Analysis of the Costs of Truckload Freight Operations

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This paper examines the impacts on truck costs of the most-critical financial and operational variables in long-haul, truckload freight movements. By using a truck cost model developed by the Association of American Railroads (AAR), the paper analyzes the sensitivity of truck costs to changes in fuel price, cost of capital, driver wages, tractor price, trailer price, depreciation method, and insurance cost. The effects of changes in operational factors such as truck speed, annual mileage, cargo weight, equipment type, fuel mileage, and percentage of empty backhaul are also shown. Data are drawn from various sources, which include truck-auctioneer data, truck-leasing company reports, U.S. government publications, and the AAR's field survey of rail-competitive truck movements. The principal finding of the analysis is that a reasonable minimum for mid-1979 rail-competitive truck costs is $0.83/revenue (loaded) mile and $0.055/ton-mile. It is also shown that marketing intelligence is of critical importance for making cost estimates, particularly with respect to equipment price and use, fuel price and mileage, and driver type and wages. Recent cost increases in these three areas (particularly in fuel prices) have reopened some freight markets to rail competition.

Recent rapid increases in the cost of operating tractor trailers in long-haul intercity freight markets have dramatically altered the setting in which trucks and railroads compete for freight. This paper presents the results of ongoing research that is being conducted by the Research Division of the Economics and Finance Department of the Association of American Railroads (AAR) in the area of truckload freight costs. Two basic areas are addressed in the paper: (a) what the factors are that are most critical in influencing truckload freight costs and (b) what the strategies are that truckers are using to offset cost increases.

Average mid-1979 costs by truckload operation carrier type are presented. These are followed by sensitivity analyses on the numerous factors that affect the costs of a base-case operation (an owner-operator leased to an irregular-route common carrier). This base case was selected in order to focus the analysis on a representative type of truckload freight operation. The sensitivity analysis uses a computerized truck cost model developed by the AAR (1) that employs mid-1979 truck cost components and inputs.

Several major findings result from the research:

1. The base-case truckload freight operation costs about $0.79/running mile and $0.053/ton-mile. After average empty mileage has been factored in, these figures are $0.93 and $0.062, respectively. A sizable portion of these costs are fixed or semifixed costs, which require some payment whether the truck is moving or not.
2. Three major strategies exist for offsetting cost increases: increased equipment use over time, improved fuel efficiency, and use of less-expensive tractors.
3. If the average gross revenue per loaded mile is $1.20, the owner-operator must drive in excess of 115 000 miles annually in order to earn $20 000 and meet operating costs (including brokerage fees and empty-mileage costs).

The next section of this paper documents the data sources and the truck cost model used in the research. Then average costs are presented for several classifications of motor carriers (excluding regular-route common carriage and agricultural cooperatives). A review of the base-case results and significant sensitivity analyses run on model input variables is given next, and the last section presents findings and conclusions.

TRUCK COST-MODEL DESCRIPTION AND DATA SOURCES

The AAR has revised and updated the computerized truck cost model it uses in marketing research and policy analysis. The model estimates total line-haul costs for any set of financial, operating, and equipment factors that the user specifies. It is oriented toward long-haul (more than 150 miles) truckload freight movements that are rail competitive and does not include terminal costs or pickup and delivery costs usually associated with less-than-truckload (LTL) operations.

There are two approaches to truck costing. One is to assign costs to a fixed period of time (such as one year) and then divide by annual mileage to obtain costs per mile. The other is to assign various costs on a mileage-related (variable-with-output) basis and sum to obtain a total cost-per-mile figure. The AAR model combines the two methods by assigning most costs on a time-related (fixed- or semifixed-cost) basis and some on a mileage-related (variable-cost) basis.

In owner-operator truckload freight operations, there are three major cost divisions: direct vehicle operating cost, costs associated with empty mileage, and overhead (agency or brokerage fees associated with leasing). The first two are accounted for by the model; the last is not and is more easily incorporated by viewing it as a reduction of the freight rate. It applies only to owner-operators.

Model Inputs and Output

The 36 input variables required in the model for the van base case are listed in Table 1. The variables fall into several groups:

1. Driver factors: wages (or residual, in the owner-operator case) and living expenses;
2. Capital costing factors: cost of capital (or loan rate, if an owner-operator is involved), investment tax credit, income tax rate, depreciation method, salvage values, useful life, tax life, and tractor and trailer purchase prices;
3. Operating costs: fuel cost and mileage, tire cost and life, maintenance cost per mile, overhead cost per year, insurance cost per year, and various user taxes and permit costs; and
4. Operating factors: owner of vehicle (driver or company), trailer type, miles per year, length of haul, and payload.

The operational data for the truck cost-model runs used in this paper are from a large field survey of intercity truck movements (2). The survey involves 31 000 personal interviews with intercity truck drivers made at 20 key locations around the country since 1977 (7000 in 1979). The interviews are conducted at a random time of day, day of the week, and time of the month. Each driver is asked to respond to questions about current and previous hauls, operation, and personal driving characteristics. Included are questions about legal status (carrier type), equipment, origins and destinations, and driver productivity. The sample has an intended bias against regular-route common carriers (LTL freight) and intracity local cartage.

The model's output includes cost per mile, per trip, per hundredweight, and per ton-mile. The sensitivity of trip costs to the amount of empty (nonrevenue) mileage assignable to a particular trip is also computed and output in tabular form.

Model Characteristics and Methodology

The model is designed to produce average cost figures that are applicable in costing out specific hauls. Marketing intelligence must be gathered in order to use the model successfully. The critical operational variables (miles per year, length of haul, equipment type, vehicle owner, and cargo weight) must be closely estimated, since they have significant impact on costs.

Capital costing in the model involves the use of net present-value analysis, which discounts depreciation, interest, investment tax credit, and salvage-value cash flows into a present-value figure. This figure is than divided by the economic life of the vehicle to obtain equal annual capital outlays. (Note that all capital cost computations are made separately for tractors and trailers to allow for differing economic life, salvage value, tax credit, etc.) This capital outlay and other time-related expenses (notably driver wages and expenses, insurance, and overhead) are divided by annual mileage to obtain a cost-per-mile figure. Other mileage-related expenses are then added to these to obtain the total cost per mile.

Table 1. Sample AAR truck cost-model inputs (van base case).

Variable	Name of Variable	Value
C1	Owner of capital assets	Driver
C2	Cost of after-tax capital (%)	12.5
C3	Investment tax credit (%)	10
C4	Marginal income-tax rate (%)	46
C5	Depreciation method	Straight line
C6	Interest rate on financing (used only for owner-operator cases)	15
C9	Insurance cost per year including cargo ($)	5000
D1	Driver wages per year including benefits ($)	19 600
D2	Driver expense per year ($)	3500
F1	Fuel price (cents per gallon)	90
F2	Fuel mileage (miles per gallon)	4.7
	Trailer	
L1	Purchase price including tires and sales tax ($)	11 500
L2	Economic life (years)	8
L3	Salvage value ($)	3750
L4	Tax life (years)	8
L5	Tax salvage value (%)	10
L6	Tire purchase price ($)	1150
L7	Tire life (miles)	170 000
L8	Maintenance cost (cents per mile)	1.5
M1	Miscellaneous expenses per year ($)	3500
	Tractor	
R1	Purchase price including tires and sales tax ($)	60 000
R2	Economic life (years)	5
R3	Salvage value ($)	12 000
R4	Tax life (years)	4
R5	Tax salvage value ($)	10
R6	Tire purchase price (set of 10)	1700
R7	Tire life (miles)	200 000
R8	Maintenance cost (cents per mile)	9
U1	Miles operated per year	115 000
U2	Miles operated per round trip	2600
U3	Miles operated per trip (headhaul)	1300
U4	Average payload/trip (headhaul)	15
X1	License and permit cost per year ($)	1200
X2	Third structure tax per mile (cents)	0.5
X3	Federal highway user tax per year ($)	210
X4	Equipment type	1

AVERAGE COSTS BY TYPE OF CARRIER

Rail-competitive trucking encompasses a broad spectrum of operating characteristics (3). There are numerous possible combinations of carrier legal types (common, private, contract, or exempt), trailer types [van, refrigerated van (reefer), or flatbed], and driver arrangements (union or nonunion, owner-operator, or company driver). This section focuses on variations in truck costs that exist across carrier types.

Table 2 presents results of truck cost-model runs based on interviews from the data base described above. Inputs of such averages as annual mileage, length of haul, cargo weight, fuel mileage, and driver wage were varied according to data derived from interviews. Truck movements that involved multiple-drop shipments, sleeper teams, or household goods were eliminated because they are unique operations that are not well suited to averaging. Since trailer prices, maintenance costs, and, most importantly, length of haul and annual mileage vary across equipment types, only van equipment interviews were selected, to ensure similarity and comparability.

Results in Table 2 and elsewhere indicate that company-operated trucks produce cost figures that are comparable with those from owner-operated trucks (4-6). The data indicate that company trucks have lower capital and fuel costs but higher wage and overhead costs. Trucking companies often obtain fleet purchase discounts (up to 20 percent) and certainly have a lower cost of capital than do owner-operators. They also get favorable prices on fuel, due to volume purchasing, and are more inclined to install fuel-saving devices than their capital-weak counterparts. Higher wage costs stem largely from the upward pressure of union

Table 2. Average van-trailer line-haul costs by carrier type.

Carrier Type	Annual Mileage	Cargo Weight (tons)	Length of Haul (miles)	Driver Wage per Mile (cents)	Total Cost per Mile (cents)	Total Cost per Ton-Mile (cents)
Irregular-route common carrier						
Owner-operators	115 000	15	1300	17.0	79	5.2
Company drivers	114 000	18	900	19.3	76	4.2
Private carrier[a]						
Company drivers	109 000	16	1100	20.2	80	4.9
Contract carrier						
Owner-operators	118 000	17	1300	17.0	81	4.7
Company drivers	121 000	14	1000	18.1	78	5.2
Exempt carrier						
Owner-operators	130 000	20	1300	17.4	75	3.8
Company drivers	125 000	20	1000	17.6	73	3.6

[a]Private carriers rarely lease owner-operators.

driver-wage and fringe-benefit requirements, estimated to be 25 percent of straight wages.

Although moderately higher annual mileages for owner-operators are indicated by the data, nothing conclusive is shown about cargo weights. As is commonly asserted, owner-operators must drive more to make competitive wages, even with their tax advantages.

BASE-CASE RESULTS AND SENSITIVITY ANALYSES

This section presents results from truck cost-model runs by using the base case mentioned above and describes the sensitivity of these base-case truck costs to changes in critical variables. The variables addressed include trailer type, driver factors, capital costing factors, fuel-price and fuel-economy factors, and several operational factors, including annual mileage and cargo weight.

Table 3. Input data for truck cost model.

Variable[a]	Value: Van	Reefer	Flatbed
C1	Driver-owned	Driver-owned	Driver-owned
C5	Straight-line	Straight-line	Straight-line
U1 (miles)	115 000	130 000	100 000
U2 (miles)	2600	3500	2500
U3 (miles)	1300	1700	1150
U4 (tons)	15	19	19
X4	Van	Reefer	Flatbed
F1 (cents/gal)	90.0	90.0	90.0
F2 (miles/gal)	4.8	4.7	4.9

[a]See Table 1 for names of variables.

Trailer-Type Cost Differences

The model was run by using input values for three trailer types--vans, reefers, and flatbeds. Inputs and results are shown in Tables 3 and 4. The results indicate that, despite higher capital and operating costs, reefer operations produce unit costs equal to or below those of van or flatbed operations. This is due to the longer hauls and higher annual mileage productivity regularly achieved by reefer operators and to their lower ratio of empty to total miles. Note, however, that flatbeds achieve the lowest cost per hundredweight, due to higher average cargo weights and shorter hauls.

The van base case, which serves as the basis for further sensitivity analyses (see Table 5), operates at $0.79/running mile and $0.053/ton-mile (Table 4). The cost-per-mile formula that results from the base-case run is

$$TCM = \$0.30 + (\$55\ 000/M),$$

where TCM = total cost per running mile and M = annual mileage. This equation is estimated to be valid between approximately 50 000 and 180 000 miles/year. Mileages outside this range significantly alter the proportions of fixed to variable truck costs, especially driver wages, capital costs, and maintenance costs.

Impact of Driver Wages

Driver wages constitute 22 percent of the total van base-case operating costs per mile ($0.17/$0.79) and more than one-third of the fixed cost component ($19 600/$55 000). Table 2 shows that wages can

Table 4. Truck cost-model output for van, reefer, and flatbed base case.

Operating Cost (cents/mile): Item	Value: Van	Reefer	Flatbed
Driver	17.0	18.0	17.8
Driver expense	3.0	2.7	3.5
Capital cost	19.2	20.0	21.9
Fuel cost	18.7	19.1	18.4
Maintenance cost	10.5	11.0	10.5
Tire cost	1.5	1.5	1.5
Licenses and permits	1.0	0.9	1.2
Third structure tax	0.5	0.5	0.5
Federal highway user tax	0.2	0.2	0.2
Insurance cost	4.3	3.8	5.0
Miscellaneous expenses	3.0	2.7	3.5
Total[a]	79.1	80.5	84.1

Operating Cost per Trip ($): Item	Value: Van	Reefer	Flatbed
Cost per round trip	2057	2817	2102
Cost of headhaul	1029	1368	967
Cost per ton-mile	0.053	0.042	0.044
Cost per hundredweight	3.429	3.601	2.544

[a]Totals are not exact due to rounding of figures.

Table 5. Sensitivity analyses on percentage of loaded mileage for three cost-model cases.

Loaded Miles as a Percentage of Total Miles	Van: Total Cost per Loaded Mile (cents)	Van: Total Cost This Load ($)	Reefer: Total Cost per Loaded Mile (cents)	Reefer: Total Cost This Load ($)	Flatbed: Total Cost per Loaded Mile (cents)	Flatbed: Total Cost This Load ($)
1.0	79.1	1029	80.5	1368	84.1	967
0.9	87.9	1143	89.4	1520	93.4	1074
0.85	93.1	1210	94.7	1610	98.9	1137
0.8	98.9	1286	100.6	1710	105.1	1208
0.7	113.0	1470	115.0	1955	120.1	1381
0.6	131.9	1715	134.2	2281	140.1	1611
0.5	158.3	2057	161.0	2737	168.1	1934

range up to about 30 percent of costs in the private-carrier case. The labor component could conceivably reach 35 percent of costs if driver expenses (lodging and food) are included and if union drivers are used. Basically, for every additional $1000 of compensation, truck costs per mile rise about $0.01.

Base-case driver earnings are $19 600/year. This figure is actually not a salary per se but represents a residual of the freight revenue. Gross freight revenue data obtained in the survey indicate that $1.20/mile (including Interstate Commerce Commission fuel surcharges) was appropriate for this type of operation in mid-1979. The $1.20/mile gross revenue is reduced by the leasing fee paid to the carrier and by empty mileage, as shown below, which leaves $0.17 for the driver and $0.61 for vehicle operating cost (1-2):

Item	Cost ($)	Percentage of Gross Revenue
Carrier leasing fee	0.29	24
Empty mileage factor	0.13	15
Driver residual	0.17	17
Direct vehicle operating cost	0.61	44

Residuals in the exempt owner-operator sector appear to be comparable but, since annual mileage is so much higher, annual incomes are higher also.

Nonunion company drivers also report per-mile earnings of $0.17-0.19. However, their employers frequently pay approximately 25 percent more than that for Social Security and unemployment taxes, health and welfare benefits, holidays and sick leave, and workmen's compensation. This raises company driver wages to about $0.21-0.24/mile, or $21 000-$26 000/year (based on 100 000-110 000 miles/year). Teamster's wages are even higher. (The 1979 National Master Freight Agreement ratified in mid-1979 provides hourly wages of $10.65 and fringe benefits of $3.25, or a total of $13.90/h. A 2080-h workyear yields $28 912 annually. Teamsters paid by the mile are compensated more than $0.30/mile.)

Capital Costing Factors

Capital ownership costs constitute 24 percent of total line-haul costs in the van base case and 40 percent of fixed costs. The $60 000 tractor input into the model (7,8) accounts for $0.16/mile on its own, while the $11 500 van trailer only makes up $0.025/mile. Note that the useful life of the tractor is assumed (Table 1) to be five years and that of the trailer is eight years.

Table 6 shows capital cost changes when variations are introduced in several of the 16 input variables that enter the capital costing formulas. Variables selected for analysis include investment tax credit rates, depreciation methods, interest rates on the truck loan, and several others.

Significant changes were found when the interest rate on the owner-operator's truck loan was altered. Each additional percentage point of interest is shown to add about $0.008/mile over the life of the truck. The use of an accelerated depreciation schedule is shown to save the trucker only slightly more than $0.01/mile; similarly, trailer price and trailer economic-life changes have only a small impact on total costs. (Trailer-related costs make up only about 7 percent of total operating costs in the base case.)

Without question, the single most important factor in determining truck capital costs is the price of the tractor. As noted above, tractor capitalization alone constitutes $0.167/mile, or 21 percent of the total costs (36 percent if tractor insurance, tires, and maintenance are added). A change of $10 000 in the initial capital outlay for a tractor can change operating cost per mile by almost $0.03 (with salvage value raised or lowered concurrently by $2000).

Changes in tractor economic life combined with changes in economic salvage (resale) value produced similarly significant results. Many factors come into play when changing these variables, however, because maintenance costs and the investment tax credit allowed also change with economic and tax life, respectively.

Strategies for capital cost reduction center around high equipment use and reductions in initial outlay. New entrants into the industry are more likely to succeed if they resist the temptation to splurge on a tractor that has excessive horsepower and all the glamorous options. A reduction of $0.03/mile in operating costs can translate into $3500/year in the base case, or a present value of $13 000 ($3500/year for five years at 10 percent). The effect of high equipment use is discussed in the section on annual mileage.

Fuel Price and Fuel Economy

One of the most pressing issues in the trucking industry is that of fuel prices and fuel economy. While the 55-mph speed limit sponsored by the U.S. Department of Transportation was directed primarily at the trade-off between speed and fuel mileage, this section will address the impact that fuel cost and fuel mileage have on total trucking costs.

Fuel costs have grown from about 15 percent of total truck line-haul costs per mile in 1977 to more than 23 percent today. Paxson has shown (9) that the cost impact of fuel price increases on trucks is nearly double that on rail. Table 7 shows that price increases of $0.30/gal (33 percent) yield increases of $0.063 in cost per mile (8 percent). Such a price increase computes to $7200/year in the base case. Fuel-mileage changes yield similarly dramatic results. An improvement of 1 mile/gal can save $0.032/mile or $3700/year in the base case.

Strategies for fuel-cost reduction are numerous. They include the installation and use of fuel-saving engines, wind deflectors, radial tires, special gearing, lightweight accessories, and synthetic lubricants. The savings that accrue to the trucker seem to outweigh the small incremental costs of using these items. Most fleet operators are moving ahead rapidly with such fuel-saving measures, but owner-operators are not aggressively pursuing these strategies, probably due to shortage of capital or concern about the appearance of their trucks and their powerful engines.

Annual Mileage, Length of Haul, and Truck Speed

The final general area of analysis is that of the effect of operating changes on truck line-haul costs. It is shown that annual mileage, length of haul, truck speed, cargo weight, and empty mileage are critical inputs in truck costing.

Annual Mileage

The single most important variable in determining truck line-haul cost per mile is annual mileage (Table 8) (1,2). This is due to the fact that the fixed and semifixed portions of truck costs--capital costs, insurance costs, licenses and fees, overhead, and driver wages--are becoming so prohibitively large. The annual Hertz truck cost study (5) cited

Table 6. Truck cost sensitivities to capital costing factors (van base case).

Variable	Base-Case Value	Change	Capital Cost per Mile (cents)	Total Cost per Mile (cents)	Change from Base Case (cents)
C3 (%)	10.0		19.2	79.0	
		12.5	18.8	78.7	-0.3
		7.5	19.4	79.4	+0.4
C5	Straight-line		19.2	79.0	
		Double-declining balance	17.9	77.7	-1.3
C6 (%)	15		19.2	79.0	
		19	22.5	82.3	+3.3
		11	16.1	75.9	-3.1
L1 ($) and L3 ($)	11 500 and 3750		19.2	79.0	
		13 500 and 3950	19.7	79.5	+0.5
		9 500 and 3550	18.8	78.6	-0.4
R1 ($) and R3 ($)	60 000 and 12 000		19.2	79.0	
		70 000 and 14 000	21.9	81.8	+2.8
		50 000 and 10 000	16.3	76.3	-2.7
R2 (years) and R3 ($)	5 and 12 000		19.2	79.0	
		7 and 10 000	16.6	76.5	-2.5
		3[a] and 14 000	24.2	84.1	+5.1

[a]Tractor tax life is equal to three years.

Table 7. Truck cost sensitivities to fuel cost and mileage (van base case).

Variable	Base Value	Change	Fuel Cost per Mile (cents)	Total Cost per Mile (cents)	Change from Base Case: Cents	Change from Base Case: Percent
Fuel cost ($/gal)	0.90		18.7	79.0		
		1.50	31.3	91.6	+12.6	+16
		1.20	25.0	85.3	+ 6.3	+ 8
		0.60	12.5	72.8	− 6.3	− 8
Fuel mileage (miles/gal)	4.8					
		5.8	15.5	75.8	-3.2	− 4
		3.8	23.7	84.0	+5.0	+ 6

Table 8. Impact of annual mileage on truck costs and driver compensation.

Annual Mileage	Truck Costs: Per Mile (cents)	Truck Costs: Total ($)	Driver Compensation: Per Mile (cents)	Driver Compensation: Total ($)
90 000	71	63 900	7	6 300
115 000	61	70 200	17	19 600
140 000	57	79 800	21	29 400

insurance as the fastest-rising component of truck operating costs.

Table 8 shows the sensitivity of truck costs per mile and driver income to annual mileage changes. A per-mile cost reduction of 7 percent is obtainable by driving 140 000 miles/year as opposed to 115 000 miles. Note also that the driver's effective mileage wage increases to $0.21/mile at this level. In essence, the driver has paid his fixed costs, so that more of the freight revenue accrues to him and not to the truck manufacturer or the insurance company.

As fixed costs increase, there is a greater penalty for idle time and empty mileage. Hence, the incentive for increased equipment use (and for hours-of-service violations) becomes stronger, and drivers redouble their efforts to keep their trucks loaded and moving as much as possible.

Length of Haul

Length of haul is critical to truck unit costs, mainly because there is a correlation between length of haul and annual mileage. Data from AAR and the U.S. Department of Agriculture (10) support the assertion that, in general, longer hauls correspond to greater annual mileage and hence lower unit costs. (AAR data show that movements in the range of 250-500 miles average 99 000 miles/year, those of 500-750 miles yield 105 000 miles/year, those of 750-1000 miles yield 112 000 miles/year, etc., up to those of 2500-2750 miles, which yield 127 000 miles/year. On the average, an increase by one length-of-haul increment translates into an additional 3000 miles/year.)

Truck Speed

Variations in overall truck speed also have a dramatic effect on annual mileage and unit costs. Increases of 5 mph on a schedule of 300 days at 11 h/day translate into 16 500 additional miles annually. The unit-cost effect of such a productivity increase would be slightly offset, however, by slight increases in fuel consumption, wear and tear on the truck, and possibly fines for speeding.

Cargo Weight

Cargo weight affects truck costs most noticeably by increasing the wear on tires, trailer, and engine and by increasing third-structure taxes (in some states) and fuel consumption. However, the total difference between running with 15 tons and running empty is less than $0.05/mile. AAR data indicate that two-thirds of the movements weigh between 9 and 21 tons. In the table below, fuel mileage changes of 0.2 mile/gal were assigned for every 3-ton change.

Cargo (tons)	Cost per Ton-Mile ($)	Cost per Hundredweight ($)
9	0.088	5.72
12	0.067	4.35
15	0.053	3.49
18	0.046	2.96
21	0.040	2.58

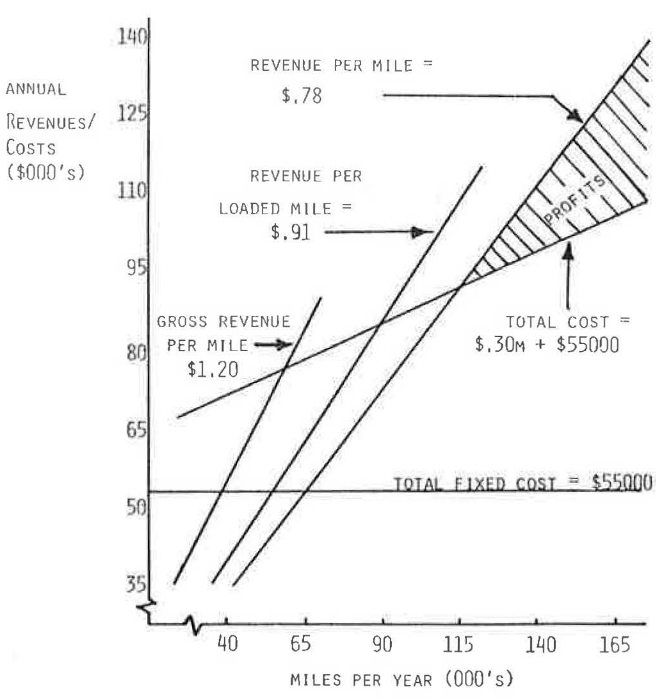
A ton-mile cost reduction of up to 30 percent is possible with a load of 21 tons compared with the base-case haul of 15 tons. There is a strong incentive for carrying overweight loads, especially when the chances of detection are perceived to be slight (11).

Empty Mileage

Finally, empty mileage is a very important variable in determining truck cost levels. AAR statistics show an average of 15 percent empty mileage associated with base-case operations. A sensitivity analysis for empty mileage for the van base case showed truck costs of $0.93/mile and $0.062/ton-mile at 85 percent of capacity.

Actually, empty mileage is best accounted for by adjusting revenues rather than cost figures, which change only slightly when the truck is empty. This concept is shown in Figure 1. This break-even analysis assumes an average revenue per loaded mile of $1.20 and a brokerage fee of 24 percent. The effect of the 15 percent average empty mileage is to reduce the overall net revenue per running mile. Net revenue per loaded mile is $0.91 ($1.20 x 0.76). Each additional percentage point of empty mileage to total mileage results in a need to drive 2000 additional miles/year to break even. The base-case driver would break even at about 90 000 miles if empty miles could be reduced to zero; however, with 15 percent empty miles, 25 000 miles more must be driven to break even.

Figure 1. Mid-1979 base-case break-even analysis.



SUMMARY AND CONCLUSIONS

This paper presents findings from research conducted on the average costs of truckload freight operations. A base case was selected and sensitivities were run to determine potential variations in average costs; potential strategies used to offset cost increases were discussed. Base-case costs were $0.79/running mile and $0.053/ton-mile. When average ratios of loaded to empty mileage are factored in, these costs increase to $0.93/running mile and $0.062/ton-mile.

Several major strategies emerged from the sensitivity analyses. First, by decreasing tractor purchase price, truck costs can be decreased as much as $0.03/mile, or $0.002/ton-mile. Increasing fuel mileage by 1 mile/gal achieves similar cost reductions. Increases in annual mileage productivity can yield a 7 percent reduction in per-mile costs. Cargo weight increases can reduce ton-mile costs to about $0.04.

Combinations of the above strategies produce a reasonable minimum for rail-competitive truck costs of $0.71/running mile and $0.04/ton-mile (by using a driver wage of $0.19/mile and 150 000 miles/year). The factoring in of 15 percent empty mileage raises these costs to $0.83/running mile and $0.055/ton-mile.

The massive cost increases that rail-competitive truckers are experiencing create definite incentives for violating hours-of-service regulations, for overloading trucks, and for speeding. It has been shown that by doing these things, the base-case operation can reduce per-mile costs up to 10 percent and ton-mile costs up to 25 percent.

The cost increases also place the truck operators in the position of requiring rate increases that may open up marketing opportunities for U.S. railroads. Recently, some of the movement of fresh fruits and vegetables that are shipped east from California has been recaptured by several railroads after the market had long been dominated by trucks. Although the final impetus for this traffic diversion was the nearly simultaneous occurrence of the independent truckers' strike and rail-rate deregulation on fresh fruits and vegetables, the railroads have retained much of this traffic since the end of the strike. Future diesel-fuel, driver-wage, and truck-price increases could intensify and expand such marketing opportunities for rail.

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Marketing Advantages of Size in the General-Freight Motor Carrier Industry

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This paper focuses on a hypothesis that has been offered as an alternative explanation for the increasing concentration observed in the general-freight motor carrier industry. Although economic research on this question has traditionally been directed to the cost structure of the industry, this paper addresses a demand-side explanation, namely, the hypothesis that general-freight carriers with extensive terminal networks possess important marketing and service advantages over small firms. A formal test of the hypothesis that size affects marketing advantages, based on city-pair market data collected from carriers that offer single-line service in selected transcontinental markets, provided the following results. Those carriers with the largest route networks, whether measured by the number of terminals or by the number of standard-metropolitan-statistical-area (SMSA) points served, did not (other things being equal) possess the largest share of overall less-than-truckload (LTL) revenue in the lanes studied. Indeed, other factors, such as a carrier's relative financial health and regional identification, appeared to play a greater role in explaining market share than did network size. Nevertheless, carriers with extensive networks did earn higher average LTL revenue per shipment pound than did carriers that served a smaller number of terminals or SMSA points. These results, although based on a limited sample of city pairs, indicated that carriers with extensive terminal networks have balanced market-share objectives against other objectives such as shipment yield. Moreover, such carriers have been more successful in competing for high-rated traffic than have smaller carriers. The results thus suggest that, under the present regulatory system, large interregional general-freight carriers possess significant marketing advantages in soliciting high-rated freight and that these advantages have contributed to the high relative growth and profitability of such carriers.

This paper examines the hypothesis that large general-freight carriers that serve many points enjoy important marketing or service advantages over smaller firms (1-3). According to this hypothesis, carriers that offer regular service to many points will (other things being equal) win the greatest market shares in any given city-pair market. This hypothesis is supported by informal observations of shipper behavior in selecting motor carriers, which indicate that shippers have a strong preference for minimizing the number of carriers with which they deal and do so by selecting carriers that provide the greatest route coverage. Such a practice minimizes the number of interactions between shipper personnel and carriers, minimizes congestion at the shipper's loading docks, and concentrates the shipper's bargaining power, e.g., in negotiating special commodity or point-to-point rates.

The hypothesis of the marketing advantages of size is of particular interest in view of the controversy that surrounds the economics of the general-freight or less-than-truckload (LTL) segment of the motor carrier industry. This debate has focused on whether the increasing concentration observed in LTL transportation is the product of Interstate Commerce Commission (ICC) regulation or of structural economic factors.

Traditionally, research on this question has been directed to the cost side of the industry, i.e., to the issue of cost economies of scale. Over the past 20 years a number of studies have attempted to estimate the most efficient size for a general-freight carrier. The results of these studies suggested that economies of scale (if they exist at all) are achieved only by certain regional carriers, while interregional carriers are characterized by constant returns to scale (4-5).

Economists have interpreted the cost-study evidence as indicating that any given market should be able to support substantially more carriers than it currently does and accordingly that high concentration ratios reflect artificial regulatory restrictions on entry into the market. In contrast, members of the general-freight carrier industry have argued that concentration trends are explained by the nature of demand for LTL transportation, i.e., by the marketing advantages that accrue to large carriers that serve many points. They argue that, in the absence of regulation, the industry would come to be dominated by a few large firms. Given the importance of this question, this paper presents a formal test of the marketing-advantages hypothesis.

The next section of the paper discusses general-freight carrier marketing and service strategies as they have evolved under ICC regulation. Next, an empirical investigation of the relationship between the major dimensions of carrier service--route coverage, quality of service, and marketing effort--and carrier market performance in 18 transcontinental lanes is presented. A summary of the study's conclusions ends the paper.