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The Cost Structure of the U.S. Railroad Industry Under Deregulation*

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ABSTRACT

The concept of revenue adequacy of the railroad industry has been a national goal since 1976. The Interstate Commerce Commission "Constrained Market Pricing" guidelines emphasize increased rates on so-called captive traffic to achieve railroad revenue adequacy. The purpose of the paper is to estimate the potential contribution of cost-saving opportunities to the goal of railroad revenue adequacy.

A simultaneous system of equations of cost and demand functions is estimated by using the jointly generalized least squares method. Economies of traffic density, firm size, and shipment characteristics are estimated and alternative public policies are suggested to help achieve the goal of revenue adequacy by restructuring the railroad industry.

I. INTRODUCTION

Prior to and after World War II, the rate of return on net investment in the railroad industry was very low (Association of American Railroads, *Railroad Facts*). Since 1960, several major railroad companies declared bankruptcy and the Rock Island Railroad was liquidated. Federal regulation was believed to be partly responsible for the low earnings, bankruptcies and liquidation because the regulations made it difficult for railroads to shed unprofitable operations and to adjust quickly to meet shifting demands, intermodal competition and rising costs.

In 1976, the Railroad Revitalization and Regulatory Reform Act (4R Act) introduced the concept of revenue adequacy into railroad rate-making. Revenue adequacy was defined as a level of earnings sufficient to enable a carrier to meet all expenses, retire a reasonable amount of debt, cover plant depreciation and obsolescence, and earn a return on investment adequate to attract new capital. The Staggers Rail Act of 1980, which substantially deregulated the railroad industry, retained the concept of revenue adequacy. In August, 1985, the ICC adopted "Constrained Market Pricing (CMP) to serve as guidelines in determining the reasonableness of rail captive coal rates" to achieve the objective of revenue adequacy (Interstate Commerce Commission, 1985). The ICC has begun to draft rate reasonableness guidelines for non-coal traffic (Traffic World, May 5, 1986).

CMP emphasizes increased freight rates based on the inelastic demand for rail transport of so-called captive traffic. CMP does address the cost side by stating that captive coal shippers should not be required to pay more than is necessary for efficient service where inefficiencies can arise from operating, structural and pricing policies. However, most of the public debate has focused on the price implications of CMP. There has been little research and public debate on the potential contribution of adjustments in the railroad industry to cost reduction and, hence, to railroad revenue adequacy through non-price alternatives.

Several railroad cost functions have been estimated using historical data. Borts conducted a statistical cross-sectional analysis of the variance of freight costs for Class I railroads based on 1950 data. Keeler estimated a Cobb-Douglas multiproduct cost function based on 1968-70 railroad data. Harris estimated a linear cost function using 1972-73 railroad data and included average length of haul as an explanatory variable. Sidhu, Charney, and Due used a linear model to estimate long-run average cost functions for Class II railroads based on the 1968 and 1973 Class II railroads based on the 1968 and 1973 Class II railroad cross-sectional data. Harmatuck argued that inflexible work rules and the standardization of certain railroad operating procedures make it more appropriate to estimate cost functions based on activities. He estimated a joint translog cost function using 1968-70 railroad data. Caves, Christensen, and Swanson (1980) estimated the growth in productivity in the rail industry by fitting a translog cost model to 1951-74 railroad data to estimate the elasticities of total cost with respect to output and factor prices. Friedlaender and Spady estimated a translog cost function of Class I railroads based on 1968-70 cross-sectional data. Caves, Christensen, and Swanson (1981) estimated a generalized translog cost model of Class I railroads based on 1955-74 cross-sectional data. Braeutigam, Daughety, and Turnquist estimated a hybrid cost function for a single railroad firm by fitting a flexible translog model to 1969-77 time series data. They called their model a hybrid because they incorporated engineering information (speed of services) to improve model specification.

Caves, Christensen, Tretheway and Windle argue that the earlier rail cost studies have yielded biased estimates of returns to density. We believe that the earlier studies are of limited value for evaluating alternative policies to deal with the revenue adequacy problems of the railroad industry and deriving the implications of alternative policies on agriculture for the following reasons:

1. All previous studies are based on old data ranging from 1955 to 1974 with 1968–1970 the most popular study years. The structure of today's railroad industry is significantly different from the railroad industry that was analyzed by previous studies.

2. Since the underlying true cost function can not be identified, the earlier studies can only be interpreted for the railroad industry in the time period studied. No conclusions can be drawn outside the data range.
3. Model specification of earlier studies usually includes both capital price and firm size which violates the domain of either a short-run or a long-run cost function. A short-run cost function should not include a capital price variable while a long-run cost function should not include a firm size variable. Moreover, only two of the previous studies use more advanced theoretical specification, more modern functional form and more thorough cost accounting (Caves, Christensen, Tretheway and Windle).
4. Under deregulation, output price and quantity are determined simultaneously and endogeneously. Theoretically, it is more meaningful to estimate cost and demand functions simultaneously.

The purposes of this paper are to estimate a simultaneous system of cost and demand functions of the railroad industry under a deregulated environment, to identify structural changes on the railroad industry that could reduce railroad costs, to formulate public policies that could help achieve revenue adequacy of the railroad industry from a lower cost approach rather than from a higher price approach, and to identify the direction of future research opportunities.

II. A SIMULTANEOUS SYSTEM OF COST AND DEMAND

Since firms in general, and railroads in particular, typically cannot adjust all factor inputs in an optimal fashion in the short run, it is likely that they are operating along an efficient long-run cost function. Thus, estimates of long-run cost functions are often subject to bias because firms are not in long-run equilibrium. Therefore, we specify and estimate the following short-run cost and demand functions:

$$SRTC = f(r_i\text{'s}, Q, S, SC_i\text{'s}, D) \quad (1)$$
$$P = LRMC \quad (2)$$
$$Q^d = f(P, MKTG, D) \quad (3)$$

where:

SRTC = short-run total freight costs,
r_i's = input prices of labor and fuel,
Q = output measured as revenue ton-miles,
S = firm size measured as road miles,
SC_i's = shipment characteristics include average length of haul in miles, load factor measured as net ton-miles divided by gross ton-miles, percent of unit-train operation measured as total unit-train miles divided by total freight train miles,
D = dummy variable for year,
P = price level of rail services measured as average revenue per ton-mile,
LRMC = long-run marginal costs,
Q^d = demand for rail services measured as revenue ton-miles,
MKTG = total marketing expenses measured as the summation of marketing expenses and advertising costs.

A. Model Specification

In the short-run, capital expenditures are fixed and their impact on the short-run cost function depends on the amount of capital rather than the price of the capital. Hence, capital price is not included in our short-run cost model. Firm size in route miles is included as a proxy variable to represent the fixed amount of capital and to reflect the existence of economies of scale as well. Shipment characteristics included average length of haul, unit train miles as a percent of total miles, and load factor. The concept of rate tapering implies that average costs are inversely related to length of haul. Low cost unit-train operations reduce average freight cost. The load factor reflects the mix of commodities as well as the percent of empty car miles. The year dummy variable reflects the intercept differences of the 1983 and 1984 cost functions. The limited number of degrees of freedom prohibits testing for slope differences between 1983 and 1984 and the intercept and slope differences among railroads.

The demand for freight transportation is largely a function of rates. Shipment characteristics, such as length of haul, load factor, and percent of unit-train operation also affect demand indirectly through costs and prices. Therefore, these variables were excluded from the demand function. Competitive truck and barge rates faced by each individual railroad are not available. Marketing expenditures are included in the demand function to identify it from a supply function. A dummy variable is used to reflect the differences in demand among different years.

The linkage between a cost function and a demand function is the firms' pricing behavior. Friedlaender and Spady found that long-run marginal cost pricing without subsidies is both feasible and desirable on higher-density mainline rail routes. They argue that long-run marginal cost pricing for all commodities in the railroad industry is, in principle, feasible but they doubt that either the real world marketplaces or political considerations would actually allow it. Under deregulation, railroads have substantial pricing freedom; hence, since October, 1980, prices have become endogenous variables. Moreover, the actual or potential competition to bring prices down to long run marginal costs is more likely to occur under deregulation and, in fact, rail grain rates have fallen sharply since 1980. As our study is based only on 1983-84 data from deregulated Class I railroads with relatively high traffic density, we assume that pricing behavior is based on long-run marginal costs. This assumption could be very restrictive. In a competitive industry, this will provide a stable equilibrium. A natural monopoly will always result in losses so long as there are too many firms in the industry (Keeler, 1983).

B. Functional Form

There are many functional forms that can meet economic regularity conditions and reflect the characteristics of demand and cost functions of the railroad industry (Berndt and Khaled). Theoretically, one is not likely to identify the best functional form because the underlying true functions are unknown. We selected the translog function as our cost model because the translog function is a second order approximation of Taylor's expansion of an arbitrary function, and also because it was used in almost al previous rail cost estimations, and thus our results can be more readily compared with those of previous studies.

Rail transport services are inputs into other industries. Therefore, the demand for rail services are derived demands from the using industries. Assuming that the cost functions of other industries can be approximated by a second order approximation of Taylor's expansion, the input factor demands for rail services are first order approximations of Taylor's expansions. Hence, we select a Cobb-Douglas model to estimate the demand function, as the Cobb-Douglas model is a first order approximation of Taylor's expansion of an arbitrary function.

Based on Shepherd's lemma, input share functions can be derived from a translog function by taking a partial derivative with respect to the input price.

Based on the envelop theorem, the long-run marginal cost function can be derived from the short-run cost function by taking a partial derivative of the short-run cost function with respect to firm size to find the optimal firm size and inserting the optimal firm size into the short-run marginal cost function to derive a long-run marginal cost function. Hence, the whole system based on a translog cost function is as follows:

$$
\begin{aligned}
SRTC = {} & \alpha_0 + \Sigma\alpha_i \ln(r_i) + \alpha_Q \ln(Q) + \alpha_S \ln(S) \\
& + \Sigma\alpha_{SCi} \ln(SC_i) + \tfrac{1}{2}\Sigma\alpha_{ii} \ln(r_i)\ln(r_i) \\
& + \tfrac{1}{2}\alpha_{QQ} \ln(Q)\ln(Q) + \tfrac{1}{2}\alpha_{SS} \ln(S)\ln(S) \\
& + \tfrac{1}{2}\Sigma\beta_{ii} \ln(SC_i)\ln(SC_i) + \beta_{ij} \ln(r_i)\ln(r_j) \\
& + \Sigma\beta_{iQ} \ln(r_i)\ln(Q) + \Sigma\beta_{iS} \ln(r_i)\ln(S) \\
& + \Sigma\Sigma\theta_{ij} \ln(r_i)\ln(SC_j) + \theta_{QS} \ln(Q)\ln(S) \\
& + \Sigma\theta_{Qi} \ln(Q)\ln(SC_i) + \Sigma\delta_{Si} \ln(S)\ln(SC_i) \\
& + \Sigma\Sigma\delta_{ij} \ln(SC_i)\ln(SC_j) + \tau D
\end{aligned}
$$

$$
\begin{aligned}
Share_i = {} & \alpha_i + \alpha_{ii} \ln(r_i) + \beta_{ij} \ln(r_j) + \beta_{iQ} \ln(Q) \\
& + \beta_{iS} \ln(S) + \Sigma_j \theta_{ij} \ln(SC_j)
\end{aligned}
$$

$$
\begin{aligned}
P * Q/SRTC = {} & \alpha_Q - \theta_{QS}\alpha_S/\alpha_{SS} + (\alpha_{QQ} - \theta_{QS}\theta_{QS}/\alpha_{SS}) \ln(Q) \\
& + \Sigma(\beta_{iQ} - \beta_{iS}\theta_{QS}/\alpha_{SS}) \ln(r_i) \\
& + \Sigma(\theta_{Qi} - \delta_{Si}\theta_{QS}/\alpha_{SS}) \ln(SC_i)
\end{aligned}
$$

$$
\ln(Q) = \lambda_0 + \lambda_1 \ln(P) + \lambda_2 \ln(MKTG) + \lambda_3 D
$$

III. ESTIMATION PROCEDURE AND HYPOTHESIS TESTING

The seemingly unrelated regression technique (Zellner) was used to estimate the cost function, share functions, pricing identity, and demand function as a single multivariate system. The seemingly unrelated regression technique will increase the efficiency of the estimation as long as restrictions across equations are imposed and covariances among equations do not equal zero.

Each variable has been rescaled by its geometric mean which permits us to interpret the results as an approximation to the true underlying cost function in the neighborhood of this point. Prediction outside the data range is, however, of limited meaning. Total cost and demand were deflated by output level and firm size, respectively, to obtain average costs and demand per route mile. Total way and structures costs were deducted from total costs. Hence, we are implicitly assuming that railroad firms are in disequilibrium with respect to the stock of way and structures. Moreover, restrictions across equations were imposed to satisfy the economic requirements of linear homogeneity in input prices and pricing behavior assumption.

The Glejser's test of heteroscedasticity is performed against output level and firm size, respectively. The validity of the model is tested by comparing the predicted values with the actual values of the cost and demand functions.

A cost function corresponds to a homothetic production structure if, and only if, the function can be written as a separable function in its output level and factor prices. Hence, homotheticity of the cost function is determined by testing $\beta_{iQ} = 0$ for all input i. A homothetric cost function can be a homogeneous function if, and only if, the elasticity of cost with respect to output is constant. Hence, homogeneity is determined by testing $\alpha_{QQ} = \beta_{iQ} = \theta_{QS} = \theta_{Qi} = 0$. If all parameters of the second order terms are equal to zero, the translog will be reduced to a Cobb-Douglas. Hence, the fit of a Cobb-Douglas function to the railroad data is determined by testing whether all parameters of the second order terms equal zero.

The elasticities of substitution and input demand elasticities in terms of cost function developed by Uzawa are estimated based on the following equations:

$$
\begin{aligned}
e_{ij} &= (CC_{ij})/C_iC_j) = b_{ij}/(S_iS_j) + 1 \\
e_i &= (b_{ii} + S_i(S_i - 1))/S_i
\end{aligned}
$$

Economies of firm sizes are estimated by taking a partial derivative of the short-run average cost function with respect to firm size while holding the traffic density constant and then adjusted by the way and structures effects. Economies of traffic density and shipment characteristics are estimated by taking a partial derivative of the short-run average cost function with respect to output and shipment characteristics, respectively, and then adjusted by the way and structures effects.

IV. DATA

The data in this analysis were taken from 1983 and 1984 railroad statistics (Association of American Railroads, January 1983 and June 1983). Beginning in 1983, the railroad industry changed from a retirement, replacement, betterment accounting system to a depreciation accounting system; thus, 1983 and 1984 data were not comparable with previous data. Moreover, the Staggers Act was enacted in October, 1980, and assuming the railroad companies needed time to adjust to the deregulated environment, the 1983 and 1984 data are the latest available comparable data which reflect the impacts of railroad deregulation.

Total short-run costs are defined as total annual freight operating costs. Way—the track—and structures costs are the sum of way and structures depreciation and interest. Output level is measured by total revenue ton-miles. Firm size is measured by route miles in service. Percent of unit-train operation is estimated by dividing total unit-train miles. Unit-train miles were collected by the Association of American Railroads (AAR) according to the ICC definition. Marketing expenditures include marketing, advertising, and public relations costs. Price (freight rate level) is measured by revenue per ton-mile. All data were available from the AAR, except marketing expenditures, which were available from the AAR, except marketing expenditures, which were obtained from ICC reports (U.S. Interstate Commerce Commission 1980 and 1981).

There were 30 and 28 Class I railroads in 1983 and 1984, respectively. The Western Maryland Railway Company was included in the reports of the Baltimore & Ohio Railroad Company in 2983. The Elgin, Joliet and Eastern Railway Company was excluded because it is primarily a switching railroad serving the Chicago area. Hence, we have 55 observations for these two years.

V. THE RESULTS

Table 1 presents the results of structure and goodness of fit tests of the model. The tests for homothetic and homogeneous procution structures were accepted. The test for functional form indicates that the translog model fit the railroad data better than the Cobb-Douglas model. The heteroscedasticity test indicates that heteroscedasticity did not exist in the railroad data with respect to either output levels or firm size.

The validity of the whole system is tested by comparing the actual cost and demand values with the predicted cost and demand values. The results indicated that the differences between actual cost and predicted cost, and actual demand and predicted demand were both insignificant.

Table 2 presents the coefficients of the cost and demand models. All first order variables in the short run average cost model were significant at the five percent level. The signs indicate that short run average costs increase as labor and fuel prices and size of firm increase. Short run average costs decline as quantity, length of haul, unit trains and load factor increase. Input share equations can be derived directly from the cost function. The only significant variables in the input share equations are the intercepts and length of haul. Fuel share increases directly and labor share varies inversely with length of haul.

Price—freight rate—was the major variable that significantly explained the variance among railroads' demands. As a large portion of the commodities carried by railroads are relatively low value, high volume commodities, it seems reasonable that shippers' selection of transport mode is based heavily on freight rates.

Table 3 presents the estimated elasticities at the mean values. The elasticity of substitution between labor and fuel and the own factor demand elasticities were insignificant. The estimated elasticities of traffic density and shipment characteristics indicate that average cost declined significantly with increases in traffic density, average length of haul, unit train operations and load factor. Load factor was the most

TABLE 1
Test results of goodness of fit and structure of the model.

Hypothesis	F value
1. Short-run homothetic production structure	0.014
2. Short-run homogeneous production structure	0.764
3. Cobb-Douglas vs. the translog	2.645*
4. Heteroscedasticity	
a. output	0.48
b. firm size	0.32
5. Validity of the model	
a. cost function	0.38
b. demand function	0.23

*Significant at 5 percent level.

TABLE 2
Estimated coefficients of the cost and demand models.

Model	Variable	Parameter estimate	Standard error
Cost	Intercept	-0.338	0.027*
	r_1 (labor price)	0.863	0.034*
	r_2 (fuel price)	0.137	0.034*
	Q (output in ton-miles)	-0.157	0.022*
	S (size in road miles)	0.163	0.030*
	SC_1 (length of haul)	-0.217	0.067*
	SC_2 (percent of unit-train)	-0.112	0.017*
	SC_3 (load factor)	-1.445	0.298*
	Q x Q	0.028	0.011*
	Q x S	0.020	0.026
	Q x SC_1	0.020	0.038
	Q x SC_2	-0.002	0.005
	Q x SC_3	-0.185	0.141
	Q x r_1	0.014	0.056
	Q x r_2	-0.014	0.056
	S x S	-0.019	0.036
	S x SC_1	0.146	0.060*
	S x SC_2	0.016	0.006*
	S x SC_3	-0.313	0.207
	S x r_1	0.035	0.063
	S x r_2	-0.035	0.063
	SC_1 x SC_1	-0.182	0.078*
	SC_1 x SC_2	-0.316	0.011*
	SC_1 x SC_3	-0.388	0.456
	SC_1 x r_1	-0.291	0.057*
	SC_1 x r_2	0.291	0.057*
	SC_3 x SC_2	0.198	0.086*
	SC_3 x SC_3	-0.530	0.785
	SC_3 x r_1	-0.055	0.215
	SC_3 x r_2	0.055	0.215

TABLE 2
Estimated coefficients of the cost and demand models. (Continued)

Model	Variable	Parameter estimate	Standard error
	$SC_2 \times SC_2$	-0.019	0.003*
	$SC_2 \times r_1$	0.001	0.009
	$SC_2 \times r_2$	-0.001	0.009
	$r_1 \times r_1$	0.143	0.142
	$r_2 \times r_1$	-0.143	0.142
	$r_2 \times r_2$	0.143	0.142
	D_1 (year)	0.057	0.026*
Demand	Intercept	-0.358	0.233
	P	-0.592	0.186*
	MKTG	0.029	0.040
	D	-0.057	0.097

*Significant at 5 percent level.

TABLE 3
Estimated elasticities at mean value.

Elasticity	Coefficient	Standard error
1. Elasticity of substitution between labor and fuel	-2.18	3.16
2. Factor demand elasticity		
a. labor	-0.21	0.28
b. fuel	-0.68	1.58
3. Elasticity of traffic density	-0.19	0.03*
Elasticity of firm size	0.01	0.04
Elasticity of length of haul	-0.26	0.08*
Elasticity of unit trains	-0.13	0.02*
Elasticity of load factor	-1.73	0.36*

*Significant at 5 percent level.

TABLE 4
Comparison of returns to scale and density from previous studies.

	Economies of density	Economies of firm size	Data base years
Friedlaender and Spady (1981)	-0.14	-0.02	1968-70
Caves, Christensen, and Swanson (1981)	0	-0.01	1955-74
Harmatuck (1979)	-0.48	0.08	1968-70
Harris (1977)	-0.42	-0.03	1972-73
Keeler (1974)	-0.44	-0.01	1968-70
Caves, Christensen, Tretheway, and Windle (1984)	-0.43	0.02	1951-75
Lee and Baumel (1986)	-0.19	0.01	1983-84

important variable affecting average variable costs. The estimated elasticity of firm size were not significant. Although we did not estimate the minimum efficient traffic density, one might conclude that at current traffic levels, the economies of traffic density were not exhausted in 1983 and 1984. The minimum traffic density level where economies of density are exhausted should be higher than current traffic levels in those years.

VI. COMPARISON WITH OTHER STUDIES

Table 4 compares the estimated elasticities of density and firm size of seven studies along with the base data years. The estimated returns to firm size vary little among the seven studies. Four of the six pre-Staggers data studies found substantial returns to density while Caves, Christensen and Swanson (1981) found no returns to density and Friedlaender and Spacy found modest returns to density. Our results show higher returns to density than Friedlaender and Spady but lower than Caves, Tretheway and Windle, Harmatuck, Harris, and Keeler. Moreover, our results confirm that returns to density have not been exhausted under deregulation and returns to firm size are not significant.

VII. CONCLUSIONS AND POLICY IMPLICATIONS

The 4-R Act and the Staggers Rail Act of 1980 established a national goal of railroad revenue adequacy. The ICC has established Constrained Market Pricing guidelines on coal and is developing similar guidelines on non-coal products. These guidelines would mainly achieve revenue adequacy through rate increases on commodities with relatively inelastic demands for rail transport. There is less emphasis on the role of cost reduction in achieving railroad revenue adequacy.

The purposes of this paper are to estimate the cost reduction potential of further structural adjustments in the railroad industry, to identify alternative public policies that could be pursued to help the railroad industry achieve revenue adequacy through lower costs rather than from higher rates, and to identify additional research needs to help achieve these objectives. The reason for the analysis is that previous studies are based on single equation models and out-of-date data that do not reflect the deregulation of and the major structural changes in the railroad industry in the 1970s.

Our results indicate that, on the average, a one percent increase in traffic density will decrease short-run costs by 0.19 percent. These results suggest that deregulation and the massive structural adjustments in the railroad industry from 1950 to 1980 have not exhausted the economies of density. Historically, railroads have attempted to increase traffic density by abandoning rural branch lines. Shippers, in general, have vigorously resisted rail line abandonment. More recently, railroad companies have attempted to increase traffic density by selling low density lines to short line or regional railroads that presumably have lower cost structures. Increasing density through abandonment or sale of low density rail lines has been attractive to railroad management because these methods not only reduce costs and increase profits, but also reduce net investment which further increases return on investment and hence revenue adequacy.

Short-line railroads operating in rural areas have generally not been profitable. However, the Staggers Rail Act of 1980 permits newly formed short line and regional railroads to operate without labor contracts and without honoring prior labor agreements. While these newly formed railroad companies have lower labor costs, they generally face high debt loads and declining agricultural and manufacturing traffic levels since 1980. If successful, these railroads will fill the need of serving lower traffic rural lines and still allow the Class I railroads to lower their average costs by shedding these lines to increase traffic density. If these short line and regional railroads fail, returns to density will likely drive the railroads to further rail abandonment.

Our results show no railroad economies of size. At the same time, the economies of length of haul were significant and substantial. These findings suggest that mergers to increase size have little impact on costs but mergers could have a significant impact on costs if they result in increased length of haul and density.

The most substantial cost reducing option in the model is the load factor. A one percent increase in load factor results in a 1.73 percent decrease in average short-run costs. There are numerous opportunities to increase the load factor. Examples include loading grain and fertilizer cars to capacity, utilizing back hauls such as shipping meat in empty refrigerator cars, shipping fertilizer in empty grain cars, and placing leased rail cars in railroad car pools to reduce the empty mileage. One railroad company recently reported that a sample of 759 randomly selected loaded trailers moving on railroad flat cars on the average used only 60 percent of the trailers' cubic capacity and only 68 percent of the weight capacity (Traffic World, June 10, 1986). While some shippers utilize a limited amount of trailer on flat car shipments, fuller utilization of the capacity would reduce average costs and allow the railroad industry to achieve revenue adequacy at lower rate levels. Moreover, the railroad industry could contribute to the load factor by using incentive and contract rates to encourage fuller utilization of rail car and trailer capacity and by increasing computer-to-computer data exchange among railroads, between railroads and truckers, warehouses and shippers to fully utilize rail car capacity and to reduce empty miles. More computer-to-computer data exchange could also increase length of haul and density as a partial substitute for mergers and rail abandonment.

The economies of unit trains are significant but less substantial than density, length of haul and load factor. Major progress has been made in unit train utilization. One railroad firm had over 50 percent of its total car miles in unit trains.

In summary, the railroad industry has substantial opportunities to reduce costs. Most of the opportunity is in increasing load factor and length of haul. Lesser opportunities are in increased density and further expansion of unit trains. Captive shippers can lower their concerns about railroad pricing powers by helping the railroad industry realize these cost savings to increase profits and revenue adequacy.

VIII. OPPORTUNITIES FOR FURTHER RESEARCH

Economists have substantial research opportunities in transportation even though transportation problems are less severe than they were in the 1970 decade. First, little is known about the cost structure of newly formed short line and the rapidly growing regional railroads. Cost studies of these railroads would provide information on the probability of these railroads successfully filling the vacuum created in rural areas as Class I railroads continue to shrink in size to take advantage of economies of density.

Secondly, no research has been conducted on the impacts of alternative shippers' production and price policies on the structure of the Class I railroads, regional and short line railroads and other transportation industries. These policies could have substantial impacts on the structure and costs of the railroad industry.

Third, as more post deregulation and post depreciation accounting data become available, future research on the cost structure of the railroad industry should emphasize the problem of pooling time series and cross sectional data. Moreover, as additional years of data become available, the additional data will provide the degrees of freedom needed to experiment with models to deal with what Caves, Christensen, Tretheway and Windle refer to as unobserved network effects.

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ENDNOTES

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