Changes in railroad rates since the Staggers Act

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Abstract

The railroad industry was substantially deregulated by the Staggers Act in 1980. While railroad rates, as measured by industry-wide revenue per ton-mile, declined since that time, it is unclear why rates declined. Changes in commodity mix, length of haul, shipment size, lading weight, equipment ownership, railroad costs, competition from other modes, and demand for railroad transportation have all played some role. This paper assesses the importance of each of these factors in explaining the decline in railroad rates since the Staggers Act. After controlling for changes in commodity mix, the analysis indicates that shippers received nearly $28 billion per year in rate reductions as a result of changes that took place between 1982 and 1996. The reduction in productivity-adjusted railroad costs explains almost 90% of the reduction in railroad rates, with other factors playing much lesser roles. © 2000 Elsevier Science Ltd. All rights reserved.

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1. Introduction

The economic benefits of railroad deregulation are well established. Winston (1985, 1993), Kahn (1990), Hahn and Hird (1991), and Viscusi et al. (1995, pp. 553–574) all provide reviews of this literature. A major issue within this literature is whether shippers have benefited from lower railroad rates. The original study by Boyer (1987) concluded that railroad rates had not fallen as a result of deregulation, and may even have risen slightly. As more years of data became available, researchers such as McFarland (1989), and Winston et al. (1990, p. 28) reached the more neutral conclusion that rates had been unchanged or slightly reduced. With still more data in hand, later
researchers such as Barnekov and Kleit (1990), Burton (1993), and Wilson (1994) concluded that railroad rates had unambiguously fallen.

Recent policy discussions have now focussed debate on the issue of why railroad rates fell after deregulation. Some shippers claim that the decline in rates is primarily due to changes in railroad traffic characteristics, such as an increasing percentage of bulk commodities, increased length of haul, and increased private ownership of equipment (National Industrial Transportation League, 1998, pp. 12–18). The railroad industry argues that these reductions reflect cost savings, heavierladings, and increased shipment size (Rockey, 1998, pp. 18–37).

The purpose of this paper is to determine the relative importance of the various factors underlying the decline in railroad rates since the Staggers Act. Section 2 describes the study methodology including the model, estimation techniques, and data used. Section 3 presents the regression results. Section 4 calculates the dollar value of railroad rate reductions due to each of the factors. Section 5 contains the conclusions.

2. Methodology

2.1. The model

Previous studies estimated reduced form railroad rate equations developed from explicit or implicit models of the supply and demand for railroad transportation. Specification of the rate equation evolved over time, with different researchers adopting different specifications for sometimes unexplained or contradictory reasons. This section formally derives a reduced form railroad rate equation from the economic theory of the firm.

The demand for freight transportation is derived from the productive activities of shippers. The long-run cost function for shipper \( i \) can be specified as

\[
LRSC_i = LRSC_i(P_r, P_s, P_o, I),
\]

where \( P_r \) is the factor price of railroad transportation, \( P_s \) the factor price of substitute transportation, \( P_o \) a composite price index of all other factors of production used by the shipper, and \( I \) is the shipper’s output.

Applying Shephard’s Lemma, the demand for railroad transportation is

\[
Q_i(P_r, P_s, P_o, I) = \frac{\partial}{\partial P_r} LRSC_i(P_r, P_s, P_o, I).
\]

Since cost functions are homogeneous of degree one in factor prices, the input demand functions are homogeneous of degree zero in factor prices (Henderson and Quandt, 1971, p. 69). Dividing by the composite price index of all other factors of production, and relying on the homogeneity of the demand function, the quantity of railroad transportation demanded, measured in ton-miles, is

\[
Q_i = Q_i \left( \frac{P_r}{P_o}, \frac{P_s}{P_o}, I \right).
\]
Eq. (3) indicates that the demand for railroad transportation depends on the price of railroad and substitute transportation relative to the composite price index of all other factors of production employed by the shipper.\(^1\)

The total cost of railroad transportation can be specified as

\[
C = C\left(\bar{W}, \bar{T}, \bar{Q}\right),
\]

where \(W\) is a vector of railroad input factor prices, \(T\) is a vector of railroad shipment characteristics, and \(Q\) is a vector of railroad outputs, measured in ton-miles.

The marginal cost incurred in providing \(Q_i\) ton-miles of railroad transportation services to shipper \(i\) is

\[
MC_i = \frac{\partial}{\partial Q_i} C\left(\bar{W}, \bar{T}, \bar{Q}\right).
\]

If shipper \(i\)'s traffic is not subject to maximum rate regulation, then the railroad determines the profit maximizing price \(P_i^*\) according to the usual profit maximization condition

\[
P_i^* = \frac{1}{\left(1 + \frac{1}{E_i}\right)} MC_i,
\]

where \(E_i\) is shipper \(i\)'s elasticity of demand for railroad transportation. If shipper \(i\)'s traffic is subject to maximum rate regulation, then the profit maximizing price is given by

\[
P_i^* = K \times MC_i,
\]

where \(K \geq 1.0\) is a constant markup exogenously determined by the regulator.

2.2. Estimation

Eqs. (3) and (5)–(7) constitute a fully specified model of railroad rate determination. A reduced form rate equation for this model was developed using a generalized Cobb–Douglas specification. Under this specification, the revenue per ton-mile of commodity \(i\), terminated by railroad \(j\), in car ownership type \(o\) (railroad vs. private), in year \(t\) may be written as

\[
RPTM_{ijot} = \text{EXP}(a) \times (\text{LOH}_{ijot})^\beta \times (\text{SS}_{ijot})^\gamma \times (\text{LOAD}_{ijot})^\delta \times \text{EXP}(\zeta \times \text{OWN}_o) \\
\times (\text{COST}_j)^\theta \times (\text{TKPRICE}_t)^\phi \times \text{EXP}(\psi \times \text{IP}_{it}),
\]

where \(RPTM\) is the revenue per ton-mile (cents), \(\text{LOH}\) the length of haul (miles), \(\text{SS}\) the shipment size (tons), \(\text{LOAD}\) the tons per car (tons), \(\text{OWN}\) the car ownership (railroad = 0, private = 1),

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\(^1\) Some time series studies specified the demand for transportation in terms of nominal rates. Deriving the demand for transportation from a shipper cost function illustrates why this is incorrect. If demand is specified in terms of nominal rates (with other factor prices excluded), and the nominal price of railroad transportation is unchanged over time, then the quantity of railroad transportation demanded would be unchanged over time. However, if the price of other factors of production increased over time, then the price of railroad transportation would have fallen relative to the price of other productive inputs, increasing the quantity of railroad transportation demanded. Use of nominal rates therefore results in a misspecification of the model.
COST the railroad cost index, adjusted for productivity \((1982 = 100)\), TKPRICE the price of truck transportation (cents per ton-mile), and IP is the annual percentage change in industrial production.

Taking natural logarithms of both sides results in a linear equation,

\[
\ln(RPTM_{ijot}) = \alpha + \beta \ln(LOH_{ijot}) + \gamma \ln(SS_{ijot}) + \delta \ln(LOAD_{ijot}) + \zeta \ln(COST_t) + \varphi \ln(TKPRICE_t) + \psi \ln(IP_t) + \epsilon_{ijot},
\]

where \(\ln\) is the natural logarithm of the variable in question, and \(\epsilon\) is a normally distributed error term. \(^2\)

The \(\alpha\) coefficient represents the intercept term. The \(\beta\), \(\gamma\), and \(\delta\) coefficients are the elasticities of RPTM with respect to LOH, SS, and LOAD, respectively. These variables capture the effect of changing shipment characteristics on railroad costs. As LOH, SS, and LOAD increase, some indivisible railroad costs such as trip origination and termination costs, shipment billing costs, and equipment ownership costs remain essentially unchanged, resulting in declining average costs and lower prices. The coefficients of these three variables should therefore be negative, so that an increase in any of these variables would reduce the revenue per ton-mile. \(^3\) The \(\zeta\) coefficient is used to calculate the percentage change in RPTM resulting from the use of shipper-owned equipment. When shippers use their own equipment, the rate paid to the railroad no longer includes the ownership cost of the equipment. This coefficient should therefore be negative, so that switching to private ownership of equipment would cause a one-time \((\exp(\zeta) - 1) \times 100\) percentage reduction in railroad revenue per ton-mile. The \(\theta\) coefficient is the elasticity of RPTM with respect to COST, a productivity-adjusted railroad cost index. This coefficient should be positive, in that reductions in railroad costs lead to reduced revenue per ton-mile. The \(\varphi\) coefficient is the elasticity of RPTM with respect to TKPRICE. If railroad transportation and truck transportation are substitutes, then an increase in the price of truck transportation would increase the demand for railroad transportation, making the coefficient of this variable positive. \(^4\) The \(\psi\) coefficient is used to calculate the percentage change in RPTM resulting from an increase in industrial production. This coefficient should be positive, so that an \(x\) percent outward shift in the demand for railroad transportation would cause an \((\exp(\psi \times x) - 1) \times 100\)% increase in railroad revenue per ton-mile. The generalized Cobb-Douglas specification contains no restriction on the sum of the \(\beta\), \(\gamma\), \(\delta\), and \(\theta\) coefficients.

\(^2\) Railroad and truck service attributes also affect the demand for rail service and hence rail rates. Railroad and truck service attributes are not included in the regression because time series data on these variables are simply unavailable. While this may cause an omitted variable bias in the regression coefficients, the bias depends only on the relative values of these variables, and is most likely to occur in high-valued commodities, which are not usually the subject of shipper concerns.

\(^3\) These variables may not be entirely exogenous, since railroads would be expected to concentrate on the types of traffic for which they have a comparative advantage. However, numerous other factors such as increased use of western coal, the growth of international trade, and changes in manufacturing patterns have also had a major effect on these variables, which therefore may be viewed as exogenous.

\(^4\) Oum and Waters (1996) review several recent studies indicating that truckload (TL) trucking company costs exhibit constant returns to scale. If TL costs exhibit constant returns to scale, and competition in TL trucking forces truck rates to equal marginal costs, then changes in rail rates would affect the quantity of truck transportation demanded, but not the price. TKPRICE may therefore be viewed as exogenous.
Eq. (9) was estimated using annual data from 1982 to 1996 in order to use the maximum amount of reliable data. Previous commodity-specific rate studies for coal (e.g., Atkinson and Kerkvliet, 1986; Dalton and Redisch, 1990; MacDonald, 1994; Dennis, 1999) and for grain (e.g., Babcock et al., 1985; Fuller et al., 1987; MacDonald, 1987, 1989), indicate that the behavior of rates may vary across commodities. In order to allow for possible variation across commodities, and also to control for changes in commodity mix, a regression was run for each of nine two-digit Standard Transportation Commodity Code (STCC) commodities which accounted for at least one billion dollars in Class I railroad revenue in 1996. Intermodal traffic was included as a tenth, separate, commodity due to its unique characteristics. The ten commodities analyzed accounted for almost 90% of industry revenues in 1996. In order to estimate the effect of ownership, each commodity regression included separate observations for traffic carried in railroad and privately owned cars. Since data points represented different amounts of output, each data point was weighted by the associated number of ton-miles when formulating the regression. The regressions were also corrected for possible serial correlation using the Cochrane–Orcutt procedure.

2.3. Data

The data sources and construction of each of the variables used in the model are described in detail in Appendix A.

Table 1 provides a summary of the revenue per ton-mile data. The first column of the table lists the commodities, sorted in order of 1996 railroad revenues. The second column shows the 1996 revenues associated with those commodities. The third and fourth columns show the revenue per ton-mile for each commodity (in 1996 dollars) in 1982 and 1996, respectively. The last column shows the percentage change in revenue per ton-mile for each commodity over the 14-year period. Revenue per ton-mile declined by 39–59% for each of the ten commodities. The decline was greatest for coal and food products, and least for chemicals and transportation equipment. The percentage declines for the other commodities were fairly uniformly distributed between the two extremes.

Table 2 presents the percentage changes in the independent variables. The first two columns of this table again list the commodities and their 1996 railroad revenues. The next seven columns list the percentage change associated with each variable from 1982 to 1996. IP, COST, and TKPRICE show the largest percentage change over the period. The change in COST was assumed to be the same for all commodities, since there was no information on the costs associated with individual commodities. The change in TKPRICE was also assumed to be the same for all commodities for the same reason. SS and LOAD changed slightly less over the period, while OWN and LOH

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5 The sampling methodology of the Surface Transportation Board’s Carload Waybill Sample was changed in 1982 to correct for undersampling of unit train and multi-car shipments (Wolfe and Linde, 1997). This makes it impossible to develop meaningful measurements of railroad shipment sizes prior to that date.

6 Class I railroads are the largest railroads in the United States. In 1996 Class I railroads had operating revenue of at least $255.0 million each, and accounted for 91% of industry revenue.
changed the least over the period. \(^7\) Note that in some cases LOH, SS, LOAD, or OWN declined over the period.

### 3. Regression results

The regression results are reported in Table 3. The first column of this table lists the commodities, sorted in order of their 1996 railroad revenues. The next eight columns list the regression coefficients for the intercept term and each independent variable. The \(t\)-statistics are reported beneath their associated regression coefficients. The last three columns present the \(R^2\) and Durbin–Watson statistics for the regression, along with \(N\), the sample size.

The model fit the data well in most cases. Most of the \(R^2\)'s were in the range of 0.7–0.8 or better, and the Durbin–Watson statistics indicate the lack of residual serial correlation. The regression

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\(^7\) Changes in SS, LOAD, and OWN for intermodal traffic may reflect changes in the reporting of multi-well cars, rebilling, and other data reporting issues over the period.
<table>
<thead>
<tr>
<th>Commodity</th>
<th>Intercept</th>
<th>LOH</th>
<th>SS</th>
<th>LOAD</th>
<th>OWN</th>
<th>COST</th>
<th>TKPRICE</th>
<th>IP</th>
<th>Adj. $R^2$</th>
<th>D–W</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>3.224</td>
<td>-0.517</td>
<td>-0.023</td>
<td>-1.147</td>
<td>-0.157</td>
<td>1.257</td>
<td>0.445</td>
<td>0.228</td>
<td>0.831</td>
<td>2.113</td>
<td>470</td>
</tr>
<tr>
<td>Intermodal traffic</td>
<td>-2.990</td>
<td>-0.254</td>
<td>-0.176</td>
<td>-0.241</td>
<td>-0.007</td>
<td>1.284</td>
<td>0.759</td>
<td>0.151</td>
<td>0.491</td>
<td>2.064</td>
<td>7885</td>
</tr>
<tr>
<td>Chemicals</td>
<td>1.159</td>
<td>-0.298</td>
<td>-0.119</td>
<td>-0.625</td>
<td>0.171</td>
<td>1.155</td>
<td>0.234</td>
<td>0.612</td>
<td>0.739</td>
<td>1.879</td>
<td>516</td>
</tr>
<tr>
<td>Transportation equipment</td>
<td>-2.742</td>
<td>-0.188</td>
<td>-0.074</td>
<td>-0.345</td>
<td>-0.972</td>
<td>1.701</td>
<td>0.266</td>
<td>0.439</td>
<td>0.479</td>
<td>2.041</td>
<td>470</td>
</tr>
<tr>
<td>Agricultural products</td>
<td>0.901</td>
<td>-0.345</td>
<td>-0.199</td>
<td>0.154</td>
<td>0.053</td>
<td>0.591</td>
<td>0.129</td>
<td>-0.008</td>
<td>0.725</td>
<td>2.233</td>
<td>489</td>
</tr>
<tr>
<td>Food products</td>
<td>1.751</td>
<td>-0.316</td>
<td>-0.407</td>
<td>-0.372</td>
<td>0.071</td>
<td>0.845</td>
<td>0.578</td>
<td>-0.665</td>
<td>0.850</td>
<td>2.156</td>
<td>511</td>
</tr>
<tr>
<td>Pulp and paper</td>
<td>0.539</td>
<td>-0.343</td>
<td>0.276</td>
<td>-0.923</td>
<td>-0.033</td>
<td>1.226</td>
<td>0.316</td>
<td>0.047</td>
<td>0.427</td>
<td>2.310</td>
<td>507</td>
</tr>
<tr>
<td>Lumber</td>
<td>0.311</td>
<td>-0.243</td>
<td>-0.266</td>
<td>-0.231</td>
<td>-0.104</td>
<td>0.821</td>
<td>0.495</td>
<td>0.301</td>
<td>0.758</td>
<td>2.322</td>
<td>492</td>
</tr>
<tr>
<td>Primary metals</td>
<td>3.433</td>
<td>-0.505</td>
<td>-0.249</td>
<td>-0.809</td>
<td>0.009</td>
<td>1.194</td>
<td>0.348</td>
<td>0.243</td>
<td>0.822</td>
<td>1.953</td>
<td>448</td>
</tr>
<tr>
<td>Stone, clay, and glass</td>
<td>1.942</td>
<td>-0.428</td>
<td>-0.194</td>
<td>-0.445</td>
<td>0.167</td>
<td>1.029</td>
<td>0.270</td>
<td>0.413</td>
<td>0.658</td>
<td>2.343</td>
<td>509</td>
</tr>
</tbody>
</table>
coefficients almost always had the correct sign and almost always were statistically significant at
the 95% confidence level. The coefficients which did have an incorrect sign were almost all in-
significantly different from zero. 8

The values of the coefficients also appear to be reasonable. The LOH, SS, and LOAD coeffi-
cients each represent the elasticity of RPTM with respect to the variable in question. A 1% in-
crease in LOH reduced RPTM by 0.2–0.5%. A similar change in SS reduced RPTM by
0.0–0.4%, 9 while a 1% change in LOAD reduced RPTM by 0.2–1.1%. 10 Converting from rail-
road to privately owned equipment usually resulted in a one-time cost savings of 0–15%. In the
case of coal traffic, this one-time cost savings was (EXP(−0.157) − 1)*100 = 14.5%. A 1% de-
crease in COST reduced RPTM by anywhere from 0.6% to 1.7%, with most reductions of 1.0% or
greater. This behavior is consistent with Eqs. (6) and (7), wherein rates are set at some markup
over marginal cost. A 1% increase in TKPRICE increased RPTM by anywhere from 0.1% to
0.8%. Lastly, a 1% increase in IP usually resulted in a 0.1–0.6% increase in RPTM. This relatively
small responsiveness of railroad rates to increased demand is consistent with firms that are
experiencing nearly constant marginal costs. Oum and Waters (1996) provide a review of the
recent railroad cost function literature.

4. Changes in railroad revenue per ton-mile

The regression coefficients and the data on traffic characteristics were used to calculate the
overall change in revenue per ton-mile associated with each variable from 1982 to 1996. The total
change in revenue per ton-mile from all sources over the period from 1982 to 1996 can be cal-
culated by taking the total differential of Eq. (8). If s percent of ton-miles of a given commodity
are shipped in privately owned equipment, and 1 − s are shipped in railroad owned equipment,
then the total change in revenue per ton-mile for a given commodity over the period can be
written as

\[
\Delta \text{RPTM} = [(\beta/\text{LOH})\Delta \text{LOH} + (\gamma/\text{SS})\Delta \text{SS} + (\delta/\text{LOAD})\Delta \text{LOAD} + (\theta/\text{COST})\Delta \text{COST} + (\phi/\text{TKPRICE})\Delta \text{TKPRICE} + \psi \Delta \text{IP}] \times [sRPTM_p + (1-s)RPTM_r] + [(\text{EXP}(\zeta) - 1)RPTM_r] \Delta s,
\]

where \(\Delta\) represents the change in the respective variables over the period 11, \(\beta, \gamma, \delta, \zeta, \theta,\) and \(\phi\) are
the regression coefficients, and \(\text{RPTM}_p\) and \(\text{RPTM}_r\) are the estimated revenue per ton-mile for
traffic shipped in privately owned and railroad owned equipment, respectively.

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8 There are three cases (chemicals, food products, and stone, clay, and glass) where OWN has an incorrect positive
sign that is statistically significant. In each case, this appears to reflect the existence of tank car traffic within the larger
two-digit commodity group. Tank cars are almost exclusively owned by non-railroads, and if the commodities in these
cars have a greater revenue per ton-mile than the other commodities in the group, then OWN would have a positive and
statistically significant coefficient.

9 The positive SS coefficient in the pulp and paper regression was statistically insignificant.

10 The positive LOAD coefficient in the agricultural products regression was statistically insignificant.

11 The change in industrial production was calculated as a percentage of the 1982 value.
Eq. (10) illustrates how the total change in RPTM over the period can be estimated as the sum of separable effects for each of several independent variables. The effect of each independent variable, in turn, is the product of the change in that variable over the period and the effect of that variable on RPTM. The total change in RPTM can be evaluated either from the perspective of 1982 traffic looking forward, or 1996 traffic looking backward. The former method corresponds to calculating the components of a Laspeyres price index using 1982 as the initial year, while the latter method corresponds to calculating the components of a Paasche price index using 1996 as the final year. Since the current policy debate focuses on the effect of changes in railroad rates on current shippers, the latter method was adopted.

The change in the independent variables over the period and the 1996 share of ton-miles carried in privately owned equipment were calculated directly from the data for each commodity. The predicted total change in industry average RPTM, and the predicted change in industry average RPTM associated with each of the independent variables, were calculated by evaluating Eq. (10) at the 1996 industry average values of the independent variables for each commodity. The changes in RPTM for a given commodity were then multiplied by the 1996 ton-miles for that commodity to obtain an estimate of the annual savings to 1996 shippers as a result of the changes in revenue per ton-mile that occurred between 1982 and 1996.

The results of this calculation are shown in Table 4. The first two columns of this table list the commodities sorted in order of their 1996 ton-miles. The next seven columns show the savings to 1996 shippers of the given commodity (in billions of 1996 dollars) associated with changes in the respective independent variables. The bottom two rows show the sum of savings across all ten commodities associated with changes in an independent variable, and the share of all savings accounted for by changes in each independent variable. The last line of the table shows the total annual savings to shippers associated with changes in all independent variables across all commodities.

Table 4 illustrates that shippers saved nearly $28 billion per year (in 1996 dollars) as a result of changes in railroad revenue per ton-mile that took place between 1982 and 1996. This estimate is consistent with the 54% decline in railroad industry revenue per ton-mile in real terms since 1982 (Association of American Railroads, 1982–1996c). These savings are larger in percentage terms than those estimated by Wilson (1994, p. 17), and Burton (1993, p. 430), and are at the upper end of those estimated by Barnekov and Kleit (1990, p. 21) after adjusting for inflation. Winston (1998) found that the estimated annual savings due to deregulation in various industries tended to increase over time as firms were able to adjust more fully to the deregulated environment. It is therefore not unreasonable to expect that later estimates using more recent data would show larger savings.

COST, by itself, accounted for more than $24 billion per year in rate reductions. Eighty percent of these cost-related reductions occurred in the four largest revenue commodity groups: coal, intermodal traffic, chemicals, and transportation equipment. The two largest reductions, for coal and intermodal traffic, occurred where railroads have substantially increased the use of

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12 Gisser (1981, pp. 130–133). The difference in calculations between the two methods reflects changes in traffic mix over the period.
unit train and double stack technologies since 1982. TKPRICE accounted for $6.5 billion per year in railroad rate reductions, approximately 23% of the total reduction in rates. The effect of TKPRICE was largest for intermodal traffic, where competition from trucks is greatest. The next most important factor, IP, partially offset the rate reductions due to reduced costs. Increased industrial production increased railroad rates by approximately $5 billion per year, or 18% of the total change in rates, with the largest increases coming in chemicals and transportation equipment. Increases in LOAD accounted for approximately $1.3 billion per year in rate reductions, approximately 5% of the total reduction in rates. The largest reductions attributable to this variable were for coal, where higher capacity cars have become more common. The next most important factor was increased LOH, which accounted for $600 million per year in rate reductions, approximately 2% of the total savings to shippers. Essentially all of these rate reductions again were concentrated in coal, where long-haul shipments from western states have greatly increased. Changes in SS had a slight effect, accounting for approximately $19 million per year in railroad rate reductions, approximately 0.1% of all railroad rate reductions. Changes in OWN had the least effect, accounting for approximately three million per year in rate reductions. Essentially all of these ownership-related rate reductions were concentrated in coal, but were offset by ownership cost increases in other commodities.

Note that changes in LOAD and SS both appear to be responsible for increased intermodal rates. This may have been due to increased single-shipment billing of intermodal shipments in later years, which reduces both the apparent shipment size and lading weight.

Table 4
Summary of railroad revenue per ton-mile changes (billion 1996 $)

<table>
<thead>
<tr>
<th>Commodity</th>
<th>1996 ton miles (bil)</th>
<th>LOH</th>
<th>SS</th>
<th>LOAD</th>
<th>OWN</th>
<th>COST</th>
<th>TKPRICE</th>
<th>IP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>501.081</td>
<td>−0.610</td>
<td>−0.077</td>
<td>−1.134</td>
<td>−0.072</td>
<td>−5.660</td>
<td>−1.555</td>
<td>0.461</td>
</tr>
<tr>
<td>Intermodal traffic</td>
<td>204.745</td>
<td>−0.051</td>
<td>0.475</td>
<td>0.706</td>
<td>−0.004</td>
<td>−4.689</td>
<td>−2.154</td>
<td>0.500</td>
</tr>
<tr>
<td>Chemicals</td>
<td>143.151</td>
<td>0.003</td>
<td>−0.094</td>
<td>−0.319</td>
<td>0.050</td>
<td>−4.655</td>
<td>−0.732</td>
<td>2.347</td>
</tr>
<tr>
<td>Agricultural products</td>
<td>139.486</td>
<td>−0.166</td>
<td>0.036</td>
<td>0.030</td>
<td>0.015</td>
<td>−0.954</td>
<td>−0.162</td>
<td>−0.004</td>
</tr>
<tr>
<td>Food products</td>
<td>82.901</td>
<td>−0.019</td>
<td>−0.215</td>
<td>−0.166</td>
<td>0.008</td>
<td>−0.877</td>
<td>−0.466</td>
<td>−0.355</td>
</tr>
<tr>
<td>Lumber</td>
<td>61.778</td>
<td>−0.092</td>
<td>−0.097</td>
<td>−0.088</td>
<td>0.000</td>
<td>−0.960</td>
<td>−0.450</td>
<td>0.355</td>
</tr>
<tr>
<td>Pulp and paper</td>
<td>48.927</td>
<td>−0.006</td>
<td>0.040</td>
<td>−0.118</td>
<td>0.000</td>
<td>−0.397</td>
<td>−0.079</td>
<td>0.012</td>
</tr>
<tr>
<td>Primary metals</td>
<td>46.705</td>
<td>0.001</td>
<td>−0.051</td>
<td>−0.193</td>
<td>0.000</td>
<td>−0.960</td>
<td>−0.218</td>
<td>0.159</td>
</tr>
<tr>
<td>Transportation equip.</td>
<td>34.463</td>
<td>0.285</td>
<td>0.012</td>
<td>0.084</td>
<td>0.003</td>
<td>−4.526</td>
<td>−0.549</td>
<td>1.378</td>
</tr>
<tr>
<td>Stone, clay, and glass</td>
<td>33.032</td>
<td>0.051</td>
<td>−0.048</td>
<td>−0.091</td>
<td>0.004</td>
<td>−0.743</td>
<td>−0.152</td>
<td>0.183</td>
</tr>
<tr>
<td>Total change due to factor</td>
<td>−$0.606</td>
<td>−$0.019</td>
<td>−$1.290</td>
<td>$0.003</td>
<td>−$24.420</td>
<td>−$6.517</td>
<td>$5.036</td>
<td></td>
</tr>
<tr>
<td>Percent of total change</td>
<td>2.2%</td>
<td>0.1%</td>
<td>4.6%</td>
<td>0.0%</td>
<td>87.8%</td>
<td>23.4%</td>
<td>−18.1%</td>
<td></td>
</tr>
<tr>
<td>Total change in revenue per ton-mile</td>
<td>−$27.812</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The results in Table 4 illustrate the relative importance of the various factors contributing to railroad rate reductions. Some shippers claim that the decline in railroad revenue per ton-mile since deregulation is primarily due to changes in railroad traffic characteristics, such as an increasing percentage of bulk commodities, increased length of haul, and increased private ownership of equipment. The railroad industry argues that these reductions reflect cost savings, heavier lading, and increased shipment size. This study controlled for changes in commodity mix by running separate regressions for each commodity. The results of this study indicate that productivity-adjusted railroad cost reductions, by themselves, account for almost 90% of the rate reductions, with the other factors in the study playing much lesser roles. The increased length of haul and increased private ownership of equipment cited by some shippers account for only about 2% of the reduction in railroad revenue per ton-mile since deregulation.

5. Conclusions

While the economic benefits of railroad deregulation are well established, recent policy discussions have focussed debate on the issue of why railroad rates fell after deregulation. Some shippers claim that the decline in rates is primarily due to changes in railroad traffic characteristics, such as an increasing percentage of bulk commodities, increased length of haul, and increased private ownership of equipment. The railroad industry argues that these reductions reflect cost savings, heavier lading, and increased shipment size.

This paper used a reduced form railroad rate equation to determine the relative importance of the various factors underlying the decline in railroad rates since the Staggers Act. Commodity mix was controlled for and effects were allowed to vary across commodity by running separate regressions for each of ten major two-digit STCC commodities. The regression coefficients and data on traffic characteristics were used to calculate the overall change in revenue per ton-mile associated with each independent variable by calculating the total differential of the rate equation. The change in revenue per ton-mile was applied to 1996 traffic levels to determine the annual savings to shippers.

The results of this study indicate that shippers saved nearly $28 billion per year (in 1996 dollars) as a result of the changes in railroad revenue per ton-mile that took place between 1982 and 1996. Productivity-adjusted railroad cost reductions, by themselves, accounted for almost 90% of the rate reductions, with the other factors in the study playing much lesser roles. The results of this study also indicate that the increased length of haul and increased private ownership of equipment cited by some shippers accounted for only about 2% of the reduction in railroad revenue per ton-mile since deregulation.

Acknowledgements

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Appendix A

This appendix describes the data sources and construction of each of the variables used in the model.

A.1. Dependent variable

Most previous railroad rate studies use RPTM data derived from the Surface Transportation Board’s (STB) Carload Waybill Sample. The Carload Waybill Sample contains detailed data on the revenue, tonnage, commodity type, and shipment characteristics of hundreds of thousands of railroad movements. The data on commodity type and shipment characteristics are generally considered to be accurate. However, contract confidentiality, revenue adjustments, sampling error, and other factors make the revenues and tonnages reported in the Carload Waybill Sample, and hence the ton-miles and RPTM, differ from the actual levels generated by the railroads. Wolfe and Linde (1997) have shown that the growth of contracts and other factors cause the Carload Waybill Sample to overstate railroad revenues in recent years to the point that the overstatement may obscure recent rate trends.

In order to provide more accurate data on RPTM, the Waybill revenue and tonnage data were adjusted to match those reported in the Association of American Railroads’ (AAR) Freight Commodity Statistics (FCS) database (AAR, 1982–1996a). The FCS database reports the actual tonnage carried and the actual revenues ultimately received by each Class I railroad for two and three-digit STCC commodities. The FCS database does not contain information on ton-miles carried, shipment characteristics, car ownership, or revenues received by non-Class I carriers.

The adjusted RPTM data were developed as follows. First, the Carload Waybill Sample was used to calculate the reported total revenue and reported total tonnage for each commodity terminated by each railroad in each year in the FCS. Terminations on railroads not listed in the FCS were aggregated into a single “all other” railroad category. Second, the FCS revenue and tonnage for each commodity terminated by each railroad in each year were divided by the corresponding reported Waybill revenue and tonnage to obtain adjustment factors for each commodity terminated by each railroad in each year in the FCS. Overall, the average adjustment was approximately 3% for both revenue and tonnage. Third, the revenue and tonnage for each observation in the regression data set were multiplied by the appropriate adjustment factors, effectively calibrating reported Waybill revenues and tonnages to FCS values. Revenue and tonnage for railroads not listed in the FCS were adjusted using the FCS average for that commodity in that year. Next, the adjusted tonnage for each observation was multiplied by the ton-weighted length of haul for each observation, resulting in an adjusted estimate of the ton-miles for each observation. The adjusted revenue for each observation was then divided by the adjusted ton-miles for each observation, resulting in an adjusted RPTM for each observation that was consistent with the actual tonnage carried and the actual revenues ultimately received by each Class I railroad. Lastly, each observation’s RPTM was then converted to constant 1996 dollars using the Implicit Price Deflator for Gross Domestic Product (GDP) (Executive Office of the President, 1998, p. 284). Unlike the Producer Price Index (PPI) or Railroad Cost Recovery Index (RCR) used in some previous studies, the GDP deflator represents the composite price of the broad range of factors of production employed by shippers, as specified in the demand function.
A.2. Independent variables

LOH was calculated directly from the Carload Waybill Sample for each observation. This was done by dividing total ton-miles for the observation (tons multiplied by distance traveled) by total tons for the observation. The result was a ton-weighted average length of haul.

SS was calculated directly from the Carload Waybill Sample for each observation. This was done by dividing total lading tons for the observation by the total number of shipments (records) in the observation.

LOAD was calculated directly from the Carload Waybill Sample for each observation. This was done by dividing total lading tons for the observation by the total number of cars in the observation.

OWN was determined using the reporting marks of the car on the Waybill record. Reporting marks ending in X were considered to be privately owned cars, with the exception of TTX reporting marks, which were considered to be railroad owned cars. TTX is wholly owned by the participating railroads, and usually operates under a leasing arrangement whereby the handling railroad pays TTX for the use of TTX cars. Use of these cars is not likely to result in an ownership discount.

COST was calculated using a productivity-adjusted cost index. By adjusting for productivity, the cost index reflects not just changes in input prices, but rather the actual costs incurred by railroads in providing transportation. The Rail Cost Adjustment Factor (RCAF) unadjusted for productivity was used as the initial cost index, with a value of 1982 = 100 (AAR, 1982–1996b, Tables G, H, I). Dividing this index by a productivity index resulted in a productivity-adjusted cost index. Productivity was measured using the productivity adjustment factor in the RCAF for the period 1989–1996 (AAR, 1982–1996b, Tables G, I). The railroad productivity index reported by Duke et al. (1992) was used for the years 1982–1989. This index takes account of productivity growth from all sources, and is very similar to the productivity adjustment factor in the RCAF. The two productivity indexes were linked using the common year of 1989.

The high negative correlation (−0.93) between the cost and productivity indexes makes it impossible to obtain reliable estimates of these effects separately. The productivity-adjusted cost variable used in this study is essentially a ratio specification, which allows the effects of both variables to be included in the model. Changes in length of haul and shipment size can also affect measured productivity, which in turn affects productivity-adjusted costs. Inclusion of length of haul and shipment size as separate variables in the regression allows the effect of productivity-adjusted cost changes to be estimated independent of the effect of these variables.

TKPRICE was constructed using truck revenue per ton-mile divided by the GDP deflator. Revenue per ton-mile for Specialized Carriers is reported in Financial and Operating Statistics (American Trucking Associations, 1982–1996). Specialized Carriers do not incur the local pickup and delivery costs of the large less-than-truckload (LTL) carriers, and thereby provide a better representation of rail-competitive truck rates than those used in previous studies.

IP was measured using the Index of Industrial Production (Federal Reserve Board, 1982–1996). The relevant two-digit commodity index was used for all commodities except grain, which was measured using total bushels of grain produced in the United States (US Department of Agriculture, 1982–1996). The production index for all manufactures was used to reflect the heterogeneous nature of intermodal traffic. An annual percentage change specification of this variable was chosen in order to avoid multi-collinearity with the cost variable.
References