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Estimating Rail Transport Costs for Grain and Fertilizer

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Estimating Rail Transport Costs for Grain and Fertilizer*

THOMAS P. DRINKA, C. PHILLIP BAUMEL, AND JOHN J. MILLER

INTRODUCTION

A major problem encountered in developing models to measure relationships among the production, transportation, and marketing of agricultural products is the estimation of rail cost. One estimation procedure uses rail rates as an approximation of rail costs (11). Two difficulties characterize this approach. First, rail rates may not exist for all shipment sizes between all origins and destinations considered by the model. Second, rail rates at times are established by means of the "value of service" concept, rather than with sole regard to cost of service.

A second estimation procedure—an engineering approach—measures the impact of changes in freight operations upon rail cost(12). In this approach, railroad unit cost is considered a function of the individual line-haul and terminal activities which comprise a freight movement. Many researchers, however, lack the expertise and resources needed to gather the engineering and field data required by this approach.

A third Procedure—a statistical approach—utilizes standard regression techniques to estimate a "cost function", by examining the relationship between distance and published rail rates or rail costs averaged over shipments of all commodities moved, lengths of haul, and Class I line-haul railways (5).

A fourth procedure is to adjust published rail cost data to estimate the cost of hauling specific products between specific origins and destinations in selected shipment sizes (2). This procedure, used in this analysis, follows rail cost adjustment methods prescribed by the Interstate Commerce Commission, and published as Statement No. 1C1-72, *Rail Carload Cost Scales, 1972* (10), hereinafter referred to as the "ICC Scales". This document is the most widely accepted and reliable source available for public use.

"Variable cost" in the ICC Scales reflects costs which are considered to be a

*One of three reports prepared for publication under the responsibility of the NC112 Publications Subcommittee on Transportation Costs—David E. Moser, Chairman, C. Phillip Baumel, and William F. Payne. The other two publications are *Estimating Truck Transport Costs for Grain and Fertilizer,* by William F. Payne, C. Phillip Baumel, and David E. Moser, and *Estimating Barge Transport Costs for Grain and Fertilizer,* by David E. Moser and Michael W. Woolverton.

function of traffic over the long-run period and at average traffic densities; it includes:

> . . . freight operating expenses, rents and taxes (excluding Federal Income Taxes) plus an allowance for the cost of capital before Federal Income Taxes on 50 percent of the road property and 100 percent of the equipment used in freight service . . . A study recently completed by the Section of Cost and Valuation produced new percent variable factors separately for individual expense accounts or groupings of expense accounts . . . The percent variable ratios range from a low of .44 for Account 373, Station Employees and other Miscellaneous Transportation Expenses, to a high of .97 for Accounts 392 through 402, Train Expenses. These ratios replace the previous overall ratio of .80 applicable to freight operating expenses, rents and taxes (excluding Federal Income Tax) (10, pp. 3-5).

The cost of capital is based on the actual amount of total interest payments divided by the total amount of outstanding debt. Rates of return on investment "were applied to the original cost of land and rights, road property, and equipment, including an allowance for working capital, material and supplies, less book depreciation on total depreciable property and book amortization on road property" (10, p. 5).

A basic objection has been levied against the application of rail cost coefficients derived from Rail Form A. As noted by the Interstate Commerce Commission:

> The formulas were initially designed mainly for the purpose of developing costs in the aggregate for transportation service conducted by large groups of carriers within certain territories or regions. Thus, the emphasis in these formulas has been upon, and the results achieved reflect, general overall average operations performed under average conditions . . . [Thus,] when the costs of a specific carrier handling particular traffic between certain points are involved, the application of such formulas may not be appropriate without substantial adjustments and various refinements to reflect the peculiar situation under consideration (9, p. 386).

Thus, costs estimated on the basis of regional averages may be inapplicable to specific traffic moving between specific geographic points by a specific railroad at a specific point in time. Associated with this limitation is the argument against the use of any single standardized cost formula to reflect a wide variety of rail operating conditions as well as the observation that such a standardized methodology introduces rigidity into costing procedures. The Commission has recognized this limitation and has noted that generally:

> . . . the formulas produce estimated costs based mainly upon historical data to which average factors, mirroring a hypothetical average carrier operating under average conditions, are applied. To the extent that the actual operations of a specific carrier may deviate from such average, the results may or may not be meaningful in the evaluation of a certain specific prospective situation. Although the present formulas may properly continue to be utilized as a point of departure and serve as general guides for cost analyses, the results should be considered no

> more than a rough measure of the true costs, unless substantial adjustments are made in the application of the formulas to reflect the particular conditions surrounding the specific transportation (9, p. 387).

The basic procedure in this analysis is to apply adjustments to the ICC average costs to more closely reflect the single-car costs of hauling grain and fertilizer. The estimates of single-car grain and fertilizer costs are based on the adjustment provisions specified by the ICC Scales. Additional adjustments were then made to reflect the cost saving associated with selected sizes of multiple-car shipments.

A second limitation of the ICC Scales is that the formula specifies a constant line-haul cost per hundredweight-mile. There is some reason to believe that this formula tends to have an upward bias for long distance heavy-loading movements. For example, the actual wages of the conductor and the brakeman are based on the number of cars in the train, regardless of the size of the car or the weight of the commodity being hauled. However, in the ICC Scales, the cost of these trainmen is based on trailing gross ton-miles. Thus, the trainmen wage costs are biased upward for commodities such as grain in covered hoppers. While the bias is present in all movements, it tends to place a heavier weight on longer distance movements, since the line-haul costs become a larger portion of the total costs.

Despite these limitations of the ICC Scales, this study utilizes this basic source of data for estimating rail costs. The ICC Scales are classified into costs attributable to various operations and services, and are presented as average unit costs for all traffic. By working forward from these unit-cost data which apply to the line-haul and terminal activities of freight movement, the ICC Scales can be adjusted to be consistent with particular car types, commodities, routings, shipment sizes, and so on.

ADJUSTMENTS FOR SINGLE-CAR GRAIN SHIPMENTS

The adjustments applied to the basic single-car cost coefficients appearing in Table 3 of the ICC Scales are specified in this section.

Item 9. Allowance for Circuity

Railroad companies provided data on the step-by-step physical movement of grain consignments originating on their individual lines and terminating at the markets under consideration. These data defined the actual route by which a consignment moves under a normal set of circumstances from each origin to each destination and, therefore, provided the "actual" (as distinguished from "short-line") total miles from each origin to each destination. Hence, no adjustment was required with respect to rail circuity. The matrix of actual mileages was compiled from the *Handy Railroad Atlas of the United States* (6).

The definition of way and through trains follows that of "Petroleum Rail Shippers' Association v. Alton and Southern Railroad et al" (8, pp. 646-47). The total actual mileage from each origin to each destination was stratified into way train and through train miles under the assumption that once a consignment becomes part of a through train, it remains part of that train through its destination. This analysis, therefore, did not employ the territorial average way train short-line miles utilized by the ICC Scales (10, p. 6).

Item 10. Treatment of Loss and Damage Claim Payments

Carload unit costs in Table 3 of the ICC Scales exclude loss and damage claim payments. A study of an Iowa train-loading facility with official weight scales indicated a boxcar loss of 1.0786 percent of origin weight and a hopper car loss of 0.3188 percent of origin weight of grain. The representative mid-1974 per bushel prices of $3.1112 and $6.4714 for corn and soybeans, respectively, are used to estimate the amount of the loss and damage cost for boxcar and hopper car losses.

Item 11. Average Load by Territory and by Type of Car

This study assumes that boxcars and hopper cars hold 62.5 and 98.0 tons of corn and soybeans respectively.

Item 14. Tare Weight

The study assumes a standard 40-foot general service unequipped boxcar with tare weight of 26.0 tons and a covered hopper car with tare weight of 31.5 tons. It is assumed that single-car traffic is composed of both types of equipment and that multiple-car consignments move solely in covered hopper cars.

Item 15. Treatment of Special Services

The term "special services" includes the per carload costs of train supplies and expenses, and station employees. These costs are included in Table 3 of the ICC Scales. Boxcar supplies and expenses costs are replaced by the cost of a grain door; installation cost of the door is assumed equal to the station employees special services cost. For hopper cars, the cost of supplies and expenses is excluded; station employees cost is included to reflect the labor cost of opening and closing hopper doors.

Item 17. Treatment of Origin and Destination Portion of Freight-Train Car Costs

Territorial variable cost per carload at either the point of origin or destination included the following: freight-train car maintenance, depreciation, and return on cost of freight-train cars other than mileage cars. Estimated ownership costs were substituted for the territorial variable ownership cost of the ICC Scales. The estimation of ownership cost—including depreciation, return on investment, and maintenance—of a boxcar and hopper car is based on mid-1974 prices and costs and on the following assumptions.

1. The purchase price of a general service unequipped boxcar is $20,000, and covered hopper car with liner is $22,000.
2. The service life of cars in single-car and 3- to 10-car shipments is 20 years; hopper cars dedicated to random shipments of at least 25 cars are assumed to last 18 years; and the life of those dedicated to scheduled shipments is 15 years. The service lives of cars assumed in this study represent the best available judgment of actual economic car life under typical operating conditions.
3. The salvage value of a boxcar is $1,750, and a hopper car is $2,750.
4. A 10-percent interest rate.
5. A 346-day year (that is, 5 percent shop margin) for cars in single-car and 3- to 10-car shipments, a 337-day year (that is, 7.5 percent shop margin) for hoppers dedicated to random shipments of at least 25 cars, and a 328-day year (that is, 10 percent shop margin) for hoppers dedicated to scheduled shipments.
6. The car maintenance cost is assumed to be 3.0 cents per car-mile for equipment in single-car and 3- to 10-car service, 2.7 cents per car-mile for hoppers dedicated to random shipments of at least 25 cars, and 2.6 cents per car-mile for hoppers dedicated to scheduled shipments. These maintenance costs include labor and material, payroll additives and departmental overhead.

Per diem interest and depreciation—excluding car maintenance—was computed from the following formula (7, p. 620):

$$\text{Per Diem A.E.C.} = \frac{P\left(\frac{i(1+i)^n}{(1+i)^n - 1}\right) - S\left(\frac{i}{(1+i) - 1)}\right)}{d}$$

where

A.E.C. = annual equivalent cost,
P = purchasing price,
S = salvage value,
i = interest rate,
n = years of service life, and
d = number of operating days per year.

Under the above assumptions, it follows that the per diem interest and depreciation cost for boxcars and hopper cars, respectively, dedicated to single car and 3- to 10-car service is calculated as

$$\frac{(\$20{,}000)(0.11746) - (\$1{,}750)(0.01746)}{346} = \$6.70$$

and

$$\frac{(\$22{,}000)(0.11746) - (\$2{,}750)(0.01746)}{346} = \$7.33;$$

for hopper cars dedicated to multiple-car shipments of at least 25 cars, similarly, the per diem cost is $7.78; and for hopper cars dedicated to scheduled shipments, the per diem cost is $8.55. No allowance is made for tax credits. Thus, these costs are not directly comparable with leasing costs.

Table 1 shows representative turnaround times for single-car grain shipments from central Iowa to selected destinations. These turns and the multiple-car turns shown in Table 3 are based upon the January 1974 to February 1975 experience of approximately 950 covered hopper cars leased by Iowa grain shippers.

Table 1

Representative Turnaround Times for Single-Car Grain Shipments from Central Iowa Origins to Selected Destinations in Days

Destination	Turnaround Time
Des Moines, Iowa	16.0
Cedar Rapids, Iowa	19.0
Sioux City, Iowa	16.0
Omaha, Nebraska	18.6
Dubuque, Iowa	16.0
Muscatine, Iowa	16.4
Pekin, Illinois	20.0
Chicago, Illinois	21.9
Kansas City, Missouri	20.0
St. Louis, Missouri	21.1
Gulf ports	32.7

Source: Iowa grain shippers.

Item 18. Treatment of Interchange Switching Costs

Territorial costs for interchange switching service have been included in the ICC Scales as a line-haul cost; no interchange switching cost is incurred by traffic handled by a single railroad. Since the actual route from each Iowa origin to each destination is known, the territorial average interchange cost is replaced by the actual switching cost.

Item 20. Percent Empty Return of Equipment

The ICC in April 1962 instituted proceedings with the purpose of determining "whether the approval and adoption of certain cost formulas would result in general improvement of the quality of cost evidence presented in formal proceedings . . ." (9, p. 300). One of the principal findings of the proceedings is the following: "There is no universally acceptable method of apportioning joint or common costs, and any method of apportionment utilized for ratemaking purposes should be designed to reasonably reflect the specific circumstances attending the transportation performed" (9, p. 326). Therefore, it is valid to adjust the empty return ratio between the origin and destination under consideration when estimating the cost of transportation between those two points.

The territorial empty return ratios utilized by the ICC Scales range from 0.59 to 0.64 for general service unequipped boxcars and from 1.00 to 1.05 for covered hopper cars. Since the tonnage moving into the study area in boxcars is limited to a greater extent than reflected in these territorial averages, the present study assumes the boxcar ratio to be 0.80; the hopper car ratio is assumed to be 1.05 to reflect circuitous routing of the empty car.

ADJUSTMENTS FOR MULTIPLE-CAR GRAIN SHIPMENTS

The multiple-car shipments analyzed include shipments ranging in size from 3 to 10 cars, 25 cars, 50 cars, and 85 cars. The following definitions are made:

1. A "full train" is defined to be a group of cars of sufficient number to move from origin to destination and back as a through train. Although the number of cars required to qualify as such a unit varies among individual railroads, depending upon available power and the track profile, it is herein assumed that 50 cars is the minimum number satisfying this definition.
2. A "random" shipment is one which is scheduled at the discretion of the shipper; the analysis considered random shipments of size 3 to 10, 25, and 50 cars.
3. A "scheduled" train is one which operates continuously, making round trips to a destination and returning to the origin stations on a year-round basis; the analysis considered scheduled shipment of 85 cars.

The adjustments applied to the ICC Scales are examined in this section.

Item 12. Type of Train

Appendix E of the ICC Scales exhibits territorial averages by type of train with respect to differences in weight of the trailing tons, the number of locomotive units, and wages of train and engine crew. In this analysis, the trailing ton weight (excluding caboose) of multiple-car shipments was adjusted to be consistent with the hopper car payload (Item 11, single car) and tare weight (Item 14, single car). To reflect the fact that 50-car shipments typically move with "fill cars", the trailing weight of this shipment size has been raised by 12.5 percent. Based upon these adjusted trailing weights, the estimated number of "equivalent" locomotive units required for each multiple-car case is consistent with Appendix E territorial averages. Territorial average crew wages are retained for random shipments.

The cost of train operations is divided between the expense of providing the capacity to move freight and the expense of utilizing that capacity; "capacity is provided by purchasing the equipment and labor needed to run the railroad" (4, p. 15). During the October 1973 to September 1974 period, the monthly proportion of commercial grain sales originating in Iowa ranged from an estimated 5 percent in September to an estimated 11.08 percent in November. If Iowa shippers had had access to annually scheduled train service during this period, a uniform 8.33 percent of total sales could have moved to market monthly—a reduction of 24.82 percent from the peak month. That is, in the absence of random surges in grain shipper transport demands, this annual volume of grain could have been moved to market with a reduction in railroad capacity reflected in fewer rail cars, reduced crew wages, and fewer locomotive units.

The hopper car capacity saving is accommodated by the representative turnaround times utilized (Item 17, multiple-car). The labor capacity saving is assumed to be 6 percent of the wage cost incurred by random multiple-car shipments; this reduction is realized through reduced crew costs and fringe benefits, since there is no requirement to "deadhead" crews under a fully scheduled shipping system. Scheduled trains to the East Coast and West Coast operate over mountainous terrain; this analysis assumes that the "constructive allowances" paid to crews handling shipments to these markets offset the deadheading cost savings. The locomotive unit capacity saving is accommodated by applying a 24.82 percent reduction to the components of ICC Scales reflecting locomotive investment and maintenance cost.

Item 16. Treatment of Origin or Destination Switching Costs

The territorial variable cost per carload for switching at either the point of origin or destination includes locomotive expenses, fuel, crews, and track maintenance related to switching. The number of per car switching minutes required to perform a switching maneuver decreases as the number of cars in the cut increases; this study assumes that the per carload origin or destination switching cost decreases as shown in Table 2.

Item 17. Treatment of Origin or Destination Portion of Freight-Train Car Costs

Table 3 shows representative turnaround times for multiple-car grain shipments from central Iowa to selected destinations. As in the single-car adjustment, these turnaround times are based upon the January 1974 to February 1975 experience of approximately 950 covered hopper cars leased by Iowa grain shippers and were used to estimate the ownership cost of railroad cars.

Item 18. Treatment of Interchange Switching Costs

Territorial costs for interchange switching service have been included in the ICC Scales as a line-haul cost; no interchange switching cost is incurred by traffic handled by a single railroad. The territorial average interchange cost is replaced by the cost incurred by the actual number of switches encountered by each movement. As with origin or destination switching costs (Item 16, multiple-car), it is assumed that the variable per carload interchange switching cost decreases as the size of shipment increases.

Item 19. Treatment of Intertrain and Intratrain Switching Costs

Territorial costs for intertrain and intratrain switching service performed in making up and breaking up trains at intermediate train yards on the carrier's own lines are included in the ICC Scales as a line-haul cost. Since a full train once assembled does not require such service, this cost was deducted for all multiple-car shipments of 25 cars or more.

Table 2

Percent Reduction of per Carload Variable Switching Cost of Selected Multiple-Car Sizes from Single-Car Shipments

Shipment Size	Percentage Reduction of Variable per Carload Switching Cost from Single-Car Costs
3-10	32.33
25	68.34
50	72.84
85	74.70

Source: Wright, Walter B., "How Cars in Multiple Cut Costs." Railway Age, January 4, 1960, pp. 23-35.

Table 3

Representative Turnaround Times for Multiple-Car Grain Shipments from Central Iowa Origins to Selected Destinations by Selected Shipment Sizes in Days

Destination	Number of Cars per Shipment			
	3-10	25	50	85 Scheduled
Cedar Rapids, Iowa	--	13.3	11.0	--
Sioux City, Iowa	--	11.2	9.2	--
Omaha, Nebraska	--	13.0	10.7	--
Dubuque, Iowa	13.0	11.2	9.2	--
Muscatine, Iowa	13.5	11.5	9.5	--
Pekin, Illinois	--	15.0	12.9	--
Chicago, Illinois	18.5	16.0	13.8	--
Kansas City, Missouri	--	14.0	11.6	--
St. Louis, Missouri	--	14.8	12.2	--
Gulf ports	30.0	22.5	17.7	10.0

Source: Iowa grain shippers.

Item 20. Percent Empty Return of Equipment

The empty return ratios of hopper cars in multiple-car service are assumed to be the following: 1.05 for cars in 3-10 service, 1.025 for cars in 25-car and 50-car random shipments, and 1.00 for cars in scheduled service.

Item 22. Station Clerical Costs

Terminal variable station clerical expenses per shipment (origin plus destination) include the wages and salaries of employees engaged in the following activities: auditing, preparation of waybills, accounting, billing, and others which occur in general offices. It is assumed that 25 percent of this per carload cost is fixed per shipment (regardless of shipment size) and that the residual is apportioned among individual cars of the shipment.

ADJUSTMENTS FOR SINGLE-CAR FERTILIZER SHIPMENTS

The adjustments applied to the basic single-car cost coefficients appearing in Table 3 of the ICC Scales are analogous to the adjustments utilized for grain shipments. Only those adjustments which differ between the two commodities are considered below.

Item 10. Treatment of Loss and Damage Claim Payments

The types of fertilizer considered—potash, urea, ammonium nitrate, and phosphates—are assumed to move in covered hopper cars. The representative mid-1974 per ton prices of $57.30, $156.00, $117.50, and $145.25, respectively, and the hopper car loss of 0.3188 percent of origin weight are utilized to estimate loss and damage.

Item 15. Treatment of Special Services

It is assumed that "station employees special services" reflect the labor cost of opening and closing hopper doors. This assumption is consistent with the grain adjustments. Two cents per hundredweight is added to cover the cost of dry-sweeping the hopper at the point of destination.

Item 17. Treatment of Origin or Destination Portion of Freight-Train Car Costs

The estimation of hopper car ownership costs is based on mid-1974 prices and costs and on the following assumptions:

1. The purchase price of covered hopper car with liner is $22,000.
2. The purchase price of a liner is $900.
3. The service life of a hopper is 18 years.
4. The service life of a liner is 5 years.
5. The salvage value of a hopper is $2,750.
6. A 10-percent interest rate.
7. A 346-day year (that is, 5 percent shop margin) for hoppers in single-car and 3- to 10-car shipments and a 337-day year (7.5 percent shop margin) for hoppers dedicated to random shipments of at least 25 cars.
8. The car maintenance cost is assumed to be 3.0 cents per car-mile for hoppers in single-car and 3- to 10-car service and 2.7 cents per car-mile for hoppers in random shipments of at least 25 cars.

Based upon these assumptions, the per diem interest and depreciation—excluding car maintenance—is estimated to be $7.95 for hopper cars in single-car and 3- to 10-car service and $8.16 for hopper cars in random shipments of at least 25 cars.

Table 4 shows representative turnaround times for single-car fertilizer shipments from selected origins to central Iowa destinations. These turnaround times and the multiple-car turnaround times shown in Table 5 are based upon the November 1973 to January 1975 experience of approximately 70 covered hopper cars leased by an Iowa shipper.

ADJUSTMENT FOR MULTIPLE-CAR FERTILIZER SHIPMENTS

The multiple-car shipments analyzed include shipments of 3 to 10 cars and 25 cars. The adjustments applied are analogous to those of multiple-car grain shipments; the one adjustment which differs between the two commodities is considered below.

Item 17. Treatment of Origin or Destination Portion of Freight-Train Car Costs

Table 5 shows representative turnaround times for multiple-car fertilizer shipments from selected origins to central Iowa destinations. As in the single-car adjustments, these turnaround times were utilized to estimate hopper car ownership costs.

Table 4

Representative Turnaround Times for Single-Car Fertilizer Shipments from Selected Origins to Central Iowa in Days

Origin	Turnaround Time
Beatrice, Nebraska	19.6
Sioux City, Iowa	16.0
Omaha, Nebraska	18.6
Fort Madison, Iowa	16.4
Dubuque, Iowa	16.0
Muscatine, Iowa	16.4
Bartow, Florida	37.7
Gulf ports	32.7
Saskatoon, Saskatchewan	36.6

Source: Iowa fertilizer receivers.

Table 5

Representative Turnaround Times for Multiple-Car Fertilizer Shipments from Selected Origins to Central Iowa in Days

Origin	Shipment Size	
	3-10	25
Beatrice, Nebraska	16.6	14.0
Sioux City, Iowa	13.0	--
Omaha, Nebraska	15.6	--
Fort Madison, Iowa	13.5	--
Dubuque, Iowa	13.0	--
Muscatine, Iowa	13.5	--
Bartow, Florida	34.8	26.4
Gulf ports	29.7	22.5
Saskatoon, Saskatchewan	33.6	25.7

Source: Iowa fertilizer receivers.

ADJUSTMENT OF 1972 COSTS TO REFLECT WAGE-PRICE LEVEL CHANGES

The rail costs used in this study are based upon costs reflecting the 1972 operations of all Class I line-haul railways; the ICC Scales contain no adjustments reflecting price changes for subsequent years. The Association of American Railroads (1) annually publishes the distribution of operating revenue and indices of charge-out prices and wage rates experienced by Class I line-haul railways.

Based upon these AAR data, a 1972-1974 price inflator was calculated using a Laspeyre index of the following form:

$$L_{01} = \frac{\sum_i P_{1i} Q_{0i}}{\sum_i P_{0i} Q_{0i}}$$

where

0 = base year

1 = year under consideration,

P = price,
Q = quantity, and
i = index of inputs.

By definition, this index holds the quantity of inputs constant over the two years. Using 1974 as the base year, the estimated change in the railroad cost level from 1972 to 1974 is 30.1 percent; the data used in this estimation were obtained from the 1975 edition of the AAR *Yearbook* (1). This number is interpreted as follows: If a railroad purchased the same quantity of inputs in both 1972 and 1974, it would incur a 30.1 percent cost increase in 1974 relative to 1972.

CALCULATION OF VARIABLE COST

Variable carload unit cost data based upon the 1972 operations of Class I line-haul railways, and published as Table 3 of the ICC Scales, are presented in Table 6. These data are utilized in the calculation of variable cost. Table 7 illustrates this computation for a covered hopper car moving 95 tons of freight a distance of 300 short-line miles in Region V; the terminal and line-haul data are reduced to total variable cost in cents per hundredweight.

Terminal cost is reported in the ICC Scales on a per-carload (Table 6, column 6) and a per-hundredweight (Column 7) basis. Total variable terminal expense in cents per hundredweight (Table 7, line 3) is calculated by dividing the former (Table 7, line 1) by the hundredweight being shipped, and adding this result to the latter (line 2).

Total through train short-line mileage (Table 7, line 12) is calculated by subtracting the average way train short-line mileage of all freight traffic for interline movements in Region V (line 11) from total mileage (line 10). Actual way train and through train mileages are estimated by increasing short-line mileages by the rail circuity factor, thus adjusting for routing circuity; this transformation (lines 13 and 14) is necessary, since the line-haul unit costs reported in the ICC Scales are based upon actual miles.

Line-haul cost for way and through trains is reported on a per-car-mile and per-hundredweight-mile basis. Variable way train line-haul expense in cents per hundredweight-mile (line 6) is calculated by dividing the former (line 4) by the hundredweight being shipped, and adding it to the latter (line 5); total variable way train cost in cents per hundredweight (line 13) is calculated by multiplying this result by actual way train mileage. Total variable through train cost (line 14) is calculated in an analogous manner.

Total variable cost in cents per hundredweight (line 15) is the sum total variable terminal expense (line 3), plus total variable way train cost (line 13), plus total variable through train cost (line 14).

Table 6

Variable Carload Unit Cost by Type of Train
and Type of Equipment
Region V, 1972
(in cents per unit)

Line No.	Type of Train and Equipment (2)	Empty Return Ratio (3)	Variable Expenses: Line-Haul per Car-mile (4)	Variable Expenses: Line-Haul per Cwt.-mile (5)	Variable Expenses: Terminal per Carload (6)	Variable Expenses: Terminal per Cwt. (7)
	Way Train					
24	Hopper-covered	1.00	38.75681	0.01734	9878.926	0.035
	Through Train					
40	Hopper-covered	1.00	31.04552	0.01090	9878.926	0.035

Source: Rail Carload Cost Scales, 1972, Table 3.

Table 7

Calculation of the Variable Cost of Moving a 95-ton Load (1900 cwt.) 300 Short-line Miles in a Covered Hopper in Region V, 1972

Line No.	Item	Source	Amount (cents)
1	Terminal: per carload	Table 3, line 24, col. 6	9878.926
2	per cwt.	Table 3, line 24, col. 7	0.035
3	Total per cwt.	(line 1 ÷ 1900) + line 2	5.23443
4	Way Train: per car-mile	Table 3, line 24, col. 4	38.75681
5	per cwt.-mile	Table 3, line 24, col. 5	0.01734
6	Total per cwt.-mile	(line 4 ÷ 1900) + line 5	0.03774
7	Thru train: per car-mile	Table 3, line 40, col. 4	31.04552
8	per cwt.-mile	Table 3, line 40, col. 5	0.01090
9	Total per cwt.-mile	(line 7 ÷ 1900) + line 8	0.02724
10	Mileage: Total	300	
11	Way train	73 a/	
12	Thru train	227	
13	Way train cost	(line 6 x 1.20[b]) x line 11	3.30587
14	Thru train cost	(line 9 x 1.20[b]) x line 12	7.42009
15	Total cost per cwt.	Sum of lines 3, 13, and 14	15.96039

Note: (a) The average way train mileage of all freight traffic for interline movement in Region V.

(b) The rail circuity factor of a covered hopper for interline movement.

Source: Rail Carload Cost Scales, 1972, Table 3, footnote 1.

RESULTS

The procedure of adjustments outlined above was used to transform the variable carload unit costs of the ICC Scales so as to reflect the cost of transporting corn and soybeans by alternative sizes of rail shipments from all Iowa grain origins with rail service to selected grain markets, and the cost of transporting fertilizer by alternative sizes of rail shipments from five fertilizer origins to all retail and wholesale fertilizer locations with rail service in Iowa. These adjusted unit costs were used to calculate total variable rail cost; Table 8 presents the estimated variable cost of shipping grain from Fort Dodge, Iowa, to selected markets along with the Ex Parte 305-A rail rates which were effective from June 1974 to April 1975. The published rail rates exceed the estimated rail costs for all sizes of shipments for which rates are published.

Table 9 presents the estimated costs of transporting fertilizer from five origins in various sizes of rail shipments to Fort Dodge, Iowa. The published rail rates exceed the estimated rail costs for all single-car rail shipments.

Table 8

Estimated Variable Rail Costs at 1974 Price Levels and Published Rates at Ex Parte 305-A Level of Transporting Corn from Fort Dodge, Iowa to Selected Markets in New Covered Hopper Cars by Size of Shipment in Cents per Hundredweight

Market	One-Way Rail Mileage from Fort Dodge	Shipment Size	Estimated Cost	Ex Parte 305-A Rail Rate
			Cents per Hundredweight	
Sioux City	136	single car	17.4	27.5
		25 car	14.4	28.0
		50 car	13.3	26.0
Omaha	142	single car	18.5	31.0
		25 car	15.2	29.5
		50 car	13.9	27.5
Dubuque	194	single car	19.0	25.5 (a)
		3-10 car	17.2	25.0
		25 car	15.9	25.0
		50 car	14.8	23.5
Keokuk	313	single car	24.3	(b)
		3-10 car	22.6	(b)
		25 car	21.2	(b)
		50 car	19.9	(b)
Chicago Export	380	single car	26.7	35.0
		3-10 car	25.0	(b)
		25 car	23.5	32.5
		50 car	22.0	30.5
Kansas City	338	single car	25.5	41.5
		25 car	22.0	36.0
		50 car	20.5	34.0
Norfolk	1426	85 car continuous	51.5	(b)
Gulf Export	1290	single car	58.7	64.0
		3-10 car	58.4	60.0
		25 car	54.7	58.5
		50 car	51.2	53.5
		85 car continuous	42.5	(b)
Seattle	1984	50 car	78.9	87.5

Note: (a) Mileage rate plus 4.5¢/cwt. cost of leased car.
(b) No published rate.

Table 9

Estimated Variable Rail Cost at 1974 Price Levels and Published Rates at Ex Parte 305-A Level of Transporting Fertilizer Ingredients to Fort Dodge, Iowa in New Covered Hopper Cars by Size of Shipment in Dollars per Ton

Ingredient	Origin	One-way Rail Mileage to Fort Dodge	Shipment Size	Estimated Cost	Ex Parte 305-A Rail Rate
				--Dollars per Ton--	
Phosphate	Bartow, Florida	1821	single car	$17.00	$18.40
			3-10 car	16.74	(a)
			25 car	15.41	(a)
Potash	Saskatoon, Saskatchewan	1245	single car	13.16	19.32
			3-10 car	12.57	(a)
			25 car	11.35	(a)
Urea	Donaldsonville, Louisiana	1258	single car	13.50	18.95
			3-10 car	12.80	(a)
			25 car	11.66	(a)
Ammonium nitrate	Clinton, Iowa	256	single car	4.80	7.09
			3-10 car	4.24	(a)
Ammonium nitrate	Beatrice, Nebraska	290	single car	5.99	7.88
			3-10 car	5.07	(a)
			25 car	4.56	(a)

Note: (a) No published rate.

INTERPRETATION AND USE OF THESE ESTIMATED COSTS

The ICC Scales allow for the estimation of the variable cost of any particular rail shipment. The Cost Finding Section of the Interstate Commerce Commission summarizes the economic significance of variable costs as follows: Variable costs

> . . . provide a minimum below which rates having widespread or general application cannot fall without occasioning an out-of-pocket loss. Since such costs reflect the relative amount of transportation service received by the shipment, they provide a measure, generally in cents per 100 pounds, of the differences in the rates for shipments of varying sizes and lengths of hauls, which can be justified by differences in the cost of performing the service. Any remaining differences in the rates for the several kinds of traffic must be based on considerations other than cost (9, p. 333).

Estimated variable cost can be used as a surrogate of published rail rates. Variable cost embraces joint expenses incurred in a round trip movement of the equipment and is variable with traffic volume relative to a carrier's operations as a whole. Variable cost, although not to be employed for the determination of a rail rate, specifies the lower boundary for a pricing decision. The individual railroad company must determine a certain level over variable cost at which the established rate generates a maximum contribution toward fixed cost and the railroad's net income.

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