

WORKING PAPERS



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WORKING PAPER NO. 164

May 1988

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BUREAU OF ECONOMICS
FEDERAL TRADE COMMISSION
WASHINGTON, DC 20580

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Interstate Commerce Commission and Federal Trade Commission, respectively. The views and conclusions expressed here do not necessarily represent the opinions of the ICC, the FTC, or any of their members. The authors wish to thank James Langenfeld, Alan Mathios, Mike Metzger, Paul Pautler, Bob Stoner, John Woodbury, and an anonymous reviewer for their help with this paper.

ABSTRACT

The Staggers Act of 1980 largely ended almost a century of government regulation of railroads. This paper presents evidence that deregulation has had a positive impact on the economy. Specifically, deregulation has generated billions of dollars worth of efficiency gains, contrary to the relatively modest gains estimated by Boyer (1987). In performing the analysis the paper examines several aspects of railroad deregulation, and uses a reduced form econometric model to measure the effect of deregulation on rail rates.

I. INTRODUCTION

The Staggers Rail Act of 1980 largely ended almost a century of government regulation of railroads. Railroads were given substantially more rate flexibility and managerial control over their operations, and both intermodal and intramodal competitiveness were increased (motor carriers were largely deregulated simultaneously). In this paper we explore three possible areas of gain due to Staggers: lower rail rates for shippers, higher quality service, and increased railroad profits.

In a recent article, Boyer (1987) concludes that the annual efficiency cost of railroad regulation was roughly \$90 million. Our analysis, starting from the same data used by Boyer, suggests that his estimate is low by about two orders of magnitude: the actual efficiency gains thus far from the partial railroad deregulation following the Staggers Act are probably between \$9 to \$15 billion per year.

II. AN EXAMINATION OF BOYER'S MODEL

Boyer presents a simple, one equation model of the effect of deregulation on rail rate levels. He then applies his regression results to estimate deadweight losses due to regulation. We have two fundamental problems with this model.

First, Boyer's rate level model appears to be seriously misspecified. This results in an improper estimation of the magnitude of the effects of deregulation and a mistaken conclusion about the direction of the resulting price changes. Boyer's efficiency gain estimate is based on the conclusion that railroad rates had been held below marginal costs and rose slightly

(towards marginal costs) because of deregulation. However, our analysis shows that rates and costs have actually fallen significantly.

Second, and more importantly, his approach ignores much larger impacts of deregulation on cost levels and service quality (that is, Boyer looked at relatively small "triangles" instead of "rectangles" of welfare gains due to allowing more efficient methods of service and production). Thus, the rate declines largely represent net efficiency gains to the economy rather than transfers from producers to consumers. Further, since there have been improvements in product quality (discussed below in Section V), Boyer's estimates of deadweight loss triangles are inappropriate in this context.

Boyer's rate model explains aggregate average rail rates (per ton-mile, in real dollars) by "DEREG", a dummy for deregulation and "WEIGHT",¹ a variable meant to adjust for changes in traffic composition (the amount of bulk goods being shipped) and service quality (page 411). "YEAR" (calendar year) is added in a second equation. Boyer does not include any demand side variables in his specification. Equation (2-1) lists Boyer's full model.

$$(2-1) \quad \ln(\text{Average Rate}) = a_0 + a_1\text{DEREG} + a_2\ln(\text{WEIGHT}) + a_3\text{YEAR} + e_0$$

The DEREG dummy is positive, though insignificantly so, in both equations (See Table 1). When we extend Boyer's model to include data for 1985 and 1986, and correct his DEREG dummy to begin in 1981 instead of

¹ Boyer's WEIGHT or "average weight of freight trains" is net ton-miles per train-mile, a measure of average train load.

1980² we obtain very low Durbin-Watson statistics. This suggests an omitted variable bias in Boyer's specifications.

There are at least two significant problems with this specification beyond the lack of demand side variables. First, Boyer's construction of the dummy variable implies that the full effects of rail deregulation occurred overnight on January 1, 1980.³ But deregulation did not occur overnight, and not at the beginning of 1980. Although the deregulatory process actually began many years earlier, it proceeded at a very slow pace before Staggers. The Staggers Act itself did not become law until near the end of 1980 (October 15) and it took many months for the Interstate Commerce Commission to implement the radical changes prescribed by the new law. It took even longer for shippers and railroads to learn how to respond to the new opportunities and circumstances. If a dummy variable is to be used, "deregulation" should at least begin in 1981 rather than 1980. We suggest below in Section III a more plausible measure of the gradual implementation of the Staggers Act.

A second serious problem with this specification is that, on theoretical and empirical grounds, we believe the variation in WEIGHT itself to be largely a result of deregulation. By using the DEREK dummy variable to measure the effect of deregulation, Boyer's specification ignores the effects which worked through changes in WEIGHT.⁴ In our view the WEIGHT

² See our discussion below on the construction of Boyer's dummy variable.

³ Boyer's DEREK dummy has a value of zero prior to 1980 and one thereafter.

⁴ This is analogous to arguing that the benefits of airline deregulation resulted mainly from higher load factors (percent of seats filled) without recognizing that it was primarily deregulation which made those higher load factors attainable.

variable largely reflects the influences of deregulation and changes in traffic composition.⁵

While the influence of traffic composition on train weight is fairly straightforward, understanding the influence of deregulation on train weight requires some discussion of the history of rail rate regulation. One of the most widely recognized features of traditional ICC regulation was that it was extremely difficult for railroads to adjust rates on individual movements. As Boyer notes (p. 415), "ICC policy discouraged railroads from offering large shippers rate decreases unless they were also available to small shippers..." This was true even (perhaps especially) when the rate decreases were tied to more efficient traffic handling methods. The ICC long resisted rate reductions resulting from cost-saving innovations such as the "Big John" hoppers, unit trains, or multiple-car shipments (Keeler, 1983, Chapter 2; Hilton, 1969). The system of rate regulation could not fully recognize cost savings of this type, and the system prevented larger shippers from enjoying economies stemming from their size (Barnekov, 1987). The effect of these policies was largely to prevent efficient larger shipments, by preventing railroads from inducing shippers to make such shipments.

ICC rate policies began loosening very gradually in the late 1960s as railroads' steadily worsening financial circumstances forced some regulatory response. By the late 1970s, much coal was already moving in unit trains at rates which at least partly reflected the efficiencies of that type of service. Some reduced rates began to be permitted on multiple-car shipments of other commodities, such as grain (though on a restricted basis). This may properly

⁵ Certain commodities, particularly "bulk" commodities such as coal and grain, tend to be moved in larger shipments (more and heavier cars per shipment).

be considered as partial rate deregulation, although these rate cases remained slow, costly, and hotly contested.

This gradual thawing of regulatory rigidities generated the incentives for railroads and shippers which led to increases in shipment sizes which, in turn, are probably a principal cause of the rise in WEIGHT before 1980.⁶ After Staggers, rates became quite flexible and this process speeded up considerably. In this context, it can be seen that WEIGHT is largely a function of the rate deregulation process in the years before and after Staggers.

In addition to the change related to regulatory conditions, variations in WEIGHT also partly reflect more purely "technological" changes such as the gradual replacement of older, smaller freightcars by newer, larger cars. In Section III we attempt to separate the parts of WEIGHT due to deregulation and to changes in traffic composition.

III. AN ALTERNATIVE RAIL RATE MODEL

A. Specification

Because it is not plausible to expect that the impact of the Staggers Act occurred overnight, we have sought a measure of its gradual implementation in the context of a reduced form model. The most important single aspect of Staggers was arguably the contract provision -- which

⁶ Unfortunately, there is no reliable historical data series directly measuring average rail shipment sizes. The closest is the ICC's Waybill Sample, taken from railroad shipping documents. However, the sampling methodology was sharply altered in 1982 in a way which makes it impossible to compare shipment sizes before and after that date. A principal reason for this revision was that the old methodology did not accurately reflect multiple-car shipments. So the pre-1982 data is not reliable for measuring shipment sizes.

formally legalized rail service contracts,⁷ provided virtually total confidentiality of contract rates and terms, and exempted contract rates from direct regulatory review. A very few contracts were made in 1979 and before passage of the Staggers Act in 1980, and the number increased somewhat in 1981. Over the next several years, contracts became increasingly important. By 1986 contracts were being filed at the rate of about 1500 per month, rates on this traffic were virtually completely unregulated. The infamous "regulatory lag" which froze the rate structure so effectively before 1980 had been virtually eliminated and a majority of rail, coal, and grain traffic was moving under contract.⁸

Contracts are certainly not the only important development since passage of the Staggers Act, but the other developments are more difficult to represent.⁹ The rate at which contracts were filed represents the extent

⁷ Contracts between carriers and shippers were traditionally held to violate the "common carrier obligations" of carriers and to constitute "unreasonable discrimination". The ICC had issued a policy statement late in 1978 reversing this long-held position that rail service contracts were unlawful (Ex Parte No. 358-F, *Railroad Contract Rates*, November 9, 1978). However, the legal status of this policy statement remained uncertain until passage of Staggers and implementation of the necessary regulations. Railroads and shippers were uncertain as to what was permitted, and little use was made of the new option until contract rules were issued in 1981 and digested by parties.

⁸ As of 1985, 63 percent of all coal and 57 percent of all grain movements were made under contracts rather than tariffs. (Association of American Railroads, Railroad Coal Traffic Statistics, 1986.) Unfortunately, the special surveys on which these estimates are based were not conducted for earlier years, so a time series of this measure cannot be generated. The only data series reflecting the extent of contracting is of the number of contracts filed.

⁹ Other important developments include greater flexibility for tariff rates, easier abandonments or sales of unprofitable track segments to smaller carriers, exemptions of certain types of traffic from regulation, some progress on controlling labor costs, and greater managerial control over operations (see Barnekov, 1987).

to which at least one key aspect of Staggers was implemented and applied by users. As our measure of the extent of implementation of the Staggers Act, therefore, we use "STAGGERS", the number of rail contracts each year¹⁰ divided by the number in 1986. This normalization will aid in the interpretation of our regression coefficients.

In addition to the limited deregulation of the 1970s and the accelerated deregulation of the 1980s, there have been other significant changes in rail traffic over this period. There has been a steady shift in the commodity mix toward bulk commodities, and a steady increase in average length of haul. We introduce both of these factors in explaining rail rates, and treat them as exogenous of deregulation.¹¹ The variables used are "BULK", the fraction of rail tonnage accounted for by bulk commodities¹² and "HAUL", the natural log of the average length of haul for the rail system as a

¹⁰ Rail contract statistics were supplied by the ICC's Office of Transportation Analysis, which partially estimated the distribution of contracts between 1979 and 1980. A commenter suggested the possibility that the rate of contract filings might reflect cyclical factors, however we found a low correlation.

¹¹ These trends may not be entirely exogenous, since greater rate flexibility may have helped the railroads (and increased motor carrier competition may have forced them) to concentrate on the types of traffic for which they have a comparative advantage. But numerous factors (for example, the discovery and development of the Western coal fields, or changes in manufacturing patterns) contributed heavily to both these trends and may be viewed as independent of deregulation.

¹² The two largest volume bulk commodities are coal and grain, and these are the two commodities for which there have been the greatest changes in handling methods (such as introduction of unit trains). Although there are other important bulk commodities (ores, crushed stone, etc.), we felt that using coal and grain should capture most of the effects of the shift in traffic mix. Because of data availability problems in the earlier years, we used "farm products" instead of grain; but grain accounts for over 90 percent of the farm products tonnage. Source: Association of American Railroads, Statistics of Railroads of Class I in the United States, Years 1969 to 1979, and Analysis of Class I Railroads from 1979 on.

whole.¹³ The price of railroad fuel in real dollars was also used as an explanatory variable. Fuel accounted for between four and ten percent of railroad costs over this period, as fuel prices varied substantially.¹⁴

To model the demand factors in our model, we included a variable GNPCH that measures the year to year percent change in GNP, and thus accounts for cyclical demand influences. Recognizing the importance of intermodal competition (particularly since motor carrier deregulation occurred simultaneously with railroad deregulation), we have also used the log of motor carrier rates as an additional explanatory variable.¹⁵ Of course, truck rates are partly endogenous in this model, since rail and truck rates influence each other. However, given the size of the data set, using two stage estimation for the effect of truck rates is not feasible. We thus run our regressions with and without truck rates in the specification.

¹³ That is, not for individual carriers. Average length of haul (ton-miles per ton) was calculated from Class I railroad data as reported in Association of American Railroads, Railroad Facts, 1985 and 1987 editions. This differs slightly from the "average haul" figures reported therein, which include *estimated* tonnages and ton-miles for smaller railroads. Since our dependent variables reflect only Class I railroads, we limited our independent variables to the same railroads. Since 1978 twelve small railroads have dropped out of Class I status. Our measure is slightly overstated because tons originating on smaller railroads are not included in the denominator, while the ton-miles generated by these shipments are in the numerator. However, the excluded roads accounted for less than two percent of 1978 Class I revenues.

¹⁴ Fuel prices are from Railroad Facts, 1985 and 1987 editions. Fuel cost shares are from the same source for recent years, and from Statistics of Railroads of Class I (cited in fn 12 above) for early years.

¹⁵ These rates are actually only for Class I "Instruction 27" carriers, that is, those with annual revenues exceeding \$5 million and which earn more than 75 percent of their revenues from intercity service. These carriers are dominated by LTL (small shipment) traffic. It would be preferable to use rate data for only larger shipments (which compete more directly with railroads), but this data is not readily available in a comparable form (particularly on a ton-mile basis).

We do not include YEAR as a variable in our specification. In regressions run with data prior to 1981 (that is, prior to the Staggers Act) the coefficient on year is insignificant and positive, as it is in Boyer's model. After 1980 YEAR is highly collinear with STAGGERS. YEAR is normally used to represent general technological progress; but this seems to have been absent in the railroad industry in the decade before Staggers. To the extent to which technological innovation was applied after 1980, it was probably made possible by changes in the regulatory environment brought about by the Staggers Act.

Before testing our full model we test our hypothesis that WEIGHT is primarily a function of deregulation and traffic mix. STAGGERS alone accounts for 67 percent of the variance in WEIGHT. Adding BULK generates an R-square of 0.94. We use the residuals from this estimating equation ("WRES") as a variable to reflect the other changes occurring over our data period. Now we have the three factors of WEIGHT in our model, STAGGERS, BULK, and WRES, the relatively small unexplained portion.

Finally, we used real revenue per ton-mile as our dependent variables, deflated by both the GNP Implicit Deflator and the PPI (for Total Finished Goods). The choice of price indices could affect the results substantially, because the two indices diverged sharply in the years surrounding 1980 -- just as Staggers began to be implemented. We prefer the GNP Deflator because (unlike the PPI) it includes services as well as commodities and because a Paasche index (GNP Deflator) is weighted by current preference after adjusting for price changes, and a Laspeyres index (PPI) uses weights based on past preferences. But since Boyer used the PPI, we present the results both ways. We also extend the data set two years to 1986.

Thus, our full model is

$$(3-1) \ln(\text{WEIGHT}) = b_0 + b_1\text{STAGGERS} + b_2\text{BULK} + e_1$$

$$(3-2) \ln(\text{Avg Rates}) = c_0 + c_1\text{STAGGERS} + c_2\text{BULK} + c_3\ln(\text{WEIGHT}) + c_4\text{FUEL} \\ + c_5\ln\text{HAUL} + c_6\text{GNPCH} + c_7\ln(\text{TRUCK}) + e_2$$

Inserting (3-1) into (3-2) yields the model we estimate

$$(3-3) \ln(\text{Avg Rates}) = c_0 + c_3b_0 + (c_1 + c_3b_1)\text{STAGGERS} + (c_2 + c_3b_2) \text{BULK} \\ + c_4\text{FUEL} + c_5\ln(\text{HAUL}) + c_6\text{GNPCH} + c_7\ln(\text{TRUCK}) + c_3e_1 + e_3$$

and we expect $c_1, c_2, c_3, c_5 < 0$ and $b_1, b_2, c_4, c_6,$ and $c_7 > 0$. (The variable WRES in our specification equals the residual e_1 in equation (3-1).)

B. Results

As shown in Table 2 our results indicate that the effect of the Staggers Act was to lower rail rates substantially by 1986. Using the GNP Deflator, the Staggers Act appears to have reduced rail rates by about 14 percent, accounting for changes in traffic mix, length of haul, and intermodal competition. Using the PPI as a deflator produces somewhat lower estimates of rate reductions due to Staggers of about 11 percent. In five of the six equations, the STAGGERS coefficient is significant beyond the five percent confidence level, and STAGGERS is significant in all equations at the ten percent confidence level. Due to data limitations we have very few degrees of freedom in our model. However, the coefficient on

STAGGERS remains significant (and larger in absolute value) in any specification with fewer variables.

The coefficients on our other variables are within reasonable limits. BULK seems a bit more negative and length of haul less negative than we would have expected. The coefficient on GNP change is significantly positive, reflecting aggregate demand's impact on determining rail rates. Truck rates are positive, indicating competition, but small, indicating that the modes may not be strong substitutes. The coefficients on fuel price are significant and have the expected signs (positive) in the GNP price deflator equations. However, in the PPI equations, none of the coefficients on fuel price are significant.

These results suggest that deregulation saved shippers billions of dollars. Annual rail freight revenues were \$35.0 billion in 1980, measured in 1986 dollars. Based on our estimates, by 1986 shippers were saving about \$3.5 to \$5 billion¹⁶ because of rate reductions, after correcting for changes in such factors as commodity composition, length of haul, and fuel prices.

IV. DEREGULATION AND SERVICE QUALITY

The reduction in rates is not the only benefit to shippers, however. Boyer states that he used train WEIGHT to reflect a *decline* in quality of service, on the view that larger shipments mean less frequent shipments and less handling by railroads. However, there is currently no reliable evidence on whether service frequency has declined or increased. Further, the handling to which Boyer refers was a major source of uncertainty, damage

¹⁶ \$35 billion times 0.11 equals \$3.85 billion, \$35 billion times 0.14 equals \$4.90 billion.

and delay. Its reduction has contributed in large part to the greater speed and reliability now provided to shippers and represents an *increase* in quality for the shipper.

To the shipper, the quality of transportation services is reflected in the level of nontransportation logistics costs (shipper-borne costs associated with warehousing, maintaining inventories, loading and unloading, and the like).¹⁷ The nontransportation components of logistics costs are quite substantial. The cost of maintaining inventories accounts for about \$150 billion -- or nearly 85 percent of these nontransportation logistics costs. The principal determinants of inventory cost are the interest rate and the size of inventories. Although the interest rate is presumably not affected by transport deregulation, inventory level most certainly is. If freight service is faster and (even more importantly) if carriers are more reliable in achieving on-time deliveries, managers need smaller inventory levels to achieve a firm's desired level of security for production and/or sales.

One of the important drawbacks of the pre-1980 regulatory system was that it did not permit carriers to offer service reliability guarantees.¹⁸ Modern inventory management methods (such as so-called "just-in-time" techniques) were generally not feasible in the United States before 1980 because the transportation system was not allowed to provide reliable

¹⁷ A good estimate of total logistics costs for 1986 is about \$440 billion, of which roughly \$260 billion represent total freight transportation costs and \$180 billion represent nontransportation components of logistics costs (Delaney, 1987).

¹⁸ Provisions such as the (now common for motor carriers) full or partial refunds of transport charges on delayed shipments were prohibited by ICC interpretation of the statute. Operations were also inhibited by other aspects of regulation, such as the intricate system of restrictions on motor carrier authorities.

service. Consistent with the regulatory changes, Delaney has shown (1986, 1987)¹⁹ that inventory levels have been substantially reduced since 1981. He estimated that total logistics cost fell from 14.5 percent of GNP in 1981 to 11.1 percent in 1986. That is, if logistics accounted for the same fraction of GNP in 1986 as in 1981, total logistics costs would have been over \$130 billion greater. About \$50 billion of this reduction can be ascribed to lower interest rates; but the remaining \$80 billion or so results about equally from lowered freight costs and from lower inventory levels.²⁰ Although it is possible to ascribe some portion of the reduction in inventory levels to other sources (for example, improvements in data processing), most of these could have had little impact apart from the improved reliability and speed made possible by deregulation.

It is quite difficult to apportion the roughly \$40 billion in nontransport logistics savings between rail and truck service, since most of the data used to estimate logistics costs are not available on such a basis. But if rail-related savings are roughly proportional to rail revenues, tons, or ton-miles, they would be about \$8, \$10, or \$12 billion respectively. Of course, rail commodities tend to be of lower unit value than truck commodities. Thus speed of shipment is presumably of less significance. But the costs associated with storage of the vast quantities of these commodities

¹⁹ Delaney's analysis was criticized in a pamphlet by Michael K. Evans (1987). The controversy has been reviewed in Beier and Stone (1988). Beier and Stone generally support Delaney's analysis, with slight modifications. Their estimate for the 1980-86 reduction in inventory costs is about \$84 billion, after accounting for lower interest rates.

²⁰ The freight share of GNP has fallen just over one percent since 1981, or about \$40 billion. Source: Transportation Policy Associates, Transportation in America, Fifth Edition, July Supplement, (Washington, D.C., 1987), p. 4.

are nonetheless very substantial, and even with bulk commodities substantial savings are likely to have resulted from lower inventory levels. Therefore, even if the logistics savings resulting from rail deregulation are less than proportional to rail traffic shares, they are unlikely to be much less so. Thus, rail-related logistics savings can be conservatively estimated to be in excess of \$5 billion and may be closer to \$10 billion annually.

V. OTHER IMPACTS OF DEREGULATION

Railroad deregulation also has had broad impacts in enabling railroads to reduce their operating costs by about twenty-five percent,²¹ resulting in an increase in profits despite the sharp reductions in rates. It is very difficult to compare profits with precision, but average profits ("net railway operating income") for the most recent three years have been about \$1 billion higher than for the three years before 1980. However, changes in accounting methodology in 1983, which had the effect of sharply lowering reported depreciation, may account for up to half of the increase in profits.²²

There has also been a sharp reduction in railroad employment: nearly 40 percent since 1980. An analysis of the net welfare impact of this reduction would, however, be complicated because many discharged workers received

²¹ Such gains have been possible primarily because of the loosening or elimination of regulatory restrictions on pricing and on managerial control of railroad assets. For a detailed discussion, see Barnekov (1987). For earlier analyses of rigidities and inefficiencies induced by rail regulation, see Felton (1978), Barnekov (1980), Sumner and Ferguson (1980), Ventura (1970), and Rastatter and Snow (1970).

²² Railroad profit data and accounting comparisons were taken from "Supplemental R-1 Data," attached to the annual reports of each major railroad submitted to the ICC.

substantial compensation from the railroads. Average earnings of remaining rail workers have also risen significantly compared to other U.S. laborers since 1980.²³ Thus, it appears that deregulation did not reduce the amount of rents gained by rail workers, contrary to the experience in the trucking industry. (See Rose (1987).)

Finally, taxpayers appear to have benefitted noticeably from rail deregulation. Federal subsidies to freight railroads have declined by about \$600 million (in 1986 dollars) since 1980, now amounting to only about \$60 million annually.²⁴

VI. CONCLUSION

A comprehensive estimate of the savings from transport deregulation should take into account the change in price to shippers, the change in product quality, the reduction in firms' cost structures, the impact on taxpayers and losses to labor. A rough calculation of total welfare gains from the rail deregulation resulting from the Staggers Act then would include something on the order of \$3.5 to \$5 billion in lower rates to shippers, about \$500 million in higher profits to railroads, and \$5 to \$10 billion in lower inventory-related logistics costs. Taxpayers could also be considered to have gained from the reduction of over half a billion (1986) dollars in federal subsidies to freight railroads. The effect of deregulation

²³ Comparison of 1980-86 rail average earnings from Railroad Facts with average nonagricultural earnings from Economic Report of the President, 1987, Table B-42. Real rail earnings rose about nine percent while average nonfarm real earnings declined about one percent.

²⁴ Source: Railroad R-1 Annual Reports to the ICC, published by the Association of American Railroads as Analysis of Class I Railroads, Series No. 2 (annual).

on rail labor is difficult to determine, and may have been positive or negative.

Thus, our estimate of the total annual gains from rail deregulation are from \$9 to \$15 billion. Because there is little evidence that any major group has lost from deregulation, this total represents net gains, and not merely transfers from one part of society to another. Even after generous adjustments for factors such as changes in rail traffic patterns (which we attempt to adjust for) or possible losses to labor, it would be difficult to get the net welfare gains below \$9 billion annually -- or about 100 times Boyer's estimate. Although we recognize the limitations of our data, we believe our results strongly suggest that railroad deregulation has generated significant efficiency gains for the economy.

TABLE 1

Regression Results for Boyer's Model
Dependent Variable: Natural Log of Real Rail Revenues per Ton-Mile
(Deflated by PPI, t-statistics in Parentheses)

Equation	(1)	(2)	(3)	(4)	(5)	(6)
Description	Boyer's Models ¹		Boyer's Models Adjusted ²		Boyer's Models Adjusted and Extended	
Years	1970-84	1970-84	1970-84	1970-84	1970-86	1970-86
Intercept	5.564 (6.718)	6.080 (2.564)	7.329 (10.396)	9.665 (4.200)	7.799 (8.659)	8.318 (2.655)
ln(WEIGHT)	-0.704 (-6.425)	-0.774 (-2.427)	-0.783 (-8.512)	-1.110 (-3.589)	-0.857 (-7.203)	-0.927 (-2.201)
DEREG	0.0192 (0.730)	0.0209 (0.737)	0.0440 (1.869)	0.0574 (2.183)	0.0433 (1.351)	0.0462 (1.247)
YEAR		0.00209 (0.234)		0.0076 (1.105)		0.0162 (0.174)
Adj R ²	0.904	0.896	0.922	0.923	0.910	0.904
F-stat	67.041	41.191	83.636	57.193	82.153	50.984
D-W	1.867	1.857	1.624	1.632	1.242	1.253

¹ Boyer's original model was estimated in 1967 dollars, as opposed to 1986 dollars used in this article. Thus, the constant term is slightly lower for equations (1) and (2).

² For models (3) through (6) Boyer's dummy variable for deregulation (DEREG) has been adjusted to be equal to 0 prior to 1981 and 1 thereafter.

TABLE 2

Regression Results
Dependent Variable: Natural Log of Real Rail Revenues per Ton-Mile
(t-statistic in Parentheses)
Years: 1970-86

Equation	(1)	(2)	(3)	(4)	(5)	(6)
Deflator	GNPD	GNPD	GNPD	PPI	PPI	PPI
Intercept	1.294 (26.430)	1.507 (5.347)	0.978 (2.551)	1.500 (21.325)	1.762 (4.819)	0.785 (1.428)
STAGGERS	-0.143 (-3.363)	-0.133 (-2.926)	-0.139 (-3.193)	-0.118 (-2.229)	-0.105 (-1.842)	-0.119 (-2.315)
BULK	-1.259 (-3.557)	-1.149 (-2.961)	-1.274 (-3.544)	-1.203 (-2.586)	-1.075 (-2.118)	-1.278 (-2.812)
WRES	-1.441 (-4.615)	-1.324 (-3.753)	-1.300 (-3.617)	-1.514 (-3.719)	-1.375 (-3.003)	-1.244 (-2.796)
FUEL*	0.130 (3.496)	0.135 (3.514)	0.124 (3.231)	0.0640 (1.214)	0.0721 (1.311)	0.740 (1.432)
GNPCH	0.00504 (2.100)	0.00553 (2.187)	0.00436 (1.694)	0.00862 (2.832)	0.00922 2.866	0.00667 (2.020)
ln (HAUL)		-0.160 (-0.769)			-0.198 (-0.731)	
ln (TRUCK)*			0.119 (0.830)			0.231 (1.311)
Adj R ²	0.969	0.967	0.968	0.952	0.950	0.955
F-stat	99.949	80.300	81.052	64.005	51.169	57.109
D-W	2.034	2.036	1.816	2.389	2.388	2.027

*Deflated by same deflator as dependent variable

Table 3
Description of Variables

<u>Name</u>	<u>Description</u>	<u>Source</u>
BULK	Percentage of rail shipments that are bulk goods	<u>Railroad Facts</u>
DEREG	A dummy variable for deregulation (0 prior to 1981, 1 for 1981-6)	
GNPCH	Percent change in GNP year to year	<u>Economic Report of the President</u>
FUEL	Fuel prices for railroads	<u>Railroad Facts</u>
HAUL	Average length of rail haul	<u>Railroad Facts</u>
STAGGERS	Number of rail contracts in year divided by number of rail contracts in 1986.	ICC Office of Transportation Analysis
TRUCK	Real truck rates in 1986 dollars	<u>Transportation in America</u>
WEIGHT	Average weight of train loads	<u>Railroad Facts</u>
WRES	The residual from regressing STAGGERS and HAUL on the log of WEIGHT	
YEAR	Calendar year (minus 1969)	

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