both car types, was applied to the maintenance of rolling stock for box carload service.

TABLE D-20. 1977 RAIL AVERAGE COSTS: BY REGION, CAR TYPE AND BY CARRIER SERVICE RAIL DEDICATED TOFC REFRIGERATED VAN SERVICE

		EAST	SOUTH	WEST
		1-40	1-40	1-40
Line-Haul ($/Trailer Mile)				
Labor		$.050	$.062	$.048
Maint. Rolling Stock		.139	.127	.129
Fuel, Oil & Lube		.053	.052	.052
Maint. of Way		.092	.087	.080
Other		.059	.037	.050
Total Operating		.393	.365	.359
Capital				
a) Reported Actuals		.124	.124	.056
b) NPV, Replace Ind % RTN		.229	.207	.243
c) NPV, Replace 15% RTN		.305	.291	.318
Total L.H. ($/Car Mile)				
a)		.517	.489	.415
b)		.622	.572	.602
c)		.698	.656	.677
Term. Handling (Excl. PU&D)	($/Trailer)	$122.615	$65.801	$124.053
Reported Capital (Eq. & Fac.)	($/Trailer)	.677	.846	1.182
Term. Hand. & Capital	($/Trailer)	123.292	66.647	125.235
*Term. Hand. (Excl. PU&D)	($/Ton)	8.192	4.256	8.795
PU&D (T.L.)	($/Trailer)	87.534	71.459	86.418
Ave. Load for PU&D	(Tons)	15.50	15.50	15.50
PU&D (T.L.)	($/Ton)	5.816	4.610	5.575

*40' single TOFC refrigerated trailer calculated using reported average load for TOFC operations.

APPENDIX E

TABLE E-1.3. ALLOCATION OF I.C.C. REPORTED COST ACCOUNTS TO TSC'S TRUCK COST MODEL

LINE HAUL			TERMINAL	
TOTAL LABOR			**TOTAL LABOR**	
Drivers & Helpers Owner Operator Drivers	DIRECT LABOR		Cargo Handlers Drivers & Helpers	DIRECT LABOR
Officer Salaries Department Managers Supervisory & Admin. Personnel Clerk & Administrative Other Miscellaneous Paid Time Off	INDIRECT LABOR	→	Same + Owner Operator Drivers Vehicle Repair & Service	INDIRECT LABOR
TOTAL FRINGES			**TOTAL FRINGES**	
Federal & State Payroll Tax Workmens Compensation Group Insurance Pension & Retirement Plans Health & Welfare Pensions	DIRECT FRINGES	→	Same + Other	DIRECT FRINGES
Identical As Above Accounts Including Other	INDIRECT FRINGES	→	Same	INDIRECT FRINGES
TAXES				
Fed'l & State Fuel, Lube & Oil Tax Fed'l & State Veh. Lic. & Reg. Tax (Own & Use)	DIRECT TAXES	→	Same + Real Estate & Property Tax	DIRECT TAXES
State Veh. Lic. & Reg. Fees	INDIRECT TAXES	→	Same	INDIRECT TAXES
FUEL			**FUEL**	
Fuel Oil, Lube & Coolants	DIRECT FUEL	→	Same	DIRECT FUEL
TIRES & TUBES			**TIRES & TUBES**	
Tires & Tubes	DIRECT TIRES & TUBES	→	Same	DIRECT TIRES & TUBES
MAINTENANCE			**MAINTENANCE**	
Vehicle Repair & Service Vehicle Parts Vehicle Maint.-Outside Vendors	DIRECT MAINTENANCE	→	Same	DIRECT MAINTENANCE

TABLE E-1.3. ALLOCATION OF I.C.C. REPORTED COST ACCOUNTS TO TSC'S TRUCK COST MODEL

LINE HAUL — OTHER			TERMINAL — OTHER	
Labor Fringes Expenses General Supplies & Expenses Operating Supplies & Expenses Communication Expenses Utilities Expenses Public Liab. & Prop. Damage Exp. Cargo Loss & Damage Exp. Fire Theft & Coll. Ins.	DIRECT OTHER	→	Same	DIRECT OTHER
Bldg. & Structure Ins. Bldg., Office Rents Office Equip. Rents Communication & Utilities Exp. Office & Superv. Exp. Other General Supplies & Exp. Other Employees Exp. Office Supplies Tarriff & Schedules Commission & Solicit. Agent Fees	INDIRECT OTHER	→	Same	INDIRECT OTHER

TABLE E-2. TRUCK AVERAGE OPERATING AND TRAFFIC STATISTICS GENERAL SERVICE MERCHANDISE DRY VAN

NORTHEASTERN REGION

TRUCK PERFORMANCE / CARRIER TYPE	REGULAR ROUTE COMMON	CONTRACT & IRREGULAR ROUTE	PRIVATE CARRIAGE
Average Weight Per Truckload	10.82 TONS	10.148 TONS	
Average Haul	237 MILES	101.03 MILES	250 MILES
Average Weight Per Shipment (TL)	21,665 LBS	20,000 LBS	
(LTL)	666 LBS		
Prime Mover-MPG	4.686	5.162	
Average Annual Driver & Helper Wages	$24,673	$20,798	
Average Annual Owner Operator Wages	$12,678		
Average # Truck Miles Per Year	35,000 MILES	43,000 MILES	89,000 MILES
Percent Split of Shipments - TL	3%	100%	
- LTL	97%		
Percent Split of Tonnage - TL	55%	100%	
- LTL	45%		

NOTE: These statistics are averages derived from ICC M-1 annual reports from the carriers sampled. These statistics are presented for informational purposes only, and do not enter into any of the cost calculations.

TABLE E-2. TRUCK AVERAGE OPERATING AND TRAFFIC STATISTICS GENERAL SERVICE MERCHANDISE DRY VAN

SOUTHERN REGION

TRUCK PERFORMANCE \ CARRIER TYPE		REGULAR ROUTE COMMON	CONTRACT & IRREGULAR ROUTE	PRIVATE CARRIAGE
Average Weight Per Truckload		12.68 TONS	10 TONS	
Average Haul		607 MILES	228 MILES	150 MILES
Average Weight Per Shipment	(TL)	28,900 LBS	20,000 LBS	
	(LTL)	686 LBS		
Prime Mover-MPG		4.826	4.684	
Annual Driver & Helper Wages		$22,410	$13,272	
Annual Owner Operator Wages		$13,185	--	
Average # Unit Miles Per Year		120,000 MILES	85,000 MILES	75,000 MILES
Percent Split of Shipments	TL	4%		
	LTL	96%	100%	
Percent Split of Tonnage	TL	60%	100%	
	LTL	40%		

TABLE E-2. TRUCK AVERAGE OPERATING AND TRAFFIC STATISTICS GENERAL SERVICE MERCHANDISE DRY VAN

MIDWESTERN REGION

TRUCK PERFORMANCE / CARRIER TYPE		REGULAR ROUTE COMMON	CONTRACT & IRREGULAR ROUTE	PRIVATE CARRIAGE
Average Weight Per Truckload		15.64 TONS	14.200 TONS	
Average Haul		885 MILES	242 MILES	700 MILES
Average Weight Per Shipment	(TL)	30,032 LBS	28,000 LBS	
	(LTL)	791 LBS		
Prime Mover-MPG		4.197	4.4886	
Annual Driver & Helper Wages		$23,848	$20,940	
Annual Owner Operator Wages		--	$16,955	
Average # Unit Miles Per Year		70,000 MILES	55,000 MILES	100,000 MILES
Percent Split of Shipments	TL	5%	100%	
	LTL	95%		
Percent Split of Tonnage	TL	67%	100%	
	LTL	33%		

TABLE E-2. TRUCK AVERAGE OPERATING AND TRAFFIC STATISTICS GENERAL SERVICE MERCHANDISE DRY VAN
WESTERN REGION

TRUCK PERFORMANCE / CARRIER TYPE	REGULAR ROUTE COMMON	CONTRACT & IRREGULAR ROUTE	PRIVATE CARRIAGE
Average Weight Per Truckload	15.0 TONS	14.33 TONS	
Average Haul	900 MILES	750 MILES	270 MILES
Average Weight Per Shipment (TL)	30,396 LBS	28,700 LBS	
(LTL)	652 LBS		
Prime Mover-MPG	4.248	3.297	
Annual Driver & Helper Wages	$20,067	$15,212	
Annual Owner Operator Wages	$14,657	--	
Average # Unit Miles Per Year	60,000 MILES	141,000 MILES	58,000 MILES
Percent Split of Shipments TL	3%	100%	
LTL	97%		
Percent Split of Tonnage TL	57%	100%	
LTL	43%		

TABLE E-2.1. TRUCK AVERAGE OPERATING AND TRAFFIC STATISTICS AUTO TRANSPORT CARRIERS

TRUCK PERFORMANCE / REGION	NORTHEAST	MIDWEST-CENTRAL	SOUTH	SOUTHWEST CENTRAL	NORTHWEST
AVERAGE WEIGHT PER TRUCKLOAD	6 tons	9.25 tons	7 tons	6 tons	6 tons
AVERAGE HAUL PER TRIP	162 mi	333 mi	212 mi	144 mi	144 mi
AVERAGE # TRUCK MILES PER UNIT PER YEAR	55,000 mi	61,000 mi	65,000 mi	52,000 mi	52,000 mi
PRIME MOVER - MPG	4.03 MPG	4.88 MPG	2.32 MPG	2.71 MPG	2.71 MPG
AVERAGE ANNUAL DRIVER & HELPER WAGES	$18,543/yr	$20,800/yr	$22,132/yr	$17,335/yr	$17,335/yr
REVENUE EQUIPMENT OWNED # TRUCK TRACTORS	1103 tractors	2849 tractors	653 tractors	512 tractors	512 tractors
TOTAL MILES OPERATED					
OWNED VEHICLES (000's)	53,456	164,652	39,861	25,824	25,824
VEHICLES RENTED WITH DRIVERS (000's)	4,527	14,490	227	132	132
VEHICLES RENTED WITHOUT DRIVERS (000's)	5,030	23,815	31,843	13,660	13,660

TABLE E-2.1. TRUCK AVERAGE OPERATING AND TRAFFIC STATISTICS DUMP TRUCK CARRIERS

TRUCK PERFORMANCE \ REGION	NORTHEAST	MIDWEST-CENTRAL	SOUTH	SOUTHWEST CENTRAL	NORTHWEST
AVERAGE WEIGHT PER TRUCKLOAD	24 tons	24 tons	20 tons	20 tons	20 tons
AVERAGE HAUL PER TRIP	90 mi	90 mi	6 mi	6 mi	6 mi
AVERAGE # TRUCK MILES PER UNIT PER YEAR	72,000 mi	72,000 mi	30,000 mi	30,000 mi	30,000 mi
PRIME MOVER - MPG	4.35 MPG	4.35 MPG	4.00 MPG	4.00 MPG	4.00 MPG
AVERAGE ANNUAL DRIVER & HELPER WAGES	$19,895/yr	$19,895/yr	$13,405/yr	$13,405/yr	$13,405/yr
REVENUE EQUIPMENT OWNED # TRUCK TRACTORS	N/A	N/A	N/A	N/A	N/A
TOTAL MILES OPERATED OWNED VEHICLES (000's) VEHICLES RENTED WITH DRIVERS (000's) VEHICLES RENTED WITHOUT DRIVERS (000's)	N/A	N/A	N/A	N/A	N/A

TABLE E-2.1. TRUCK AVERAGE OPERATING AND TRAFFIC STATISTICS RACK/PLATFORM CARRIERS

TRUCK PERFORMANCE \ REGION	NORTHEAST	MIDWEST-CENTRAL	SOUTH	SOUTHWEST CENTRAL	NORTHWEST
AVERAGE WEIGHT PER TRUCKLOAD	12.75 tons	12 tons	17.5 tons	13.5 tons	13.5 tons
AVERAGE HAUL PER TRIP	193 mi	169 mi	456 mi	296 mi	296 mi
AVERAGE # TRUCK MILES PER UNIT PER YEAR	53,350 mi	95,000 mi	65,100 mi	93,000 mi	93,000 mi
PRIME MOVER - MPG	4.32 MPG	5.88 MPG	3.63 MPG	4.34 MPG	4.34 MPG
AVERAGE ANNUAL DRIVER & HELPER WAGES	$16,865/yr	$15,440/yr	$14,070/yr	$13,360/yr	$13,360/yr
REVENUE EQUIPMENT OWNED # TRUCK TRACTORS	403 tractors	86 tractors	882 tractors	9 tractors	188 tractors
TOTAL MILES OPERATED					
OWNED VEHICLES (000's)	21,551	4,848	57,430	836	15,954
VEHICLES RENTED WITH DRIVERS (000's)	5,905	627	7,954	47,082	10,048
VEHICLES RENTED WITHOUT DRIVERS (000's)	1,696	4,424	----	17,235	1,254