ESO 845

FACTORS ASSOCIATED WITH GRAIN RAIL RATES IN THREE U.S. RATE TERRITORIES

By

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Selected Paper Prepared for Presentation at
The Annual Meeting of American Agricultural Economics Association (AAEA)
Clemson University
Clemson, South Carolina
July 26-29, 1981

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ABSTRACT

Through regression analysis the variability of grain rail rates in three rail rate territories was found to be significantly explained by shipment size, traveling distance, and rail rate territory. Study results are discussed as they relate to the Staggers Rail Act of 1980 and alternative pricing policies.

Factors Associated With Grain Rail Rates In Three U.S. Rate Territories

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INTRODUCTION

Efficient grain marketing in the United States is dependent on a transportation system which can effectively move grain from areas of excess supply to areas of excess demand. The "effectiveness" of the transportation system in moving grain involves not only the quality of carrier service, but also the cost of purchasing that service. The decision to ship grain by truck, railroad, or barge to a particular destination depends upon the costs and service characteristics associated with each of these modes. These costs and service considerations may change significantly in the 1980s because of the policy changes approved by Congress with the passage of the Staggers Rail Act of 1980 and the Motor Carrier Act of 1980. The Staggers Act has reduced government regulation of the railroads by permitting, among other things, increased rate making flexibility - a matter of considerable concern to the grain industry.

Since each mode of transportation has different advantages and disadvantages, the level of demand for the services of any particular mode varies widely among grain shippers. Factors such as shipping distance, volume of shipment, region of shipment, and type of grain can influence a grain shipper's decision on market destination and mode of transportation. For example, long-haul grain shippers are likely to demand rail services less when barge

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transportation is available than when it is not available. If barge transportation is not available and shipping by truck should prove too costly, the shippers have little choice but to ship by rail. In this case there is a high demand for rail services. These demand differences among shippers imply that shippers are willing to pay different rates for essentially the same services. Railroad users can be said to have different "values-of-service" for rail transportation; a shipper having a high value-of-service is willing to pay a higher rail rate than a shipper having a low value-of-service.

Rate-making policy has stirred much controversy over whether various sectors of rail traffic are paying a fair share of railroad costs. Because of the high investment expenditures required to maintain and improve rail service, it is difficult to assess what a "fair" allocation of cost would be in the railroad industry.

Since railroads are a primary mode of grain transport, any determination of optimal grain transport systems must begin with a reliable mechanism, capable of delivering accurate rail rate estimates according to specific variable restrictions. A model which yields such estimates for purposes of comparison would be an efficient tool in grain transportation decision-making. The objectives of this study are: (1) to construct a model which uses regression analysis to measure rail rates for grain transportation according to the nature of variables such as shipment size, distance travelled, and region of transport and (2) to determine the implications of these results for the grain industry.

DIFFERENTIAL PRICING AND PRICE THEORY

Economic theory states that a firm within a perfectly competitive industry will maximize revenue by setting prices at the level where marginal cost equals marginal revenue. However, due to the high fixed cost nature of the railroad industry, average costs are usually greater than marginal costs. In this situation marginal cost pricing will not yield revenues sufficient to cover full cost (Figure 1). Under marginal cost pricing, rail rate P_m is determined by the intersection of the marginal revenue curve D and the marginal cost curve MC. Costs exceed revenue by AB amount.

An effective solution to this problem is to base rail rates on "value-of-service" criteria, i.e., implement a method of differential pricing. Figure 1 demonstrates the advantage of employing this strategy. If prices P_m, P_1, and P_2 are charged to different shippers, total revenue obtained would be the area $OP_2EFDGBQ_m$. As long as this revenue is greater than or equal to the area OP_eAQ_m, the differential pricing policy would cover total rail costs.

Figure 2 demonstrates why railroads, with high fixed costs, have more incentive to use differential pricing than transport modes with lower fixed costs. As the quantity of traffic increases for the rail carrier, fixed costs continue to make up a large percentage of total costs. The ability of rail carriers to make downward adjustments in prices is facilitated by the relatively low variable costs which must be covered before contributions to fixed costs can be made.

An alternative to differential pricing is average cost pricing. In Figure 1, adjusting rail rates according to average costs instead of marginal costs reduces the quantity of rail services demanded by shippers. The degree of this reduction depends upon the demand elasticity for rail service in the BC portion of the demand curve in Figure 1.

From this analysis, it is apparent why railroad firms in most cases would prefer a differential pricing approach to rate determination. Marginal and average cost curves are valuable to a strategy of price differentiation in that they serve as points of reference. A firm needs to know the level below which it

Figure 1: Marginal Cost Pricing, Average Cost Pricing, and Value-of-Service Pricing in the Railroad Industry.

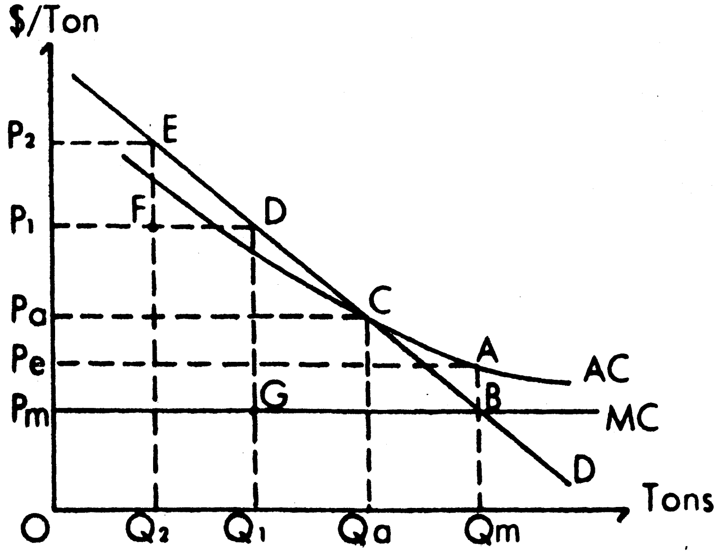
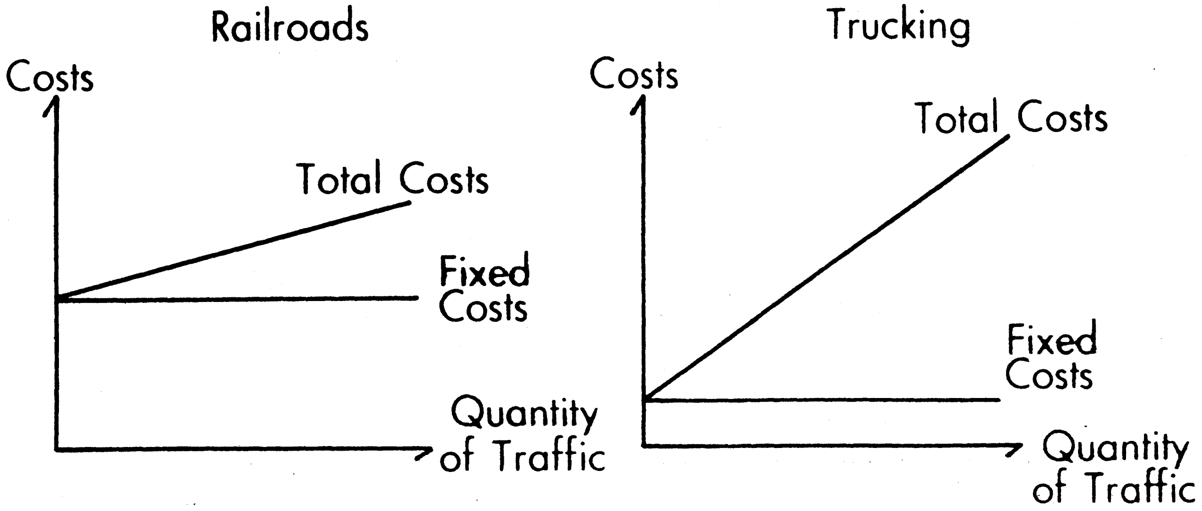


Figure 2: Comparison of Short-Run Cost Structures



should not price services and the percentage that a rate pays of fully distributed costs. Marginal and average cost curves supply this information.

LITERATURE REVIEW

Research has been completed in the areas of cost allocation, resource allocation, and value-of-service pricing policies (1,3,4,5,6). There is little if any information available regarding the specific factors which influence the present rail rate structure. This information would encourage the railroad industry to re-examine its rate structure and determine service areas where formula pricing is more efficient than an individualized pricing strategy.

Mattox and Marien (7) point out that formula rate making is not new. Current thinking in formula rates originated from work done by T.M.R. Talcott of the Norfolk and Western Railway at the turn of the century. Until the early 1950s, railroad rates were largely based on formulas developed by the Interstate Commerce Commission. Since then, individualized pricing has distorted the original smooth rate scales which were developed according to formulas.

Most freight rates today are not derived from formulas and those that have formula relationships have been distorted by the rounding of general rate increases. Yet, while few freight rates have exact mathematical relationships, the concept of formula rates is receiving more attention than ever before. The reasons which Mattox and Marien give for this attention are

- Freight rates have become extremely complicated over the years.
- Determining freight rates takes more time and effort.
- Salaries of rate specialists have gone up.
- Computers have opened up a wealth of possibilities.
- There is an increased need for rate "approximation" by purchasing, sales, production scheduling, and other functional areas of the firm.
- More operations research or management science-type research is now being done in physical distribution which increases the demand for large numbers of freight rate quotations.

While some of the statements made by Mattox and Marien are beyond the scope of this paper, it is important to note that these two authors propose that to begin a movement toward a formula rate structure, present rates must be used.

REGRESSION MODEL

In most cases freight rates form a line or curve when plotted on a graph with distance on the horizontal axis and the rate scale on the vertical axis. The variability of the dependent rate variable is explained through regression analysis. An example of a simple regression equation is:

$$\text{RATE} = b_0 + b_1 * \text{DISTANCE}$$

The intercept value 'b_0', in this case, is interpreted as the fixed cost aspect of the rate and the coefficient 'b_1' is interpreted as the variable cost aspect of the rate per unit of distance.

If more than one pattern of points is evident on a graph, variables can be added to account for intercept and/or slope differences. For example, to account for intercept differences a "zero-one" or "dummy" variable is added to the model for rail rate territories where rail rates for wheat are lower than those for other grains.

Slope differences between two point patterns can be accounted for in a single equation by adding an "interaction" variable to the model. For example, if different sizes of grain shipments were causing two differently sloped point patterns to appear on a rate versus distance graph, an interaction term 'DISTANCE * VOLUME' can be incorporated into the model.

ANALYTICAL METHOD

This study focuses on comparing the grain rail rates in three rate territories; the Western Trunk Line, the Southern Freight Association and the General Freight Traffic Committee. Since rail rates in the New England Territory were similar in terms of distance and size of shipment to those in the General Territory, some rate data from the New England Territory were combined with the General Territory data. Rail rate data for grain shipments in these territories were collected from the Minneapolis Grain Exchange, the Kansas City Board of Trade, and Landmark Cooperative in Columbus, Ohio.[1]

In the General Territory, separate rates were given for 1-car and 3-car shipments. Sample rates were chosen for a single Columbus, Ohio, origin to destinations in Pennsylvania, West Virginia, Maryland, Virginia, Delaware, New Jersey, New York, and all of the New England states. Distances between specific origin-destinations in the sample, range from 116 miles to 1,012 miles. The sample size was 72; 36 destinations, a 1-car rate and a 3-car rate for each destination. Three-car rates were consistently lower than 1-car rates because of the increased efficiencies in handling large volumes of grain.

Because of the infrequency of 1-car grain shipments to the South, Southern territory rates were available for 3-car shipments only. Sample rates in the Southern territory were selected for four origins: (1) Evansville, Indiana, (2) Louisville, Kentucky, (3) Lexington, Kentucky, (4) Cincinnati, Ohio. All of these origins are located along the border of the General and Southern territories. A total of 48 origin-destination combinations were selected with destinations located in Georgia, North Carolina, and South Carolina. Distances between Southern Territory origins and destinations range from 335 to 864 miles.

Rail rates in the Western Territory were selected for origins in Montana, South Dakota, North Dakota, and Minnesota to a Minneapolis, Minnesota, destination. Other Western rates were selected for origins to Wyoming, Nebraska, Missouri, Kansas, and Colorado to a Kansas City, Missouri, destination. All 58 of the

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[1] This investigation is limited in that it is not a comprehensive analysis of all origins and destinations involved in U.S. grain transportation. Unit train rates are another separate entity which was not reviewed.

Western Territory sample observations are 1-car rates. In general, rates are on a single-car basis in the West and Northwest regions of the country. For each origin-destination combination, the Western Territory rate book listed a separate rate for wheat and a separate rate for corn and soybeans. The wheat rate is consistently lower than the corn-soybean rate.[2] Distances between origins and destinations range from 58 to 1,222 miles.

Other information, pertinent to the study:

- to ensure accurate rate comparisons, all rate observations were effective April 1, 1980.
- All distances between origins and destinations were measured using the 1980 Rand McNally Railroad Atlas.

RESULTS AND ANALYSIS

Grain rail rates in the General Territory (rates are the same for all types of grains) were initially analyzed according to a regression model which used distance between origin and destination and shipment size as the independent variables. In a graph of 'RATE' against 'DIST' (distance) (Figure 3), where each point is represented either by a '1' or a '3' according to the size of shipment, two clear point patterns are evident. Each pattern has approximately the same intercept but different slopes. To account for these slope differences, the interaction variable 'DIST * VOL' (distance times volume) was included as an explanatory variable.

The R-square value of 0.974 indicated that 97.4% of the variation in the 'RATE' variable was accounted for by the distance and size of shipment variables. The General Territory equation (with t-statistics given in parentheses below each parameter estimate) was calculated as:

$$\begin{array}{llllll} \text{RATE} = & 42.87494723 & + & 0.09452108 * \text{DIST} & + & 0.02419145 * (\text{DIST} * \text{VOL}) \\ & (33.03) & & (40.04 & & (13.88) \end{array}$$

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[2] In the regression analysis model of Western Territory rates, a 'WHEAT' variable was not statistically significant in explaining rate variation.

Figure 3: Plot of Rate Versus Distance for Single-Car and Three-Car Grain Rail Rates in the General Territory, 1980

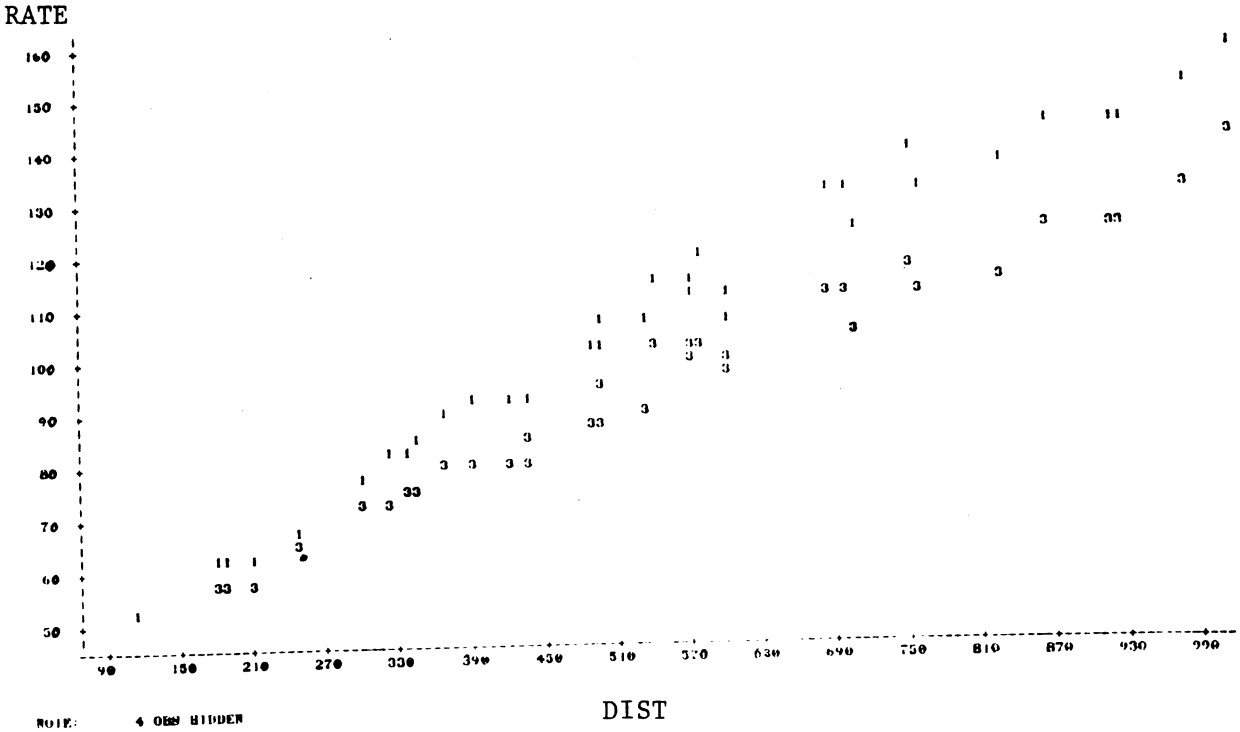
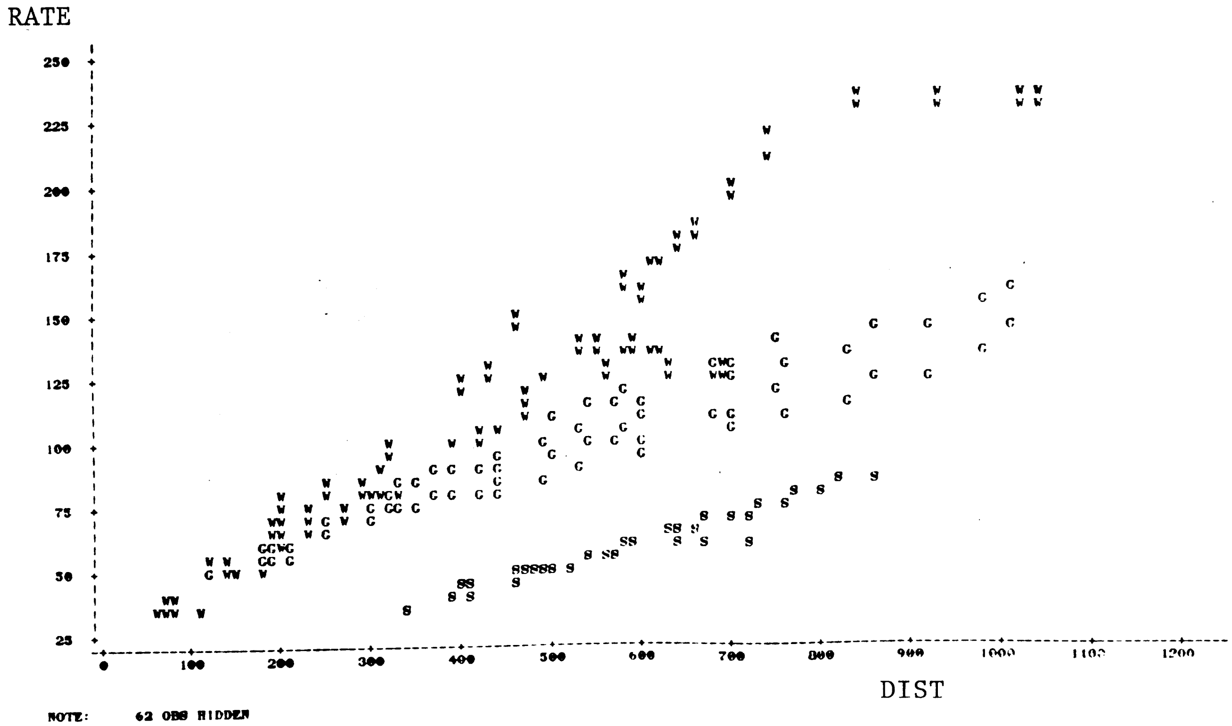


Figure 4: Plot of Rate Versus Distance For Grain Rail Rates in the General, Southern, and Western Territories, 1980.



WHERE: RATE = the dependent variable rail rate in cents per hundredweight.

DIST = the distance corresponding to a specific grain rail rate in the General Territory.

DIST * VOL = the distance corresponding to a specific rail rate for a 1-car grain shipment in the General Territory.

The model indicates an intercept of approximately 42.87 (cents per hundredweight). The coefficient of 'DIST' is the per mile amount associated with a 3-car grain shipment which is slightly over 0.09 cents per hundredweight per mile. To a 1-car shipper, an additional per mile cost is estimated by the coefficient associated with the 'DIST * VOL' variable and equals about 0.02 cents per hundredweight.

ANALYSIS OF THE COMBINED RATE DATA OF THE GENERAL, SOUTHERN, AND WESTERN TERRITORIES[3]

The graph of rate against distance (Figure 4) illustrates the wide disparities for rates among territories. Territorial curve patterns can be distinguished by recognizing that each point is designated by the first letter of the territory it represents. A model was designed which explained rate variations according to six independent variables. In addition to distance, the model includes the variables 'SO-REG' to account for the intercept differences among all three territories.

The other independent variables distinguish between a Minneapolis and Kansas City destination in the Western Territory and between a 1-car and 3-car shipment size in the General Territory. The R-square value of 0.958 indicates the model explains 95.8 percent of rate variation in the sample. The equation for this model was calculated as:

$$\begin{aligned}\text{RATE} = {} & \underset{(17.10)}{43.27430940} + \underset{(21.08)}{0.09366965} * \text{DIST} + \underset{(21.93)}{0.12614420} \\ & * (\text{DIST} * \text{MPLS}) + \underset{(14.14)}{0.9354394} * (\text{DIST} * \text{KS-CITY}) \\ & + \underset{(6.72)}{0.02442343} * (\text{DIST} * \text{VOL}) - \underset{(-5.83)}{18.06851718} * \\ & \text{W-REG} - \underset{(-19.25)}{39.25511437} * \text{SO-REG}\end{aligned}$$

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[3] See Pesch (8) for individual analyses of rate functions for the Southern and Western Territories.

WHERE: DIST = the distance in miles of railroad track corresponding to each sample rate.

DIST * MPLS = the distance for each rate corresponding to a Minneapolis destination.

DIST * KS-CITY = the distance for each rate corresponding to a Kansas City destination.

DIST * VOL = the distance for each rate corresponding to a 1-car shipment in the General Territory.

W-REG = a "dummy variable" equal to 0 unless a Western Territory is designated, whereupon its value becomes 1.

SO-REG = a "dummy variable" equal to 0 unless a Southern Territory is designated, whereupon its value becomes 1.

An important result of this model is that the Southern Territory has the lowest intercept (about 4 cents per hundredweight) of any of the three territories, an indication that of the three territories, the Southern has the lowest fixed charge. As can be seen in Figure 4, rail rates in this territory are substantially below those of the other two territories. The intercept for the Western Territory is also much less than that for the General Territory; however, Western Territory rates, as indicated by the coefficients of the variables DIST * MPLS and DIST * KS-CITY, have a much steeper slope than the rates for either of the other two rate territories. Thus, Western rail rates indicate lower fixed charges and higher variable charges than the rates of the General Territory. The coefficient of the variable DIST * VOL also indicates that 1-car rates in the General Territory are about 0.02 cents per hundredweight greater than the 3-car rates in this territory.

CONCLUSIONS

Specifically, this study has shown that:

1) a few highly significant variables (shipment size, distance traveled and rate territory) can explain variation in grain rail rates with an accuracy which makes formula rate-making a viable alternative to individualized "point-to-point" rate-making practices.

2) value-of-service pricing policies can be observed among railroad rate territories. For similar distances, rates among territories were shown in this study to vary widely.

Value-of-service pricing must be recognized as an important rate-making tool in the railroad industry. The recent Staggers Rail Act of 1980 allows railroad firms broad authority to price services, abandon unprofitable lines, merge with other firms, and sign long-term contracts with shippers. It is hoped that actions by railroad firms which reflect the demand for rail services will boost railroad profits, increase investment, and save the industry from financial ruin. If deregulation succeeds in its goal of restoring financial health to the ailing firms in the railroad industry, then railroad-dependent industries like grain marketing cannot help but benefit in the long run. All of this is expected to make railroad rate-making a more volatile and complex task than it has been previously. Formulas enabling much of this process to be computerized would permit efficiencies to be gained which were not possible under the more regulated rate-making system.

REFERENCES

1. David, Grant M. and Linda J. Combs. "Some Observations Concerning Value of Service Pricing in Transportation." Transportation Journal, Spring 1975.

2. Feldens, Aray M. Transportation Storage Network Analysis of Wheat and Soybeans in Rio Grande Do Sul, Brazil. Ph.D. Dissertation, Department of Agricultural Economics and Rural Sociology, The Ohio State University, Columbus, Ohio, 1978.

3. Griliches, Z. "Cost Allocation in Railroad Regulation." The Bell Journal of Economics, Vol. 3, No. 1, Spring, 1972.

4. Harbeson, Robert W. "Toward Better Resource Allocation in Transport." Journal of Law and Economics. October, 1969.

5. Levin, Richard D. "Allocation in Surface Freight Transportation: Does Rate Regulation Matter?" The Bell Journal of Economics, Spring, 1978.

6. Martin, Michael V. "Misallocative Effects of Value-of-Service Rail Grain Rates." Transportation Journal. Vol. 18, No. 3, Spring, 1979.

7. Mattox, Elmer A. and Edward J. Marien. "Formula Rates: An Idea Whose Time Has Returned?" Traffic World. January 24, 1972, p. 70.

8. Pesch, Michael J. A Model for Estimating Grain Rail Rates. M.S. Thesis, Department of Agricultural Economics and Rural Sociology, The Ohio State University, Columbus, Ohio, 1980.