A Statistical Sketch of Intercity Freight Demand

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•SUCCESSFUL STUDIES of the demand in other transport markets have been made, but no satisfactory efforts to model the demand for intercity freight traffic are known to the author. The recent effort by Sloss is noted (1), but difficulties, thought to be present in his techniques, may vitiate the results. This paper tries to fill this obvious gap. The estimates of the parameters of the rail and truck demand functions produced here do more, though, than fill a gap. They point to a number of interesting facts about intercity freight demand—facts not easily anticipated. It will be possible to make statements about the logic of the rate policies pursued by the two dominant freight modes during the postwar period and extrapolate these facts into tentative recommendations for future policies for both the carriers and the Interstate Commerce Commission (ICC).

The technique used in the present effort is regression analysis on time series for the period 1947 through 1966. Regression analysis is applied to obtain estimates of the income elasticity of demand, the price elasticity of demand, and the cross-price elasticity of demand for each of the two modes. Before the estimates and their significance are reported, there are a variety of issues to be considered concerning the sources for the data and potential problems common to the statistical techniques used.

Considerable care is taken in the selection of the data to be used. It is desired to employ absolutely the best data available so that the resulting estimates are in some sense definitive and as accurate as the historical record permits. The first decision is whether the analysis should be performed on a time series or on a cross section. The available data offer no choice. To obtain sufficient observations in cross section would require the use of the individual companies as the units of observation. This is not feasible. There are no statistics on the level of rates charged by individual carriers; further, if such information were available, it would reveal no (or little) internal variation, because in both the railroad and trucking industries the rates are set by regional rate bureaus so that interfirm variation does not exist. For the most successful effort to obtain cross-section estimates of the parameters of rail demand, see Roberts (2). The choice of time-series analysis is dictated.

The structure of the transport market is continually evolving, so that an ambiguity of using time-series data in the analysis is the applicability of parameters derived from the 20-year past to the short-run rate questions of the moment. Other considerations involved in the statistical techniques employed are postponed until the data series have been described.

THE DATA

The dependent variable in all our equations is the volume of freight offered for carriage by some sector of the economy to either of the two modes, rail or truck. Each year since 1923, the ICC has published Freight Commodity Statistics of Class I Railroads in the United States in which is reported the number of tons originated for each of 242 commodities that the railroads have hauled. These 242 commodities are aggregated into five commodity groups, on each of which the analysis has been performed. The groups are Products of Agriculture (hereafter cited as Agriculture), Animals and Products (Animals), Products of Forests (Forests), Products of Mines (Mines), and Manufactures and Miscellaneous (Manufactures). The ICC reports the freight volumes

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in tons only and takes no account of the distance the traffic has moved. For all 242 commodities taken together (hereafter cited as All Traffic), the ICC reports both tons and ton-miles of traffic moved. Where this information is available we estimate all equations twice, using both tons and ton-miles as the dependent variable. In fact, the choice of variable makes little difference in the results.

In 1965 the ICC discontinued the 242-commodity classification and the five commodity groups and instituted a new classification, the Standard Transportation Commodity Code (STCC). Using a splice of the old code and the STCC prepared by the Association of American Railroads, we reconstruct the 1965 and 1966 volumes of traffic for the commodities in each of the five commodity groups.

Data on truck freight volumes are far less complete. Trucking is dominated by private truckers who are under no obligation to report their activity to the ICC. The accepted estimates of truck volumes, including both regulated and unregulated carriage, are those published by the Transportation Association of America (TAA) in its annual pamphlet Transportation Facts and Trends. The TAA is a Washington lobby and research organization of the entire transportation industry so that there is no apparent incentive for it to slant its estimates. Accordingly, we use its estimates. The volumes are not disaggregated by commodity type, so that we cannot estimate equations for truck volumes corresponding to the rail equations by commodity group. Further, the TAA reports truck volumes in ton-miles only. However, to maintain full comparability between the truck and rail results as far as possible, we estimate the truck equations using both tons and ton-miles as the dependent variable. For this purpose, we obtain estimates of the truck volumes in tons by dividing the ton-mile figures reported by TAA by estimates of the average length of haul of truck freight for the corresponding years. The annual estimates of average length of truck haul are taken from a pamphlet, Motor Truck Facts, issued annually by the American Automobile Manufacturers Association.

There are as many considerations that complicate the choice of time series for the independent variables. To estimate price and cross-price elasticities requires rail and truck price indexes. In the selection of the rail price series we are presented with alternatives. On the one hand there is what we shall call the Ex Parte Price Index. Since World War II all general rate changes have been granted to the railroads by the ICC in ex parte proceedings. The ex parte changes have generally been allowed as percentage rate increases, uniform over a wide group of commodities. Since 1947 there have been 18 of these ex parte increases (all general rate changes have, in fact, been rate increases). If we begin by setting the 1947 rate at 100 percent and then compound this with the ex parte increases as they have taken effect over the years, we generate what we have called the Ex Parte Price Series.

Its usefulness as the price series for our final demand equations is marred by the fact that the railroads, in thousands of applications to the ICC, have put into force highly selective rate reductions (and some increases) that applied alone to very specific movements. Most of these selective rate changes have been made to improve the competitive posture of the railroads in specific situations; our ideal rail rate index should take these changes into account.

The ICC has in fact issued a little known rate index that does this job. The index, known as the RI-1 index, was issued for the years 1947 through 1966 as part of the Rail Waybill Study. The index was computed by taking the 1950 traffic movement shown by the 1950 Waybill Sample. This basic package of movements has then been revalued each year using the average revenues from corresponding movements for each year as the appropriate rates. The RI-1 index of rail rates on All Traffic was computed annually up through 1966. We require, in addition, price series for the five commodity groups and for the regions whose rail demand equations we are estimating. The RI-1 index was computed for each of these groups, but only up to 1961 for the commodity groups and to 1963 for the regions. We extrapolate these indexes for the years 1962 through 1966, constraining the estimates of each year to average out to the figure for the rate level on All Traffic in that year.

We require also a truck rate series. Again we have a choice from two possible series. One of these corresponds to the rail Ex Parte Rate Index described earlier.

It is a chronology of the across-the-board rate increases put into effect by the truck rate bureaus. Two such chronologies, for two different motor-carrier rate conferences, have been prepared by Josephine Olson for Del Steiner of Washington, D. C. They are nearly identical, suggesting that the different rate bureaus adhered to a common pattern of rate increases during the postwar period. This index of truck rates suffers from the same shortcoming as the Ex Parte Rate Index for railroads, namely, the failure to incorporate numerous specific rate reductions. Further, it takes no account of the imputed revenues of private and contract motor carriers.

There is, however, no analogue to the RI-1 rate index for the trucking industry, because the ICC has not made any waybill study of the trucking industry. The closest approximation to such an index that can be formed from the data available is the annual series of average revenue per ton-mile for truck freight. This is found by dividing the estimates of the total annual revenues of the trucking industry (including imputations for private trucking), as reported in the TAA's Transportation Facts and Trends, by the estimates of the number of ton-miles hauled by all trucks, as reported in the same source.

The shortcomings of this truck rate index relative to the RI-1 index of rail rates are twofold. First, it fails to maintain its weights constant from year to year, so that changes in the aggregate composition of truck traffic, as well as changes in the level of rates, are reflected in the year-to-year changes of average revenue per ton-mile. Second, we are without the data to specialize this index of truck rates by commodity groups as we have been able to do with the RI-1 index. For all its inadequacies, it is the best index available.

We need now only the time series that will permit estimates of income elasticities. For estimating the demand functions for All Traffic by rail and by truck we have selected gross national product (GNP) as our income series. GNP is entered in constant 1958 dollars, so that our regressions will be relating changes in traffic volumes to changes in the real income of the country. We deliberately do not adjust the GNP series in such a way as to make it an index of the production of physical, and hence transportable, output. Thus the substitution in the economy during the postwar years toward increasing the share of private and governmental services will be reflected in a lower income elasticity.

For estimating the regional income elasticities of rail freight demand we specialize GNP to represent gross regional products by multiplying the GNP series by the percentage of personal income accounted for by the states of each region for the respective year. The personal-income-by-state data have been taken from the U. S. Statistical Abstract. There is no better way to obtain gross regional products.

For estimating the demand equations for the five commodity groups, appropriate indexes of production have been entered in lieu of income series. Thus, for example, the volume of Products of Agriculture hauled by railroads is regressed on an Index of Crop Production compiled by the U. S. Bureau of the Census. The exact indexes of production, their sources, and the raw data series themselves are all given in the tables in Appendix A.[1] It is correctly observed that the substitution toward services and away from goods in the economy will not be reflected in the coefficients of these indexes of production; hence, these income elasticities will measure the performance of the railroads in increasing their traffic against the increase in output of physical goods potentially available to the railroads as traffic. To make a visual comparison of the trends of railroad rates and volumes during the postwar period easier, we have graphed a large number of these basic series. These graphs are shown in Appendix B.[1]

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[1] The original manuscript of this paper included Appendix A, tabulations of historical data, and Appendix B, graphs of historical data. The two Appendixes are available in Xerox form at cost of reproduction and handling from the Highway Research Board. When ordering, refer to XS-27, Highway Research Record 296.

STATISTICAL TECHNIQUE

We have committed ourselves to the use of regression analysis on time-series data. This method is frought with hazards that we would do well to examine.

We have specified the explanatory variables of our equations but have not specified the form in which they are to be entered. One obvious choice is between entering the data in natural form or in logarithmic form. The advantage of the latter is that the resulting coefficients are elasticities. Elasticities are desirable in that they are familiar as parameters of demand, and also in that they do not need dimensions (units of measurement). As desirable as the log form may be, that is not assurance that it is the better form to use, for we do not know that a straight line in log space fits the data as closely as a straight line in the space of natural numbers. This must be tested. Our choice between log and natural forms should be guided by our expectations as to the nature of the disturbance process. If the variance of the error terms were thought to be roughly constant over the interval of observations (in natural numbers), then regression using the natural numbers would preserve this homoscedasticity. If, on the other hand, the variance were thought to increase proportionally to the values of the arguments (i.e., constant coefficient of variation), then regression in log space would create homoscedasticity.

Because there is no a priori reason for suspecting one scheme of disturbances over the other, the best procedure is to test both models and choose the better after a comparison of the distribution of the residual terms. Three of the demand equations are estimated in both natural and logarithmic form. Examination of the residuals and coefficients of determination in each of the three cases yields the same conclusion: There is no marked tendency for either form to provide a better fit to the data. For reasons suggested then, the log form is chosen.

Examination of the residuals in this experiment provides still another important result: the absence of autocorrelation in the residuals. This obtains in all of the equations in which two or three arguments are used and in which reasonably high estimates of R^2 are obtained. The absence of autocorrelation has important implications. It suggests that we have escaped the "time-series problem"—the correlation of residuals resulting from the dependence of successive observations on each other. By taking observations on annual data, as opposed, say, to monthly data, we avoid the reduction in the effective degrees of freedom that such dependence implies. The absence of autocorrelation also suggests that no important explanatory variables are omitted from the explanatory set.

Another hazard attending the use of time-series data is the possibility of lagged adjustments, in this case, the possibility that traffic volumes of one year are determined by the prices of the prior year(s). The collinearity of prices and of lagged prices together with the shortness of the time series precludes testing for the appropriate lag structure. It is assumed that a year is sufficiently long and that volumes adjust to prices within the year.

The inclusion of the competitor's price level and an index of production in addition to own-price level in the explanatory set is sufficient to identify the relationship being estimated as a demand rather than a supply relationship. But it seems likely before the estimation is carried out that the price of so fully identifying the relationship will be excessive multicollinearity among the arguments. We are prepared to move in two directions to combat multicollinearity should it appear.

Of particular interest in this exercise is the effect of the competing mode's rate level on the volume of traffic hauled by the other mode, i.e., the cross-price elasticity. It would be disastrous therefore if the two price series proved collinear. One way to resolve this problem should it occur is to transform the two price series into two new orthogonal series in such a way that one of the new series highlights any divergences in the two original series. This was done by forming, from the original rail and truck rate series, an average rate series and a truck-to-rail rate ratio series. If the coefficient of the rate ratio term proves significantly different from zero, this is strong evidence that the cross-elasticity is significant. A second way to combat multicollinearity should it appear is to use more sophisticated regression techniques, such as constrained regression or Bayesian prior distributions, on the coefficients. Jumping ahead to our results momentarily, we find that excessive collinearity is not a problem, so that there is no need to use the Bayesian or the constrained regression techniques. Because of the importance of testing for cross-elasticity, however, we do perform the regressions with the transformed price series in addition to the regressions with the regular price series.

We discuss a final possible hazard in our regression procedures before proceeding to the results. It is quite probable that in our model causality flows in both directions, traffic volumes influencing price as well as price determining traffic volumes. If so, we may incur least-squares bias as a result of correlation between the independent variable and the error term. The correction for this is reformulation of our model into a system of simultaneous equations, the other equations modeling this reverse flow of causation. In what follows, we proceed with a single equation in the belief that this reverse flow of causation is not of the same order of magnitude as the one we are modeling. Short of building a complete model of the demand for intercity freight transportation, what follows is believed to be the most accurate estimation of the parameters of aggregate demand for rail and truck freight service that is possible with any existing statistics.

THE RESULTS

Altogether, a total of 12 markets are studied (Table 1). For each of the 14 dependent variables two sets of equations are estimated. The three explanatory variables of each of the two sets are:

Set A:	Set B:
own rate	average rate level
competing mode's rate	truck-to-rail rate ratio
index of production or GNP	index of production or GNP

The three explanatory variables of each set are entered in every possible combination—one at a time, two at a time, and all three at once. This means that 7 equations are estimated for each of the sets of explanatory variables. Thus, each of the 14 dependent variables is the dependent variable for two sets of 7, or 14, equations. All the equations so estimated are displayed in the tables in Appendix C. The dependent variable of each table is shown at the top of the page. Each line of the table shows the coefficient(s) (elasticities) of the explanatory variable(s) entered in one equation. The standard error of each estimate is placed beneath the coefficient. The columns on the right show the coefficient of determination, R^2, and the F-ratio for each equation. The equations with the B-set of explanatory variables are shown below those of the A-set. (The A-set for the Western District is missing because attempts failed to make the computer produce these estimates.)

Before making an inspection of those crucial estimates on which our interest centers, we make a general inquiry into our overall success in estimating the parameters of demand. For this purpose we have chosen a simple statistic: the percentage of coefficients that have the "correct" algebraic sign, correct in the

TABLE 1

TWELVE MARKETS AND ASSOCIATED FOURTEEN INDEPENDENT VARIABLES

Market	Commodity Group	Area	Measure
1. Railroads	All traffic	Entire U.S.	Tons
Railroads	All traffic	Entire U.S.	Ton-miles
2. Trucks	All traffic	Entire U.S.	Tons
Trucks	All traffic	Entire U.S.	Ton-miles
3. Railroads	All traffic	Eastern District	Tons
4. Railroads	All traffic	Pocahontas Region	Tons
5. Railroads	All traffic	Southern Region	Tons
6. Railroads	All traffic	Western District	Tons
7. Railroads	Agriculture	Entire U.S.	Tons
8. Railroads	Animals	Entire U.S.	Tons
9. Railroads	Mines	Entire U.S.	Tons
10. Railroads	Coal	Entire U.S.	Tons
11. Railroads	Forests	Entire U.S.	Tons
12. Railroads	Manufactures	Entire U.S.	Tons

sense that the estimated elasticity is of the same sign as conventional economic theory predicts, i.e., price elasticity, negative; cross-elasticity, positive; income elasticity, positive. A total of 324 coefficients is estimated. Of these, 236 or 73 percent have the correct algebraic sign. Details are given in Table 2.

Several points about the percentages in Table 2 deserve to be noted. Except for the Eastern District, Animals, and Mines, all categories have coefficients with the correct sign in more than two-thirds of the cases. There is no explanation for the failure of the Eastern District to do as well as the other districts, but the poor performance of Animals and Mines may be caused by the lack of competition between trucks and rails for the carriage of these goods, so that the inclusion of the truck rate reduces the overall performance of these equations. This, in fact, appears to be what happens. The cross-elasticity of rail volumes with truck rates is negative in every instance in Mines and Animals and is therefore "incorrect." We will have an explanation of these negative cross-elasticity terms later. They are not as incorrect as they may at first seem.

The equations with two and three arguments did substantially better than the equations with only a single argument, 75 percent correct vs 67 percent. Our best identified equations perform better than our more poorly identified equations. This is interesting; it appears that a complex of factors can explain the level of intercity freight traffic volumes to a degree that single factors cannot.

Another measure of the success of our equations is taken when truck volumes are substituted for rail volumes as the dependent variable. The explanatory-variable data are kept exactly the same. The a priori expectation is that the algebraic signs of the coefficients for truck rate and for rail rate (in the A-set) and for truck-rail rate ratio (in the B-set) should switch as the dependent variable is switched in order to keep own-price elasticity negative and cross-price elasticity positive. And this is precisely what happens! The coefficients change signs properly. This is powerful evidence that the estimating equations are accurately picking out the separate effects of the various explanatory variables.

TABLE 2

PERCENTAGES OF COEFFICIENTS OF VARIOUS GROUPS OF EQUATIONS HAVING THE CORRECT ALGEBRAIC SIGN

Market	Commodity Group	Area	Measure	Percent
1. Railroads	All freight traffic	Entire U.S.	Tons	71
Railroads	All freight traffic	Entire U.S.	Ton-miles	83
2. Trucks	All freight traffic	Entire U.S.	Tons	67
Trucks	All freight traffic	Entire U.S.	Ton-miles	71
3. Railroads	All freight traffic	Eastern District	Tons	50
4. Railroads	All freight traffic	Pocahontas Region	Tons	92
5. Railroads	All freight traffic	Southern Region	Tons	79
6. Railroads	All freight traffic	Western District	Tons	83
7. Railroads	Agriculture	Entire U.S.	Tons	88
8. Railroads	Animals	Entire U.S.	Tons	38
9. Railroads	Mines	Entire U.S.	Tons	58
10. Railroads	Coal	Entire U.S.	Tons	67
11. Railroads	Forests	Entire U.S.	Tons	92
12. Railroads	Manufactures	Entire U.S.	Tons	88
Explanatory Variables and Combinations				
13. A set				71
14. B set				74
15. One argument in equation				67
16. Two arguments in equation				76
17. Three arguments in equation				73
18. Overall average				73

Let us look now at the important parameters of demand that our efforts have been leading us to. In Table 3 we set out for ready reference that equation for each transport market that performs best. In general, this has been the equation with all three explanatory variables, except in those instances in which the truck rate is thought to be an irrelevant factor.

Inspection of these equations shows that in nearly all instances we obtain high R^2's, and, correspondingly, significant F-ratios. The standard errors tend to be small, making the estimates rather stable; the t-ratios of these coefficients, found by dividing the coefficients by the standard errors, show most of the estimates to be significantly different from zero.

TABLE 3

THE PRIME DEMAND EQUATIONS

Rail Demand—Aggregate				
RR Vol. =	-0.537 RR Rate	+0.628 GNP	-0.730 TK Rate	R^2 = 0.79
Ton-miles	(0.202)	(0.241)	(0.549)	F = 8.9
RR Vol. =	-0.696 RR Rate	+0.322 GNP		R^2 = 0.76
Ton-miles	(0.166)	(0.074)		F = 11.9
Rail Demand—Eastern District				
RR Vol. =	-0.317 RR Rate	+0.425 GRP	-1.786 TK Rate	R^2 = 0.88
Tons	(0.267)	(0.391)	(0.786)	F = 18.0
Rail Demand—Pocahontas Region				
RR Vol. =	-0.964 RR Rate	+0.925 GRP	-0.749 TK Rate	R^2 = 0.77
Tons	(0.368)	(0.374)	(0.829)	F = 7.9
Rail Demand—Southern Region				
RR Vol. =	-0.136 RR Rate	+0.576 GRP	-0.521 TK Rate	R^2 = 0.92
Tons	(0.181)	(0.175)	(0.444)	F = 28.3
Rail Demand—Western District				
RR Vol. =	-0.684 AV Rate	+0.213 GRP	+0.074 Rt. Ratio	R^2 = 0.58
Tons	(0.478)	(0.221)	(0.352)	F = 2.7
Rail Demand—Agriculture				
RR Vol. =	-0.837 RR Rate	+0.370 Crop Index	+0.661 TK Rate	R^2 = 0.94
Tons	(0.118)	(0.203)	(0.208)	F = 42.1
Rail Demand—Animals				
RR Vol. =	-0.207 RR Rate	-0.997 Livestk. Index	-1.115 TK Rate	R^2 = 0.95
Tons	(0.221)	(0.556)	(0.589)	F = 50.9
Rail Demand—Mines				
RR Vol. =	-0.819 RR Rate	+0.012 Mineral Prod.		R^2 = 0.67
Tons	(0.262)	(0.181)		F = 6.9
Rail Demand—Coal				
RR Vol. =	-0.128 RR Rate	+0.953 Coal Prod.		R^2 = 0.93
Tons	(0.268)	(0.167)		F = 53.6
Rail Demand—Forests				
RR Vol. =	-0.366 RR Rate	+0.762 Lumber Prod.	+0.410 TK Rate	R^2 = 0.82
Tons	(0.143)	(0.165)	(0.161)	
Rail Demand—Manufactures				
RR Vol. =	-0.391 RR Rate	+0.682 Manuf.	-1.105 TK Rate	R^2 = 0.82
Tons	(0.208)	(0.205)	(0.552)	F = 11.2
RR Vol. =	-0.670 RR Rate	+0.289 Manuf.		R^2 = 0.77
Tons	(0.167)	(0.066)		F = 12.6
Truck Demand—Aggregate				
TK Vol. =	-1.841 TK Rate	+2.323 GNP	+0.932 RR Rate	R^2 = 0.996
Ton-miles	(0.343)	(0.151)	(0.126)	F = 676.1

Note: All variables are in logarithmic form; coefficients are elasticities.

Let us see what composite picture of the demand for intercity freight transport we can construct from our estimates of the demand parameters. We will sketch rail demand first, then conclude with truck demand.

RAIL DEMAND

The first parameters to consider in measuring the strength of demand for the services of railroads are the income elasticities or, more precisely, the elasticities of rail volume with respect to the indexes of production. Interesting results emerge. The partial regression coefficient in the first equation in Table 3 shows that the elasticity of total rail ton-miles with respect to GNP in constant dollars is a meager +0.322. This is taken from the second equation shown for aggregate rail demand. (It is believed that this is a more accurate estimate of income elasticity in that the 0.63 estimate from the first equation is offset by a trend variable for which the cross-elasticity term is acting as proxy.) Growth in the economy is generating new traffic for the railroads (abstracting from changes in the rate level) at only one-third the rate at which the economy is expanding. This is presumed to result from the fact that the economy is growing primarily in service fields (including government services), which have negligible freight requirements, and in areas of industry that produce highly fabricated outputs for which the truck is better suited to transport.

Our equations show that growth in coal output and agricultural and forest products generates new railroad traffic the most consistently of all the other commodity groups. Coal has the highest elasticity of traffic with respect to production, +0.95, showing that coal traffic parallels coal production almost exactly, as we would expect. But none of our commodity groups has an elasticity exceeding unity, implying that there is no major sector of the economy that generates rail traffic even as fast as it itself grows. Manufacturing, an important source of high-rated traffic for the railroads, yields a low 2.9 percent increase in rail volume for each 10 percent increase in manufacturing output, reflecting the fact that growth in Manufactures is chiefly in products of high unit value that favor truck transport. (Again we are temporarily using the estimate from the equation that does not include the truck rate, which appears to be acting partially as proxy for a trend term.)

All of this suggests that the development of the economy itself is a major cause of the stagnant level of rail traffic. These parameters forebode trouble for the railroads in sustaining even a minimal growth rate, if the past 20 years are any clue to the future. If the railroads are to obtain any significant traffic growth, it will not be generated autonomously by the economy, but will have to come as the result of new pricing or market strategies by the railroads. We may be able to draw some conclusions about the efficacy of pricing strategies from the other demand parameters we have estimated, the price and cross-price elasticities.

The equations show that the price elasticities of railroad volumes are negative, as expected, for each of the commodity groups and regions shown. The first equation in Table 3 shows that the price elasticity of all rail traffic is -0.54, implying that a 10 percent increase in rail rates has had the effect of reducing volumes by only 5.4 percent less than proportionately. (It should be noted with some force that our equations consistently yield estimates of rail price elasticities between -1.0 and 0, not in one or two instances alone.) This estimated inelasticity of aggregate rail demand during the postwar years is a vindication of the efforts of railroad management to effect general rate increases faster than the ICC has generally been willing to allow.

If this result could be counted on to hold for the present, it would appear to recommend a policy of raising rail rates inasmuch as the railroads are on the inelastic portion of their aggregate demand curve. Further, insofar as diminished traffic will reduce total costs as well as expanding revenues, such a policy would augment profits even more. In theory, if marginal costs are positive, profit maximization calls for pricing to achieve a point on the demand curve where price elasticity is greater (more negative) than -1.0. If raising the general rate level is felt to be drawing too strong a policy conclusion from the estimates, at a minimum the consistently inelastic estimates caution very strongly against urging a policy of general rate reductions on the railroads.

Across-the-board reductions would substantially reduce total revenues and, at the same time, add new traffic and hence new costs.

This result of inelastic demand is repeated again and again among the commodity groups, suggesting that even across-the-board increases may not be inappropriate. Manufacturing shows an elasticity of only -0.39. Only Agriculture, with an elasticity of -0.84, is close to the revenue-maximizing unitary elasticity.

Caution must be exercised before turning these findings into actual recommendations for higher rail rates. These estimates are derived from time series so that there is no assurance that a broad interval of experience along the demand curve has been encompassed. In fact, all of our historical observations may have been drawn from a very short length of our hypothetical demand curve. We have predicated constant elasticity over this range, but there is no justification to assume—indeed, there is no reason to expect—that there is constant elasticity over a longer length of the demand curve. Conventionally, the higher rates are raised, the more elastic demand becomes; there is no way to determine from our estimates how far rates could be increased before the profit-maximizing elasticity is obtained. All that we may infer from these elasticities is that quite possibly rates should be adjusted initially or marginally upward.

The danger of upward adjustments of rail rates lies in the ever-present threat of traffic diversion to other modes. We may gain some insight into how great this danger is from examination of the cross-elasticities we have estimated. We are less successful in obtaining satisfactory estimates of the cross-elasticities, for in many cases these elasticities are negative when theory predicts positive elasticities. The cross-elasticity for all rail traffic from the first equation is -0.88, implying that rail volumes fall by 9 percent as truckers raise their rates 10 percent. Although these negative elasticities have little use as a direct policy guide, suggesting nonsensically that the motor carriers could destroy the railroads by raising their own rates sufficiently, they do have a valid and very interesting historical interpretation. The trend of truck rates during the postwar period has been consistently upward as the data in the Appendix show. The negative cross-elasticity should be interpreted not as a cross-elasticity as such, but as the coefficient of a trend variable representing the steady diversion of traffic from rail to truck (a surmise that deserves explicit testing by the inclusion of a trend in the equations): What the high negative cross-elasticity signals is a persistent ability of the trucks to capture increasing quantities of traffic despite their steady rate increases.

We find this high diversion trend in the demand equation not only for the aggregate of all rail traffic but, even to a greater degree, for Manufactures for which the elasticity is -1.11. Only for two commodity groups, Agriculture and Forests, has the "diversion-trend effect" been offset by the cross-elasticity effect, yielding a properly positive cross-elasticity. As truck rates have increased by 10 percent the quantity of agricultural goods hauled by rail has risen by 6.6 percent, and the quantity of forest products going by rail has risen 4.1 percent. The implication is that the rails have done best at retrieving agricultural and forest traffic after trucks have raised their rates.

Let us proceed further with our efforts to get at the cross-elasticity between rail volumes and truck rates. We expressed fear in an earlier discussion that truck rates might prove collinear with rail rates and, therefore, create two orthogonal series from the two rate series by taking the average rate and truck-rail rate ratio. The collinearity we feared did not materialize; instead, however, the truck rate index appears to be acting as a proxy for a rail-to-rate diversion trend. To escape this new problem let us revert to our orthogonalized variables. If the coefficient of the truck-rail rate ratio is (a) positive and (b) significantly different from zero, this would be evidence that the division of traffic is sensitive to the rate relationship. We record below the approximate t-ratio for each market for which the rate-ratio coefficient is of the proper algebraic sign.

All Rail Freight	3 ?	Pocahontas Region	3 ?	Agriculture	7	Coal	-
		Southern Region	2 ?	Animals	-	Forests	2.5
Eastern District	-	Western District	2 ?	Mines	-	Manufacturing	3 ?

The estimates are not as stable as we would like; the question marks indicate widely varying coefficients, some of which are significant at the t-ratio shown. For the aggregate rail demand equation we get an uncertain t-ratio of about 3, possible confirmation of the fact that rail volumes are sensitive to the relationship of rail rates to truck rates. We get similar confirmation in the transport market for Manufactures. The two markets in which we have the most certain evidence of a significant cross-elasticity are those for agricultural and forest products. These are the same two markets for which we got positive direct estimates of cross-elasticity earlier.

We conclude that railroads may be well advised to adjust their rates marginally upward, but this is an adjustment that cannot be made indiscriminately. The advancement of rates should be a cautious one, for we do not know how far our demand curve can be extrapolated; and the division of traffic between rail and other modes is more sensitive to relative rates in some sectors than in others.

TRUCK DEMAND

Our analysis of the demand for truck transport is considerably briefer because of our inability to disaggregate by regions or commodity groups. The basic demand equation, all in logs, is reproduced below.

$$\begin{array}{lllll} \text{TK Vol.} = & -1.841\ \text{TK Rate} & +2.323\ \text{GNP} & +0.932\ \text{RR Rate} & R^2 = 0.996 \\ \text{Ton-miles} & (0.343) & (0.151) & (0.126) & F\ = 678.1 \end{array}$$

The t-ratios and F-ratio are all highly significant; virtually all variance has been accounted for.

Our expectation that growth in the economy has contributed more liberally to growth in truck traffic than to that in rail traffic is confirmed; truck volumes have expanded about two and a third times as fast as the GNP (in constant dollars). The growth prospects of the trucking industry appear excellent.

The equation shows a surprisingly large own-price elasticity, indicating that truck volumes fall 18 percent if truck rates are raised 10 percent or, conversely, that truck volumes will increase 18 percent if rates are cut by only 10 percent. Without knowing marginal costs and revenues exactly, it is only possible to say that the profit-maximizing elasticity would be somewhat greater (more negative) than -1.0. Given the extent of competition in the trucking industry, it seems likely that the estimated -1.8 elasticity is close to that profit-maximizing amount. Thus, we have little reason to expect major movements in truck rates in either direction, and railroads are unlikely to obtain that freedom to raise their rates with impunity that would be granted by substantially higher truck rates.

It is curious that our equation finds a strong negative own-price elasticity of truck traffic despite the fact that, in the analysis of rail demand, the estimates of cross-price elasticity show that rail traffic declines even as the trucks are raising their rates. Wha has apparently happened in the truck analysis is that our rail-to-truck diversion trend appears as a large income elasticity, leaving the rate variables to pick out "true" price elasticities.

The final parameter of our truck demand equation, the cross-elasticity with respect to rail rates, is properly positive, +0.93. This finding is well confirmed by the equation using the orthogonalized B-set of variables; the coefficient on the truck-rail rate ratio is six and a half times the standard error. Truck traffic, therefore, is certainly sensitive to the level of rail rates, and the motor carrier industry is well advised to keep the rate relationship in mind when setting rates, as they most certainly do.

In general, we find that the trucking industry is on an expansionary growth path. The maintenance of a proper truck rate level, especially with respect to the rail rate, must be a major consideration of the trucking industry in sustaining this exuberant growth.

SUMMARY AND IMPLICATIONS FOR PUBLIC POLICY

We summarize our results by considering the aggregate demand equation for rail traffic as a unit, then for truck traffic. The rail equation, all in logs is

$$\begin{array}{lcccl} \text{RR Vol.} = & -0.537\ \text{Rate} & +0.628\ \text{GNP} & -0.730\ \text{TK Rate} & R^2 = 0.79 \\ \text{Ton-miles} & (0.202) & (0.241) & (0.549) & F = 8.9 \end{array}$$

This equation shows that growth in the GNP is generating new rail traffic at only three-fifths the rate the economy is expanding. (We have explained elsewhere that a better estimate might be only one-third.) What rate strategy can the railroads adopt to ameliorate this situation? The outlook is dim; the railroads can probably gain, on balance, by raising their rates at least marginally, because their own-price elasticity of demand appears to be only slightly different from -0.5, indicating an inelastic market. However, we have evidence that the division of aggregate traffic is sensitive to the relationship between truck and rail rates; thus, the rails cannot push the strategy of raising rates too far, and the recommended policy for rail profit-maximization appears to be a selective readjustment of rates tending upward on balance.

The structure of demand is repeated basically unchanged in the regional markets and in the commodity-group markets we have surveyed. Manufactures are an important source of high-rated traffic for the railroads. Yet this traffic is expanding far slower than the manufacturing industry. Marginal rate increases are called for by price inelasticity; yet this traffic is certainly sensitive eventually to the relationship of rail-to-truck rates. The markets for transport of agricultural and forest products are also shown sensitive to relative rates. Only the markets for transport of animal products and minerals, including coal, do not show this same sensitivity.

This picture of demand, drawn from the past, offers little encouragement for the future. Restricted to pricing strategies, the very best that could happen to railroads would be for truckers to increase their rates substantially, after which the rails could increase their rates, and profits, with impunity. But we have seen that there is no reason to anticipate the cooperation of truckers in this strategy, so that the railroads appear boxed in with their present diminished share of the market and negligible growth rate. Significant growth in rail traffic will not be achieved by movements along the present demand curve, but only by shifts of the entire demand schedule. This will only be accomplished by bold changes in rail marketing strategy.

The trucks have no similar worries about sustaining the growth of their industry, judging only from the past; the economy is generating new truck traffic at more than twice its own rate of growth. But truck traffic in total appears to be sensitive to prices. The motor carriers may raise their prices over time to adjust for inflation and technological improvements and still maintain this growth rate; yet the path those prices follow upward appears to be a narrow one. The diversion of traffic to other modes will swiftly follow any deviation from that path, as witnessed by the high price elasticity and cross price elasticity of demand for truck transport.

We end with a few words about the implications of our findings for public policy. In one estimate after another we have found evidence that the division of traffic between rail and truck is sensitive to the relative rate level, though more so for some sectors of the economy than for others. We may offer this in evidence against the ICC's apparent belief that the market is incapable of policing freight rates and urge the ICC to move toward greater reliance on market forces as it evolves its rate policies. The demand equation we have estimated for the trucking market offers no evidence for belief in the absence of competitively determined rates from that market. Private and contract trucking almost surely provides this competition.

The equations for the rail market consistently indicate inelastic demand. If the ICC desires to permit the railroads to improve short-run profits, marginal rate increases will probably be effective. We may state the converse more firmly: There is no reason to believe that across-the-board rate reductions will improve rail profits.

Growth in the economy is generating very little new railroad traffic; price-inelastic demand implies that greater price competition will not succeed in drawing substantial volumes of new traffic to the rails. Rate juggling is a game with a small pot, even if the railroads succeed in winning it. The efforts of management are better applied elsewhere. New marketing strategies to shift the demand curve are called for if the railroads are to achieve a greater rate of growth. It is believed that present ICC policies help to divert the efforts of railroad management toward rate matters and away from providing a broader range of services in transport markets. The Commission must encourage a redirection of efforts, principally by working toward an early resolution of the rate conundrum.

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Appendix C

Regression Equations

ALL CLASSES - ENTIRE U. S.
Tons of RR Freight
1947 - 1966

	RR RATE	GNP/ $1958	TRUCK RATE	R^2	F-RATIO
1.	-.510 (.158)			.604	10.4
2.		-.075 (.087)		.200	0.8
3.			-.265 (.168)	.348	2.5
4.	-.594 (9.7)	+.069 (.085)		.624	5.4
5.	-.562 (.217)		+.072 (.196)	.608	5.0
6.		+.647 (.263)	-1.529 (.534)	.593	4.6
7.	-.403 (.231)	+.437 (.276)	-.878 (.628)	.675	4.5

ALL FREIGHT - ENTIRE U. S.
Tons of RR Freight
1947 - 1966

	AV. RATE	RATE RATIO	GNP/ $1958	R^2	F-RATIO
1.	-.439 (.178)			.502	6.1
2.		+.244 (.221)		.252	1.2
3.			-.075 (.087)	.200	0.8
4.	-.488 (.171)	+.333 (.189)		.606	4.9
5.	-1.060 (.303)		+.313 (.130)	.665	6.7
6.		+.555 (.252)	-.203 (.098)	.503	2.9
7.	-1.282 (.532)	-.197 (.384)	+.439 (.280)	.672	4.4

ALL FREIGHT - ENTIRE U. S.

Ton-Miles of RR Freight
1947-1966

	RR RATE	GNP/ $1958	TRUCK RATES	R^2	F-RATIO
1.	-.301 (.197)			.340	2.3
2.		+.153 (.086)		.388	3.2
3.			+.175 (.185)	.218	0.9
4.	-.696 (.166)	+.322 (.074)		.763	11.9
5.	-.766 (.210)		+.634 (.190)	.682	7.4
6.		+.908 (.253)	-1.598 (.514)	.677	7.2
7.	-.537 (.202)	+.628 (.241)	-.730 (.549)	.790	8.9

ALL FREIGHT - ENTIRE U. S.

Ton-Miles of RR Freight
1947-1966

	AV. RATE	RATE RATIO	GNP/ $1958	R^2	F-RATIO
1.	-.025 (.216)			.027	0.0
2.		+.680 (.179)		.667	14.4
3.			+.153 (.086)	.388	3.2
4.	-.129 (166)	+.704 (.184)		.681	14.7
5.	-1.204 (.263)		+.593 (.113)	.787	13.8
6.		+.688 (.229)	-.005 (.089)	.667	6.8
7.	-1.266 (.467)	-.054 (.336)	+.628 (.246)	.787	8.7

ALL FREIGHT - ENTIRE U. S.

Tons of Truck Freight
1947 - 1966

	RR RATE	GNP/ $1958	TRUCK RATE	R^2	F-RATIO
1.	+1.651 (.623)			.530	7.0
2.		+1.359 (.062)		.982	486.3
3.			+2.569 (.271)	.913	89.9
4.	-.247 (.170)	+1.365 (.076)		.982	230.0
5.	-.415 (.400)		+2.818 (.361)	.918	45.7
6.		+1.880 (.186)	-1.102 (.378)	.988	348.6
7.	+.334 (.157)	+2.054 (.188)	-1.643 (.428)	.991	281.9

ALL FREIGHT - ENTIRE U. S.

Tons of Truck Freight
1947 - 1966

	AV. RATE	RATE RATIO	GNP/ $1958	R^2	F-RATIO
1.	+2.634 (.439)			.816	35.9
2.		+1.972 (.704)		.551	7.9
3.			+1.359 (.062)	.982	486.3
4.	+2.407 (.312)	+1.534 (.346)		.919	46.4
5.	-.245 (.276)		+1.449 (.119)	.983	240.7
6.		-.178 (.199)	+1.400 (.077)	.983	240.9
7.	-1.322 (.362)	-.954 (.261)	+2.062 (.191)	.991	281.5

ALL FREIGHT - ENTIRE U. S.
Ton-Miles of Truck Freight
1947 - 1966

	RR RATE	GNP/ $1958	TRUCK RATES	R^2	F-RATIO
1.	+2.433 (.703)			.632	12.0
2.		+1.680 (.076)		.982	494.0
3.			+3.254 (.289)	.936	127.2
4.	+.529 (.165)	+1.551 (.073)		.989	380.4
5.	+.084 (.438)		+3.204 (.396)	.936	60.2
6.		+1.838 (.276)	-.335 (.562)	.983	238.3
7.	+.932 (.126)	+2.323 (.151)	-1.841 (.343)	.996	678.1

ALL FREIGHT - ENTIRE U.S.
Ton-Miles of Truck Freight
1947 - 1966

	AV. RATE	RATE RATIO	GNP/ $1958	R^2	F-RATIO
1.	+3.507 (.447)			.880	61.6
2.		+2.047 (.923)		.463	4.9
3.			+1.680 (.076)	.982	494.0
4.	+3.293 (.342)	+1.448 (.379)		.937	61.3
5.	+.619 (.313)		+1.453 (.134)	.986	289.0
6.		-.823 (.150)	+1.869 (.058)	.994	660.1
7.	-.921 (.289	-1.363 (.209)	-2.330 (.152)	.996	679.6

EASTERN REGION

1947 - 1966

	RR RATE	GNP/ EASTERN	TRUCK RATE	R^2	F-RATIO
1.	-1.094 [illegible]			.741	21.9
2.		-.641 (.128)		.763	25.1
3.			-1.280 (.190)	.846	45.4
4.	-.642 (.251)	-.414 (.143)		.835	19.6
5.	-.414 (.253)		-.978 (.259)	.869	26.2
6.		+.581 (.373)	-2.286 (.671)	.867	25.7
7.	-.317 (.267)	+.425 (.391)	-1.786 (.786)	.878	18.0

EASTERN DISTRICT

1947 - 1966

	AV. RATE	RATE RATIO	GNP/ EASTERN	R^2	F-RATIO
1.	-1.391 (.195)			.860	51.0
2.		-.224 (.461)		.114	0.2
3.			-.641 (.128)	.763	25.1
4.	-1.393 (.195)	-.240 (.237)		.868	26.1
5.	-1.286 (.399)		-.063 (.207)	.861	24.3
6.		+.503 (.319)	-.732 (.136)	.797	14.8
7.	-2.132 (.689)	-.687 (.464)	+.441 (.395)	.879	18.0

POCAHONTAS REGION

1947 - 1966

	RR RATE	GNP/ POCAHONTAS	TRUCK RATE	R^2	F-RATIO
1.	-.430 (.337)			.289	1.6
2.		+.290 (.153)		.408	3.6
3.			+.295 (.313)	.217	0.9
4.	-1.168 (.288)	+.611 (.138)		.759	11.5
5.	-1.331 (.384)		+1.157 (.350)	.665	6.7
6.		+1.320 (.396)	-2.086 (.757)	.651	6.2
7.	-.964 (.368)	+.925 (.374)	-.749 (.829)	.772	7.9

POCAHONTAS REGION

1947 - 1966

	AV. RATE	RATE RATIO	GNP/ POCAHONTAS	R^2	F-RATIO
1.	-.007 (.361)			.005	0.0
2.		+1.217 (.331)		.655	13.5
3.			+.290 (.153)	.408	3.6
4.	-.170 (.281)	+1.249 (.341)		.664	6.7
5.	-1.870 (.444)	+1.024 (.206)	+1.024 (.206)	.770	12.4
6.		+1.164 (.414)	+.035 (.159)	.657	6.4
7.	-1.725 (.679)	+.155 (.536)	+.933 (.379)	.771	7.8

SOUTHERN REGION

1947 - 1966

	RR RATE	GNP/ SOUTH	TRUCK RATE	R^2	F-RATIO
1.	-.217 (.343)			.148	0.4
2.		+.374 (.044)		.893	70.5
3.			+.829 (.147)	.798	31.6
4.	-.260 (.148)	+.376 (.042)		.910	40.9
5.	-.469 (.188)		+.894 (.132)	.857	23.5
6.		+.650 (.143)	-.716 (.355)	.914	43.3
7.	-.136 (.181)	+.576 (.175)	-.521 (.444)	.917	28.3

SOUTHERN REGION

1947 - 1966

	AV. RATE	RATE RATIO	GNP/ SOUTH	R^2	F-RATIO
1.	+.866 (.294)			.571	8.7
2.		+.769 (.128)		.818	36.3
3.			+.374 (.044)	.893	70.5
4.	+.434 (.207)	+.660 (.128)		.859	23.8
5.	-.489 (.237)		+.479 (.065)	.915	43.7
6.		+.205 (.187)	+.296 (.083)	.900	36.2
7.	-.670 (.379)	-.172 (.277)	+.582 (.180)	.917	28.2

WESTERN DISTRICT

1947 - 1966

	AV. RATE	RATE RATIO	GNP/ WEST	R^2	F-RATIO
1.	-.194			.298	
	(.147)				1.8
2.		+.322		.399	
		(.174)			3.4
3.			-.005	.019	
			(.059)		0.0
4.	-.244	+.372		.543	
	(.134)	(.167)			3.6
5.	-.767		+.253	.576	
	(.264)		(.102)		4.2
6.		+.489	-.091	.498	
		(.206)	(.064)		2.8
7.	-.684	+.074)	+.213	.578	
	(.478)	(.352)	(.221)		2.7

AGRICULTURE

1947 - 1966

	RAIL RATE	CROP PROD.	TRUCK RATE	R^2	F-RATIO
1.	-.224			.221	
	(.233)				0.927
2.		+.740		.721	
		(.168)			19.5
3.			+.504	.582	
			(.166)		9.24
4.	-.595	+.973		.902	
	(.115)	(.117)			37.0
5.	-.926		+.985	.930	
	(.114)		(.097)		54.5
6.		+.994	-.241	.732	
		(.370)	(.312)		9.82
7.	-.837	+.370	+.661	.942	
	(.118)	(.203)	(.208)		42.1

AGRICULTURE

1947 - 1966

	AV. RATE	RATE RATIO	CROP PROD.	R^2	F-RATIO
1.	+.277			.268	
	(.234)				1.4
2.		+.967		.929.	
		(.091)			112.5
			+.740	.721	
			(.168)		19.5
4.	+.059	+.954		.930	
	(.095)	(.095)			54.5
5.	-.645		+1.222	.831	
	(.211)		(.210)		18.9
6.		+.844	+.180	.938	
		(.119)	(.117)		61.7
7.	-.175	+.756	+.369	.942	
	(.158)	(.143)	(.207)		42.1

ANIMALS

1947 - 1966

	RR RATE	LIVESTOCK INDEX	TRUCK RATE	R^2	F-RATIO
1.	-1.256 (.443)			.556	8.0
2.		-2.146 (.200)		.930	115.4
3.			-2.177 (.186)	.940	136.4
4.	-.350 (.211)	-1.979 (.216)		.940	64.7
5.	-.140 (.221)		-2.099 (.226)	.941	66.1
6.		-.900 (.547)	-1.322 (.549)	.948	76.0
7.	-.207 (.211)	-.977 (.556)	-1.115 (.589)	.951	50.9

ANIMALS

1947 - 1966

	AVER. RATE	RATE RATIO	LIVESTOCK PROD.	R^2	F-RATIO
1.	-2.244 (.310)			.863	52.4
2.		-.920 (.522)		.384	3.1
3.			-2.146 (.200)	.930	115.4
4.	-2.235 (.214)	-.901 (.197)		.941	65.6
5.	-.796 (.355)		-1.568 (.315)	.947	73.1
6.		+.207 (.239)	-2.242 (.230)	.933	57.3
7.	-1.311 (.55)	-.403 (.333)	-1.005 (.558)	.951	50.6

MINES

1947 - 1966

	RR RATE	MINERAL PROD.	TRUCK RATE	R^2	F-RATIO
1.	-.809 (.212)			.668	14.5
2.		-.300 (.184)		.359	2.7
3.			-.698 (.176)	.683	15.7
4.	-.819 (.262)	+.012 (.181)		.668	6.9
5.	-.421 (.322)		-.423 (.272)	.718	9.0
6.		+1.018 (.214)	-1.806 (.262)	.878	28.6
7.	+.104 (.259)	+1.065 (.250)	-1.926 (.401)	.879	18.2

MINES

1947 - 1966

	AV. RATE	RATE RATIO	MINERAL PROD.	R^2	F-RATIO
1.	-.839 (.192)			.717	19.1
2.		-.299 (.371)		.187	0.6
3.			-.300 (.184)	.359	2.7
4.	-.844 (.206)	+.025 (.282)		.717	9.0
5.	-1.363 (.282)		+.473 (.202)	.796	14.7
6.		+0.150 (.485)	-.352 (.253)	.365	1.3
7.	-1.833 (.271)	-.967 (.303)	+1.076 (.250)	.881	18.4

COAL

1947 - 1966

	RR RATE	COAL PROD.	TRUCK RATE	R^2	F-RATIO
1.	-1.363 (.262)			.775	27.1
2.		+1.017 (.096)		.928	111.8
3.			-.955 (.229)	.701	17.4
4.	-.128 (.268)	+.953 (.167)		.929	53.6
5.	-.974 (.299)		-.500 (.232)	.829	18.6
6.		+.842 (.064)	-.470 (.079)	.977	179.7
7.	+.337 (.155)	+.983 (.087)	-.546 (.080)	.982	147.6

COAL

1947 - 1966

	AV. RATE	RATE RATIO	COAL PROD.	R^2	F-RATIO
1.	-1.370 (.234)			.810	34.4
2.		-.205 (.391)		.123	0.3
3.			+1.017 (.096)	.928	111.8
4.	-1.473 (.245)	+.297 (.242)		.827	18.4
5.	-.586 (.146)		+.765 (.095)	.964	110.7
6.		-.536 (.082)	+1.087 (.054)	.980	205.3
7.	-.214 (.139)	-.431 (.104)	+.981 (.086)	.983	148.9

FORESTS

1947 - 1966

	RR RATE	LUMBER PROD.	TRUCK RATE	R^2	F-RATIO
1.	-.168 (.127)			[illegible]	1.8
2.		+.819 (.181)		.730	20.5
3.			-.124 (.151)	.019	0.0
4.	-.068 (.953)	+.785 (.190)		.739	10.2
5.	-.493 (.209)		+.449 (.238)	.497	2.8
6.		+.843 (.187)	+.0748 (.106)	.739	10.2
7.	-.366 (.143)	+.762 (.165)	+.410 (.161)	.823	11.2

FORESTS

1947 - 1966

	RR RATE	MINERAL PROD.	TRUCK RATE	R^2	F-RATIO
1.	-.106 (.147)			.169	0.5
2.		+.486 (.202)		.493	5.8
3.			+.819 (.181)	.730	20.5
4.	-.430 (.136)	+.472 (.212)		.497	2.8
5.	-.001 (.107)		+.819 (.191)	.730	9.7
6.		+.375 (.139)	+.747 (.158)	.820	17.5
7.	+.044 (.094)	+.387 (.145)	+.763 (.165)	.823	11.2

MANUFACTURING

1947 - 1966

	RR RATE	INDEX OF MANUF.	TRUCK RATE	R^2	F-RATIO
1.	-.377			.379	
	(.217)				3.0
2.		+.183		.465	
		(.082)			5.0
3.			+.222	.236	
			(.216)		1.1
4.	-.670	+.289		.772	
	(.167)	(.066)			12.6
5.	-.772		+.644	.675	
	(.219)		(.207)		7.1
6.		+.895	-1.801	.779	
		(.184)	(.439)		13.1
7.	-.391	+.682	-1.105	.823	
	(.208)	(.205)	(.552)		11.2

MANUFACTURING

1947 - 1966

	AV. RATE	RATE RATIO	INDEX OF MANUF.	R^2	F-RATIO
1.	-.047			.043	
	(.255)				0.0
2.		+.700		.664	
		(.186)			14.2
3.			+.183	.465	
			(.082)		5.0
4.	-.124	+.712		.674	
	(.196)	(.190)			7.1
5.	-1.167		+.516	.810	
	(.250)		(.091)		16.2
6.		+.651	+.029	.667	
		(.246)	(.092)		6.8
7.	-1.490	-.302	+.680	.820	
	(.448)	(.347)	(.209)		10.9