Asymmetric Effects of Deregulation

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ABSTRACT

Since partial deregulation of the railroad industry in 1980, rail rates have fallen in real terms, leading many observers to conclude that deregulation has been a success. Yet, previous studies of the effects of deregulation on *aggregate* rate levels are inconclusive in identifying deregulation as the reason for lower rates. In this paper, I develop a conceptual model that nests a variety of possible effects of deregulation on the rates charged for transporting individual commodities. Deregulation may affect rates differently depending on the nature of pricing in regulated and non-regulated states, the level of cost savings from deregulation, and the price elasticity of demand. The model is used to examine the effects of deregulation on 34 different commodity classifications. The results suggest deregulation significantly affected almost all commodities, affected commodities asymmetrically, and had effects that vary through time. Initially, deregulation increased rates for some commodities, had no effect on others, and decreased rates on still others. However, by 1988, deregulation lessened rates for almost all commodities, with the largest declines being associated with long hauls and heavy loads.

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INTRODUCTION

The railroad industry was partially deregulated in 1980, substantially reducing regulatory constraints, many of which had been in place since the inception of federal regulation of railroads in 1887. Over the past century, the development of alternative transportation modes together with a slowly adjusting regulatory environment has led to a deteriorated rail network, higher costs, misallocated traffic, a decline in financial position, and ultimately to bankruptcies in the 1970s. In response to these conditions and the perception of increased competition in transportation markets, Congress passed the Stagger's Rail Act of 1980. The Staggers Rail Act reduced constraints on pricing, exit, and operations in the hope that the industry would become more productive and more responsive to competitive pressures.

Since deregulation, *aggregate* (average) rail rates have fallen in real terms. If rates have fallen because of deregulation then the cost savings from deregulation have dominated the adverse price effects of any increase market power that may have occurred. Yet, empirical studies that attempt to directly assess the impact of deregulation on aggregate rail rates have produced mixed results.[1] Thus, while aggregate real rates have fallen since deregulation, it is unclear whether the lower rates have been caused by deregulation.

Some deregulation studies have focussed on the rates charged for transporting particular commodities. While these studies cover only a small number of commodities (primarily coal and grain), they do suggest that deregulation has affected rates on

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[1] Boyer (1987) found that "...the most likely effect of deregulation has been to raise the rate level about 2% (p. 411);" Barnekov and Kliet (1990), using a variety of specifications, found deregulation reduced rates between about 16.5% to 18.5%, while McFarland (1989) found the "...available evidence suggests that deregulation either slightly reduced or had no effect on railroad rates (p. 261)."

different commodities differently. In coal markets, for example, deregulation appears to have increased rents to railroads (Atkinson and Kerkvliet (1986)), while in grain markets deregulation has been found to decrease rates (Fuller et. al. (1987) and Wilson et. al. (1988)).[2] In the model developed in this paper, deregulation increases rates if increases in markups over marginal costs dominate cost savings. Conversely, rates fall from deregulation if cost savings dominate increases (if any) in markups. Because of differences in the demand characteristics and pricing of commodities, deregulation may increase rates in some markets and decrease rates in others.

In the next section, I develop a multi-commodity model that nests pricing alternatives in regulated and deregulated states.[3] Market outcomes under both regulated and non-regulated states give rise to an expression for the effects of deregulation on rates and conditions under which deregulation will increase or decrease rates. Whether deregulation increases or decreases rates in a particular market hinges on the nature of pricing and costs in regulated and non-regulated states and the demand elasticity. Since these factors vary across commodities, deregulation is likely to affect commodities asymmetrically. The empirical contribution of the paper is a comprehensive analysis of the influence of deregulation on rates in 34 different commodity classifications which vary dramatically in terms of demand and cost attributes. I find that deregulation

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[2] In MacDonald (1989a) there is evidence to suggest that the influence of deregulation is on costs, and through costs on rates (p. 19). In addition, MacDonald (1989b) argues that the Staggers Rail Act did not increase rail market power on grain traffic, because railroads were already setting profit maximizing prices on grain during the regulated period. If true of all commodities then deregulation should reduce rates in all markets.

[3] There is a long history of pricing alternatives under regulation. In general, these alternatives have the regulator choosing prices such that markups on "captive" traffic (e.g., long-haul, heavy-load, low-value) are higher than markups on "non-captive traffic (e.g., short-haul, light-load, high value). See Friedlaender (1981), Friedlaender and Spady (1981), Boyer (1977; 1981), Keeler (1976, 1983) and Tye (1983) for excellent and complete discussions. Pricing alternatives under deregulation depend on behavior and are discussed later.

has affects that vary across commodity and through time. Initially, deregulation increased rates for some commodities, had no effect on others, and decreased rates on still others. By 1988, however, deregulation lowered rates for almost all commodities.

CONCEPTUAL ISSUES

In this section I develop a model that describes possible market outcomes under regulated and non-regulated states. In a regulated state, market outcomes may be the result of welfare optimizing or profit maximizing behavior (ineffective price regulation). Welfare-optimizing behavior is given by either first-best or second-best pricing rules. Profit-maximizing, "ineffective price regulation", may also occur in a regulated state (e.g., regulators are captive). In such cases, deregulation may reduce both markups and costs. In a non-regulated state, market outcomes may be described by monopoly, competition, and a host of other structures. These outcomes are represented in a single model that allows plausible effects of deregulation to be identified.

In modelling rail rates, there are a number of complications that likely impact both regulatory and private decisions and need be recognized in assessing the influence of deregulation. Specifically, railroads produce multiple services, may produce these services with decreasing costs, and, at least in some markets, face competition from other railroads, trucks, and water carriers. With multiple outputs, there may be both private and regulatory incentives to discriminate among classes of traffic. Private incentives to discriminate follow the standard conditions for price discrimination. Regulatory incentives to discriminate follow second-best welfare criteria (first-best outcomes are not viable).

Pricing Rules under Regulated and Non-Regulated States

In describing regulatory pricing rules, I begin with the simplest notion of regulatory behavior — that of a welfare optimizer where regulation is in place to correct market failure from excessive market power. Typically, in such a situation, the regulator maximizes the sum of consumer surplus and firm profits. In a single market without decreasing average costs, the regulator maximizes welfare by equating rates with marginal costs.

The railroad regulator's problem is more complex, however, because railroads produce multiple products that may take place with decreasing average costs. When the production of these services takes place without decreasing average costs and with independent demands, first-best outcomes require prices equate with marginal costs in each market. However, if production takes place with decreasing average costs, regulators must choose prices according to a second-best criterion. Under a second-best criterion, the regulator's problem is to find a set of prices that optimally depart from marginal costs, attempting to obtain the highest welfare possible *subject to the constraint that the firm is viable* (does not earn negative profits). That is,[4]

$$(1) \qquad \underset{P_i}{\text{MAX}}\ W = \Sigma_i\{\textstyle\int_{P_i}^{\infty} D(P_i)P_i dP_i + P_i D(P_i) - C(D_1(P_1),\ldots,D_N(P_N))\}$$

$$\textit{subject to: } \pi = \Sigma_i P_i D_i(P_i) - C(D_1(P_1),D_2(P_2),\ldots,D_N(P_N)) = 0,$$

where P_i and $D_i(\bullet)$ represents price and demand for the firm in market i=1,...,N, while $C(\bullet)$ represents the costs of the firm supplying the N markets.

[4] There are a wealth of studies examining these rules. See, for example, Baumol and Bradford (1970), Braeutigam (1979). Also, see Tye (1983) for a good discussion in the context of railroad regulation and recent issues.

In the classic case, when demands are independent, the optimal set of prices can be obtained from

(2) $(P_i - MC_i)/P_i = \{\lambda/(1+\lambda)\}/\eta_i$ $\forall$ i, and

(3) $\Sigma_i P_i D_i(P_i) - C(D_1(P_1),D_2(P_2),...,D_N(P_N)) = 0,$

where η_i is the magnitude of the own price elasticity of demand for the firm in market i (i.e., $\eta_i=|\varepsilon_i|$) and $MC_i=\partial C/\partial D_i$. In equation (2), λ is the Lagrangian multiplier on the zero profit condition. If $\lambda=0$, the constraint is not binding, and first-best outcomes are viable — with the result that $P_i=MC_i$ in all markets. When $\lambda>0$, prices increase in all markets in inverse proportion to elasticities until the firm is viable (i.e., does not earn negative profits).

The final regulatory outcome considered is that of ineffective regulation wherein prices are determined privately, but operate through the regulatory environment. In this case, firms are assumed to produce different outputs from its actual or potential competitors (if they exist). When firms set prices without constraints from competition or without regulatory restrictions, rates are determined by

(4) $\underset{P_i}{MAX}\ \pi = \Sigma_i P_i D_i(P_i) - C(D_1(P_1),D_2(P_2),...,D_N(P_N)),$

with first order conditions given by

(5) $\partial\pi/\partial P_i = Q_i + (\partial Q_i/\partial P_i)(P_i - MC_i) = 0,$ $\forall$ i = 1,2,...,N.

Equation (5) is the standard monopoly first order condition. However, a wide range of market outcomes can be represented with some modification. Specifically, firms may face competition from other railroads, truckers, barge, and potential entrants. In such cases firms may be limited in their ability to set monopoly prices characterized by equation (5). I incorporate these effects by quite generally by rewriting equation (5) as

$$(6) \qquad \partial\pi_i/\partial P_i = Q_i + (\theta_i \partial Q_i/\partial P_i)(P_i - MC_i) = 0, \qquad \forall\, i = 1,2,\ldots,N.$$

In equation (6), a wide variety of profit-maximizing outcomes can be represented.[5] These outcomes include third degree price discrimination (θ_i=1 $\forall$ i with one firm in the market); competitive (θ_i=0 $\forall$ i); and a variety of others (e.g., Cournot, Price Leadership, etc.). For these purposes, θ_i is simply an index of markups in the ith market.

In illustrating the effects of deregulation on prices I index regulatory and non-regulatory states as R and N. Regulatory and non-regulatory pricing rules can be written as

$$P_i^R = MC_i^R\{1/[1-(\theta_i^R/\eta_i)]\}$$

$$(7)$$

$$P_i^N = MC_i^N\{1/[1-(\theta_i^N/\eta_i)]\}$$

where θ_i^R represents alternative regulatory pricing rules; θ_i^N indexes the markup in the deregulation state; and η_i represents the magnitude of the elasticity for the ith commodity (i.e., $\eta_i=|\varepsilon_i|$). In regulatory states, θ_i^R may take a value of zero for first-best pricing, of $\lambda/(1+\lambda)$ for second-best pricing, and between zero and one for ineffective regulation. In non-regulated states, θ_i^N may take a value ranging from zero (competitive pricing) to one (monopoly pricing). The specific value will, however, depend more generally on the specific market structure and behavior in market i.

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[5] The generalization given in equation (6) can be made more precise with explicit assumptions of behavior. Since the interest in this paper is empirical, θ_i is used to simply reflect a range of possibilities and to index markups. Comprehensive and excellent reviews of the general modelling strategy are given by Bresnahan (1989) and Geroski (1988). Wilson, Wilson, and Koo (1988) used such a framework to analyze intermodal competition between rail and truck grain markets and the effects of deregulation. There are a number of other studies {e.g., McFarland (1989)} that begin with a markup equation of the form P=mMC. Equation (6) can be rewritten in this form when $m=1/\{1-(\theta/\eta)\}$.

Using equation (7) the effect of deregulation on prices is

$$(8) \qquad \frac{P_i^N - P_i^R}{P_i^R} = \frac{MC_i^N/[1 - (\theta_i^N/\eta_i)]}{MC_i^R/[1 - (\theta_i^R/\eta_i)]} - 1.$$

This expression suggests that the effect of deregulation may be positive or negative depending on costs before and after deregulation, markup parameters before and after deregulation (i.e., θ_i^R/η and θ_i^N/η), and the demand elasticity. In evaluating the plausible effects, I relate non-regulated and regulated costs as $MC_i^N = \delta_i MC_i^R$ and consider everal possibilities.[6]

Deregulation from First-Best Regulatory Rules

Under first-best rules, prices equal marginal cost before deregulation ($\theta_i^R=0$ for all i)). The effect of deregulation on price is positive or negative depending on the level of cost savings, the markup after deregulation, and the demand elasticity. In this case the sign of the effect of deregulation is determined by $\delta_i \gtrless 1 - \theta_i^N/\eta_i$. If cost savings are small (i.e., δ_i is close to 1) and markup effects in the post-deregulation period are large, prices under deregulation will rise. However, prices will likely fall from deregulation if cost savings are large and competition holds market power in check.

Deregulation from Second-Best Regulatory Rules

Under second-best rules, prices vary inversely to elasticities subject to the constraint that firms are viable. The markup parameter is given by $\theta_i^R=\lambda/(1+\lambda)$ for all i.

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[6] If $\delta=1$ then there are no differences between marginal costs in the regulated and non-regulated states. If $\delta_i<1$ then deregulation has a reducing effect on costs. Berndt, Friedlaender, Chiang, and Vellturo (1991) and Wilson and Dooley (1992) provide recent analyses of the influence of deregulation on costs and find dramatic cost savings from deregulation.

Using equation (8) the effect of deregulation is positive or negative depending on whether

(9) $\delta_i\{1-\{\lambda/[(1+\lambda)\eta_i]\}\} \gtrless 1-\theta_i^N/\eta_i$.

Under this condition, there are many possibilities. First, if cost savings are small, deregulation will tend to result in higher prices in captive markets and lower prices in more competitive markets.[7] But, as cost savings in markets increase (i.e., δ_i gets closer to zero) price increases will tend to diminish and may become negative. Second, "captive" markets (i.e., those markets in which the railroad faces little competition, has a severe cost advantage, etc.) will tend to experience increases in prices (or smaller decreases in prices) than markets that are not captive. Firms in captive markets have greater market power and tend to face inelastic demands. Therefore, markups (θ/η) are higher than in non-captive markets. Thus, given the same cost savings across markets, captive markets will experience higher price increases or smaller price decreases from deregulation. Third, the effect of elasticities (η) is ambiguous. The direction of the effect is given by $\theta_i^N-\delta(\lambda/(1+\lambda))\gtrless\eta(1-\delta)$. Thus, deregulation tends to lower prices in markets with elastic demands and increases prices in markets with inelastic demands. Finally, as second-best pricing departs further from first-best pricing (i.e., $\lambda/(1+\lambda)$ gets closer to one) price effects from deregulation will be smaller.

Deregulation from Ineffective Price Regulation

When deregulation occurs from an ineffective price regulation state, there are again many possibilities. First, if the markup does not change from regulated to non-

[7] If there are no cost savings (δ=1) then equation (9) can be reduced to $\theta_i^N\gtrless\lambda/(1+\lambda)$. Since, in this case, θ^N is greater than $\lambda/(1+\lambda)$ (i.e., regulation scales down non-regulated outcomes) prices will rise in all markets. The percentage increase in prices, however, will be greatest in captive markets (i.e., θ_i^N closer to 1).

regulated states (i.e., $\theta_i^N = \theta_i^R$), the influence on prices of deregulation is unambiguously negative (i.e., deregulation reduces costs, and through costs, prices). Second, if there are no cost savings (δ_i=1), the effect of deregulation is established by the sign of (θ_i^N-θ_i^R). If the markup in the deregulated state is greater than under the regulated state, prices will rise. Conversely, if the markup in the deregulated state is *less* than under the regulated state, prices will fall. Finally, prices on captive traffic (η_i small) will tend to experience larger positive effects or smaller price decreases under deregulation than will prices on non-captive traffic (η_i large).

A Summary of the Effects of Deregulation

Deregulation may have asymmetric effects across commodities depending on markup parameters before and after deregulation, demand elasticities, and cost savings from deregulation. There is some evidence that deregulation has reduced costs. Falling costs put downward pressure on rates. If departures of price from marginal cost are lower under deregulation, the influence will tend to reinforce the cost effects. However, if markups increase under deregulation, the influence on prices will counteract the influence of costs on prices. In short, it is clear from the model that deregulation may increase prices in some markets and decrease prices in other markets. In general, the effects of deregulation depend on the nature of pricing in regulated and deregulated states, the elasticities of demand, and the level of cost savings from deregulation. In the next section, I develop an empirical model to estimate the effect of deregulation given by equation (8) and examine differences across commodities and through time.

EMPIRICAL MODEL

In examining the effect of deregulation on rates charged for movements of different commodities, I use real railroad rates (P_{ti}) over time (t) for different commodity movements (i) as the dependent variable. These rates are the outcome of demand for each commodity movement, costs, and a pricing relation. The pricing relation is the result of firm or regulatory decisions which likely varies across regulatory states. If there are N markets then the system of N demand functions, a cost function in which service to each market enters as a separate output argument and a pricing relation for each of the N markets yield a reduced form for rates given by

$$(10) \quad P_{ti} = P(X^D_{t1},\ldots,X^D_{tN},X^D,X^C_{t1},\ldots X^C_{tN},X^C,\theta_{t1},\ldots,\theta_{tN}) \qquad \text{for all i.}$$

where: X^D_{ti} and X^C_{ti} represent demand and cost variables specific to commodity i at time t; X^D and X^C represent demand (e.g., GNP) and cost variables (e.g., factor prices) common to all commodities; and θ_{ti} is the market power/regulatory rule parameter that indexes the markups in either the firm or the regulatory agency pricing decision.

In equation (10), the rates of commodity i in time t depend not only on demand, cost, and competitive/regulatory conditions in its own market but also on demand conditions, cost, and competitive/regulatory conditions in other markets. Such a model is not empirically tractable.[8] For tractability, I place a number of restrictions on the model. The restrictions are that demand conditions specific to other markets, costs

[8] In Sections (5) and (6), I examine 34 commodities. In the general form (equation 10) if there are four demand, four cost, and two market power/regulatory behavior variables specific to each commodity, and two demand and two cost variables common to all commodities, there are 344 parameters per price equation and 34 price equations resulting in 11,696 total parameters.

conditions specific to other markets, and competitive/regulatory parameters specific to other markets are zero. Under these restrictions, equation (10) reduces to

(11) $P_{ti} = P(X^D_{ti}, X^D, X^C_{ti}, X^C, \theta_{ti})$.

Previous studies of aggregate railroad rates have, in principle, estimated an aggregated version of equation (11) — the average real rate of all railroad traffic, but differ in terms of variable measurement and estimation procedures. All previous studies, including Boyer (1987), McFarland (1989), and Barnekov and Kliet (1990), used the average revenue per ton-mile as the dependent variable, but use different deflators. Boyer used the Producer's Price Index (PPI); Barnekov and Kliet used both the PPI and the GNP price deflator. McFarland (1989) used the Association of American Railroads (AAR) index of input prices. In this application, I use the average revenue per revenue ton-mile across commodities and deflate by the AAR's index of input prices (The other deflators yield qualitatively similar results.), and as discussed in McFarland (1989) the AAR index has theoretical appeal.

All aggregate studies except Boyer (1987) used some measure of GNP to represent demand conditions. Barnekov and Kliet used the percentage change in GNP, while McFarland used the log of real GNP. I examined these measures along with per-capita and growth rate measures, and based on fit, I used the log of real GNP (although all specifications gave similar fit and results). To control for demand (and cost) conditions that vary dramatically across commodity (e.g., value) but not through time, a separate set of coefficients is estimated for each commodity. Thus, to the extent that demand conditions vary across commodities and are not reflected in GNP, there may well be differences in estimates across commodities.

Following other studies, cost conditions (X^C_{ti}) are represented by a set of traffic characteristics and other variables. Traffic characteristics include average length of haul, average load, and density.[9] Each of these variables is expected to negatively affect rates. Longer lengths of haul and heavier loads involve lower terminal costs per unit of output (ton-mile); while higher densities allow fixed costs to be spread over greater levels of output. Other cost side variables that do not vary across commodities (X^C) may include regulatory status, factor prices, and technological change. Regulatory status is described below. Factor prices are accounted for in the deflator of rates (see above). Technological change is represented by a linear time trend that may be impacted by regulatory change.

The final set of variables represents the influence of deregulation on rates. Following the conceptual model, the effect of deregulation may enter through the markup parameter and the cost function. If cost effects are negative and large enough to outweigh any increases in markups, rates will fall; while if costs effects are negative but not large enough to outweigh any increases in markups, rates will fall. The effect of regulation is measured differently by all of the three aggregate studies mentioned above. As deregulation was "signed" into law on October 29, 1980, Boyer used a dummy variable that took a value of zero through 1979 and a value of 1 after 1979. Barnekov and Kliet maintained that "The most important single aspect of Staggers was arguably

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[9] Other variables that have been employed are train weight and the level of bulk traffic. Train weight, the level of bulk traffic, and average load may reflect the same effect. However, train weights have increased through time and may be endogenous. The level of bulk traffic, theoretically, should have a negative effect on costs, and therefore on rates. However, the empirical evidence has been weak. For example, in McFarland (1989) the log of the percentage of traffic that is bulk has a positive but insignificant effect on rates. Given this evidence and the high correlation of bulk and train weight with average weight per mile traveled (average load), these variables are excluded. Average load also has the added benefit of being defined by commodity, while train weight and bulk represent system variables. Finally, to the extent that certain commodities are "bulk" commodities and bulk commodities travel by lower costs, the effect will be captured in the intercept and/or interaction dummy variables.

the contract provision ..."[10] Given this premise, they measure deregulation in terms of the number of contracts signed each year divided by the number signed in 1987. McFarland incorporated both Boyer's intercept shift and Barnekov and Kliet's general approach, (i.e. that deregulation was gradually implemented) to measure deregulation. He measured deregulation using a dummy shift variable, taking a value of 0 before 1981 and a value of 1 after 1980, and an interactive dummy on a time trend, allowing the influence to increase through time. In this study, I use this latter approach to measure deregulation, and define STAG=0 for years before 1981 and STAG=1 otherwise.[11] I also interact STAG with the time trend to capture the dynamic effects of deregulation. The dynamic effects likely impact technological innovations (e.g., the use of contracts, increasing use of multiple car movements, etc.) and is expected to reduce costs and, through costs, rates. To simplify presentation of the results, the time trend (YR) is measured with a zero value in 1981 so the initial effect of deregulation is the intercept (in 1972 YR is -9, and in 1988, YR=7.).

I explored both linear and double-log functional forms. The results reported in Sections 5 and 6 are based on a double log specification given by:

$$(12)\quad \log(P_{ti}) = \Sigma_i\beta_{0i} + \Sigma_i\beta_{1i}STAG_t + \Sigma_i\beta_{2i}STAG_t{*}YR_t + \Sigma_i\beta_{3i}YR_t + \Sigma_i\beta_{4i}\log(ALH_{ti}) + \Sigma_i\beta_{5i}\log(AL_{ti}) + \Sigma_i\beta_{6i}\log(DENSITY_{ti}) + \Sigma_i\beta_{7i}\log(GNP_t) + \varepsilon_{ti}.$$

[10] The contract provision formally legalized service contracts between shippers and railroads. Railroads, particularly for bulk traffic, used contracts extensively under deregulation. Contracts represent a major source of cost savings (and therefore rates) under deregulation (especially in the early years).

[11] Data availability did not allow similar treatment of deregulation as Barnekov and Kliet (1990). Further, the use of contracts has been declining since the time period of their analysis owing to a confidentiality ruling in 1986 and the introduction of new pricing arrangements e.g., the Burlington Northern's Certificates of Transportation (COTS) program.

In equation (14) The data, described in section 4, are comprised of 34 Standard Transportation Commodity Codes (STCC) from 1972-1988 for a total of 578 observations; there are 8 coefficients per STCC code for a total of 272 coefficients. Finally, as discussed in Sections 5 and 6 I perform hypothesis tests in an attempt to reduce the number of parameters.

DATA

The data pertain to 34 different STCC level 2 commodity classifications from 1972-1988 (Table 1).[12] The data are drawn from three different sources: Carload Waybill Statistics (TD-1 Report, United States Department of Transportation), Railroad Facts (American Association of Railroads), and the Economic Report of the President. In the TD-1 reports on revenues, tons, ton-miles, and carmiles by commodity were available across time. From Railroad Facts I obtained the AAR index of input prices, miles of road, and various price deflators as well as a wealth of other operating and financial statistics. From the Economic Report of the President I obtained real GNP, the GNP price deflator, and the producer price index for final goods. From this information I calculated each of the variables described in the previous section.

The essential difference between the data used here and in previous studies is the level of commodity specificity, gained through the use of the waybill data. That is, commodity specific measures of rates, average length of haul, average load, and density can be calculated. However, carload waybill data have some well-known problems [e.g., MacDonald (1989b) and in Wolfe (1986, 1991)]. Reporting methods prior to 1981 caused under-reporting of multiple car shipments. Since single car rates are usually higher than multiple car rates, observed rates before 1981 may be overstated. The effect of this change in sampling, coinciding with deregulation, may cloud the intercept shift variables in equation (12). However, as the post-1981 sampling strategy places greater weight on

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[12] An additional year was available for 1969. However, inclusion resulted in a number of outliers. Therefore, only 1972-1988 was used. There were three additional STCC level 2 codes available but only for a subset of years. These include Express and US Mail (STCC-43); Local package freight (STCC-47); and Hazardous Materials (STCC-49). Since these data were not available for the entire time period and since these data did not include both regulated and non-regulated time periods, they were omitted from the analysis.

lower priced shipments, the effect on the intercept is negative. In interpreting the results, if this bias exists, it will overstate the magnitude of negative effects and understate the magnitude of positive effects in 1981.

Table 1.—STCC Codes and Commodity Descriptions.

STCC	Commodity Description
01	Farm Products
08	Forest Products
09	Fresh Fish or other Marine Products
10	Metallic Ores
11	Coal
13	Crude Petroleum, Natural Gas or Gasoline
14	Non-metallic Minerals
19	Ordnance or Accessories
20	Food or Kindred Products
21	Tobacco Products
22	Textile Mill Products
23	Apparel
24	Lumber or Wood Products
25	Furniture or Fixtures
26	Pulp, Paper, or Allied Products
27	Printed Matter
28	Chemicals or Allied Products
29	Petroleum or Coal Products
30	Rubber or Misc. Plastic Products
31	Leather or Leather Products
32	Clay, Concrete, Glass, or Stone Products
33	Primary Metal Products
34	Fabricated Metal Products
35	Machinery
36	Electrical Machinery or Equipment
37	Transportation Equipment
38	Instruments or Photographic Goods
39	Misc. Products or Manufacturing
40	Waste or Scrap Materials
41	Misc. Freight Shipments
42	Containers, Shipping, Returned Empty
44	Freight Forwarder Traffic
45	Shipper Association or Similar Traffic
46	Miscellaneous Mixed Shipments

EMPIRICAL RESULTS

I estimated the basic model given by equation (14) by OLS with results reported in Table 2 by commodity.[13] In this model, all parameters vary across commodity classifications. Since there are eight parameters per STCC code and 34 STCC codes, a total of 272 parameters were estimated. In general, the model fits the data well R^2, calculated by commodity, of over .9 for all but two commodity classifications. Finally, most coefficients estimates have the correct sign.[14]

In general, the results suggest that deregulation affected commodities asymmetrically and has effects that vary through time. Since, the trend (YR) takes a value of zero in 1981, the regulation intercept dummy variable (STAG) measures the immediate effect of deregulation. The estimates by commodities suggest that the initial effect of deregulation had mixed effects across commodities. It is pointed out here, however, the results on coal (STCC-11) and on farm products (STCC-1) mirror the disaggregate studies (Atkinson and Kerkvliet (1986), Fuller et. al. (1987), Wilson, Wilson,

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[13] All standard errors are calculated using White's (1980) heteroskedastistic consistent covariance matrix. There are several reasons to expect heteroskedasticity to exist, including differences across commodity classifications, the regulatory state, the waybill sampling rules, etc. The results reported in the paper are more conservative than results based on estimated generalized least squares where a specific model of heteroskedasticity was estimated. I also checked for serially correlated errors by estimating each equation separately and used the results to calculate the Durbin-Watson statistics. The results did not suggest any prevalent serial correlation. Since equation (12) is a reduced form, OLS is appropriate. Some have argued, however, that some of the variables on the righthand-side may be endogenous. Since there are no available instruments in a reduced form, I checked robustness of the results by systematically excluding possible endogenous variables (i.e., ALH, AL, and DENSITY). The results are consistent with those reported.

[14] There are some exceptions on the control variables, including ALH, AL, DENSITY, and GNP. However, these exceptions are few, and virtually all are insignificantly different from zero. In general, these coefficients were not precise. In an attempt to place added structure on the models, I restricted the coefficients on ALH, AL, DENSITY, and GNP to be the same across commodities. With that added structure all coefficients were of the correct sign and significant. However, the F-statistic ($F^S(132,306)=1.6854$) was significantly different from zero and did not allow the imposition of that added structure.

and Koo (1988), and others). That is, initially deregulation increased coal rates and reduced farm product rates.

More generally, the coefficient on STAG is negative for 11 of the 34 commodities, of which 4 are statistically significant. These four negative effects, converted into percentage terms, $(P^N-P^R)/P^R)=(\exp(\beta_{1i})-1)*100$, range in magnitude from about 34% $\{(e^{-.4141}-1)*100\}$ on empty returning shipping containers (STCC-42) and are in excess of 25% for leather products (STCC-31) and waste scrap materials (STCC-40). If not due to sampling rule variation, the negative effects are consistent with a variety of explanations.[15] Based on the results in Section 2, explanations tend to have the negative effects of deregulation on costs dominating any increased markups of price over marginal costs. Under first-best pricing rules, the increase in markups is dominated by cost savings $(\theta^N/\eta<(1-\delta))$. Under second-best pricing rules, the increase in markups is dominated by cost savings $(\theta^N-\lambda/(1+\lambda))/\eta<(1-\delta)$. Finally, under ineffective price regulation, either markups fall from deregulation $(\theta^N-\theta^R<0)$ or, if positive, cost savings $(1-\delta)$ must dominate the increase in market power.

The effect is positive for 23 of the 34 STCC codes, of which 10 are statistically significant. The ten significant positive effects range up to about 15.5% for forest products (STCC-8) and are greater than 8% for non-metallic minerals (STCC-14), food and kindred products (STCC-20), tobacco products (STCC-21), textile mill products (STCC-22), lumber and wood products (STCC-24), and rubber or miscellaneous plastic

[15] The interpretation of these effects as reducing prices is unclear since, as discussed in Section 4, the waybill sampling rule changed in 1981 in a direction that likely results in lower implied prices. Thus, these negative results may simply be the effect of the sampling rule and not deregulation. It is noted, however, following this argument, the positive findings on the remaining commodities, may be even higher.

products (STCC-30). The positive results suggest that prices rose after deregulation. These positive effects suggest deregulation has resulted in increased markups that dominate any cost effects. Increased markups occur from relaxation of first or second-best rules which hold prices lower than the private market. Perhaps, the most interesting result here is that there is little evidence that deregulation did not increase market power.

While initial effects of deregulation are mixed in sign across commodities, the intertemporal effect of deregulation is almost uniformly negative for all commodities, and generally differ only in magnitude. Specifically, the interactive deregulation dummy variable on time (STAG*YR) is negative for 29 of 34 STCC codes and is statistically significant for 20 of these 29 estimates. Of the remaining five estimates all but one is statistically insignificant. These results suggest that prices have been falling faster through time than before deregulation. This is consistent with the studies suggesting deregulation has dramatically improved productivity in the industry (i.e., Berndt et. al. (1991) and Wilson and Dooley (1992)).

Table 2.—Coefficient Estimates.

	Variable[a]								
STCC	ONE	STAG	STAGYR	YR	DENSITY	ALH	AL	GNP	R^2
1	4.6948 (2.0348)	-0.0821 (-2.3929)	-0.0874 (-4.7645)	-0.0224 (-1.4645)	0.2291 (2.6906)	-1.0902 (-5.1900)	-0.4822 (-2.0518)	0.4540 (1.5661)	0.996
8	-11.2241 (-2.5662)	0.1445 (3.6667)	-0.0026 (-0.2037)	-0.1133 (-7.3004)	-0.2708 (-3.2537)	-0.1935 (-1.4125)	-0.3257 (-1.3940)	1.8359 (3.9599)	0.984
9	-5.8325 (-1.2289)	-0.0452 (-0.6192)	-0.0963 (-4.8847)	-0.0145 (-0.6196)	0.1548 (2.7713)	-0.2067 (-3.1417)	-0.3355 (-2.8103)	1.1790 (2.1559)	0.950
10	16.3135 (2.7978)	0.0365 (1.0151)	-0.0070 (-0.9829)	0.0089 (0.6422)	-0.0321 (-0.6125)	-0.4655 (-3.6186)	-1.6297 (-1.8572)	-0.7184 (-1.7719)	0.977
11	27.4687 (4.6602)	0.0426 (1.8539)	-0.0382 (-4.3994)	0.0441 (2.7443)	0.2368 (2.8253)	-0.8566 (-2.9702)	-3.1319 (-4.3873)	-1.1611 (-2.9870)	0.990
13	-12.5934 (-2.0519)	-0.0633 (-1.1904)	-0.0136 (-0.8497)	-0.0397 (-2.7468)	-0.2643 (-5.7359)	0.1004 (0.7229)	-0.8096 (-2.6930)	2.0620 (3.4306)	0.919
14	5.8233 (1.3683)	0.0831 (2.8913)	-0.0585 (-7.0349)	0.0044 (0.2974)	-0.1511 (-1.2348)	-0.8097 (-5.5185)	-0.7966 (-1.8330)	0.4390 (1.1832)	0.981
19	-12.1113 (-0.9231)	0.0065 (0.0543)	-0.1031 (-2.2967)	-0.0771 (-1.4584)	-0.0772 (-0.5022)	-0.3518 (-0.8754)	-0.5901 (-1.3404)	2.2904 (1.3285)	0.941
20	5.9496 (1.1800)	0.0912 (2.5956)	-0.0662 (-4.2571)	-0.0226 (-0.9298)	0.1014 (0.6718)	-1.1067 (-4.4414)	-0.2066 (-0.2734)	0.3142 (1.0524)	0.992
21	-5.2904 (-1.3183)	0.0821 (2.0822)	-0.0124 (-0.8658)	-0.0803 (-6.5679)	0.0036 (0.0743)	-0.0694 (-0.6279)	-0.0064 (-0.0157)	0.8494 (2.2054)	0.985
22	-6.5490 (-1.5807)	0.0856 (2.7453)	-0.0426 (-4.8564)	-0.0632 (-4.8327)	-0.0039 (-0.0525)	-0.2578 (-2.2536)	0.1771 (1.0805)	1.1369 (2.6975)	0.993
23	-18.9454 (-2.5975)	0.0259 (0.3542)	0.0144 (0.7248)	-0.0842 (-3.0096)	-0.3067 (-2.5296)	-0.3269 (-2.9993)	0.0090 (0.0366)	2.8122 (3.3663)	0.749
24	14.3990 (2.4546)	0.1032 (3.2118)	-0.0373 (-5.0670)	0.0262 (1.0709)	0.2543 (1.8180)	-0.5159 (-4.6234)	-2.1168 (-3.5943)	-0.4237 (-0.8470)	0.993

[a] The White (1980) consistent covariance matrix was used to calculate the t-statistics in ().

Table 2.—Coefficient Estimates-continued.

STCC	ONE	STAG	STAGYR	YR	DENSITY	ALH	AL	GNP	R^2
	Variable[a]								
25	-4.1046	-0.0232	-0.0700	-0.0615	-0.1957	-0.1716	-0.3326	1.0426	0.996
	(-0.6562)	(-0.3745)	(-4.8196)	(-2.1064)	(-1.6112)	(-1.7334)	(-1.1517)	(1.4313)	
25	19.1872	0.0468	-0.0040	-0.0008	0.2307	-1.1925	-0.9534	-0.9754	0.997
	(5.0486)	(4.2766)	(-1.1002)	(-0.0516)	(3.2406)	(-13.6821)	(-2.0472)	(-3.7181)	
27	-3.1800	0.0807	0.0235	-0.0782	-0.0917	-0.2367	0.2360	0.6130	0.962
	(-0.7803)	(1.4568)	(0.8179)	(-3.8613)	(-1.8424)	(-1.1860)	(1.4218)	(1.1955)	
28	13.1265	0.0361	-0.0086	-0.0105	0.0246	-1.0243	-0.4229	-0.4737	0.989
	(2.1939)	(1.4768)	(-0.6438)	(-0.4950)	(0.1645)	(-4.1934)	(-0.7172)	(-0.8795)	
29	5.0814	0.0321	-0.0384	-0.0033	-0.2875	-0.4437	-0.1894	0.1066	0.980
	(0.8077)	(1.0995)	(-2.8608)	(-0.1238)	(-2.1050)	(-1.8901)	(-0.2689)	(0.2175)	
30	3.9577	0.1077	-0.0552	-0.0454	-0.0591	-0.8356	-0.3647	0.5531	0.993
	(0.4513)	(3.0583)	(-3.3593)	(-1.4939)	(-0.3003)	(-5.0224)	(-0.8109)	(0.6014)	
31	-5.8691	-0.3185	0.0424	-0.0939	-0.0555	0.0149	-0.3761	1.0004	0.972
	(-1.2505)	(-5.0903)	(1.7245)	(-4.7839)	(-0.8469)	(0.1596)	(-4.6032)	(1.7680)	
32	4.4110	0.0463	-0.0375	-0.0173	0.0140	-0.8380	-0.0856	0.2437	0.992
	(0.7920)	(2.0408)	(-5.9223)	(-0.8769)	(0.0829)	(-5.1542)	(-0.2758)	(0.3737)	
33	10.3923	0.0113	-0.0437	-0.0098	0.1420	-0.3360	-0.8042	-0.5679	0.997
	(2.6339)	(0.5100)	(-13.5276)	(-0.7016)	(2.8583)	(-2.2414)	(-3.4320)	(-1.1864)	
34	5.4403	-0.0252	-0.0222	-0.0425	-0.3476	-0.9295	0.0420	0.3570	0.979
	(1.3913)	(-0.9834)	(-1.3169)	(-2.6102)	(-2.9651)	(-4.8211)	(0.2606)	(0.8200)	
35	6.7985	0.0084	-0.0419	-0.0267	0.0371	-0.3024	0.0713	-0.4239	0.996
	(2.4398)	(0.2878)	(-4.4030)	(-1.9862)	(0.6697)	(-2.3643)	(0.4473)	(-1.3402)	
36	1.0393	0.0203	-0.0136	-0.0518	-0.1940	-0.6258	0.0098	0.6793	0.992
	(0.1956)	(0.6084)	(-0.4894)	(-1.9935)	(-1.6578)	(-3.4762)	(0.0440)	(1.3226)	
37	5.9381	0.0173	-0.0109	-0.0188	0.0031	-0.7486	-0.8356	0.4487	0.982
	(1.8008)	(0.8078)	(-1.8238)	(-1.7416)	(0.0825)	(-5.1218)	(-4.6046)	(1.4420)	

[a] The White (1980) consistent covariance matrix was used to calculate the t-statistics in ().

Table 2.—Coefficient Estimates-continued.

	Variable[a]								
STCC	ONE	STAG	STAGYR	YR	DENSITY	ALH	AL	GNP	R^2
38	-6.2762	0.1269	-0.2073	-0.0716	0.1251	-0.4475	-1.1127	1.7782	0.959
	(-0.8386)	(1.0160)	(-5.2642)	(-3.2520)	(1.2734)	(-2.5947)	(-4.9538)	(2.0128)	
39	-4.3740	0.0397	-0.0728	-0.0804	-0.0828	-0.5103	-0.2511	1.2800	0.965
	(-0.5185)	(0.3263)	(-1.9726)	(-2.1125)	(-0.5838)	(-1.5686)	(-1.5349)	(1.2626)	
40	6.4480	-0.3175	0.0544	-0.0092	-0.5557	-0.0085	-1.2285	0.2378	0.972
	(0.8647)	(-3.6718)	(3.1538)	(-0.3953)	(-3.1589)	(-0.6264)	(-1.6273)	(0.3201)	
41	-0.8839	-0.0230	-0.0880	-0.0264	0.0170	-0.1544	-0.8961	0.8085	0.977
	(-0.1521)	(-0.6092)	(-5.3722)	(-1.6429)	(0.2482)	(-0.8662)	(-4.2068)	(1.2302)	
42	-18.0663	-0.4141	0.0229	-0.0578	-0.4004	-0.5124	-0.1508	2.9552	0.944
	(-2.5533)	(-4.2878)	(0.5941)	(-3.5543)	(-3.0757)	(-1.1193)	(-0.6988)	(3.9520)	
44	-4.5029	0.0571	-0.0265	-0.0643	-0.1190	-0.0391	-0.1043	0.7983	0.932
	(-1.0445)	(0.9403)	(-0.7235)	(-2.9810)	(-1.1059)	(-0.7358)	(-0.6324)	(1.3768)	
45	-9.9572	-0.0616	-0.0792	-0.0510	-0.2881	1.1329	-0.1120	0.5258	0.986
	(-2.0546)	(-1.4134)	(-10.1482)	(-3.1864)	(-4.7439)	(6.5829)	(-0.7691)	(0.9924)	
46	10.7917	-0.0025	-0.0510	0.0061	-0.1104	-1.2006	-0.4460	0.0776	0.994
	(2.3887)	(-0.1121)	(-5.7679)	(0.3719)	(-1.6456)	(-3.8903)	(-6.1198)	(0.2282)	

[a] The White (1980) consistent covariance matrix was used to calculate the t-statistics in ().

The effect of deregulation varies through time and is summarized across STCC code and time in Table 3. In Table 3, the effect of deregulation on the log of prices (β_{1i} + β_{2i}*YR) is reported along with the corresponding t-values. Also reported in Table 3 is the percentage "direct" effect of deregulation and the "total" effect. The direct effect is the percentage change in rates from the interaction and the time interaction dummy variables, $(P^N-P^R)/P^R = \{\exp(\beta_{1i} + \beta_{2i}*YR)-1\}*100$. The "total effect" includes any effects that operate through the explanatory variables (That is, ALH, AL, and DENSITY may have been influenced by deregulation.).[16] The 1981 column for the effect of deregulation on the log of prices is exactly the same as in Table 2 because YR takes a

[16] Ying (1989) makes a similar distinction in the case of trucking. An earlier reader suggested that Table 3 be augmented for these indirect effects.

value of zero in 1981 (i.e., YR = Year - 1981). In 1981 there are mixed results as discussed previously. However, by 1988, 29 of the 34 estimated effects are negative and 21 of these 29 are statistically significant. None of the remaining 5 positive effects are statistically different from zero. These results suggest that initial regulatory effects were mixed, but in the longer-run cost savings from deregulation have dominated initial price effects.

Finally, in recognition of plausible deregulation effects operating through the explanatory variables, I fit the logs of ALH, AL, and DENSITY to a linear time trend with the dummy intercept and interaction terms (STAG and STAGYR). Using these auxiliary regressions, values of ALH, AL, and DENSITY were evaluated at regulated and deregulated states. The result, used with equation (12) give the following expression for the total effect of deregulation:

$$(13)\quad (P^N-P^R)/P^R = \{\exp(\beta_{1i}+\beta_{2i}*YR)(ALH^N/ALH^R)^{\beta_{4i}}(AL^N/AL^R)^{\beta_{5i}}(DENSITY^N/DENSITY^R)^{\beta_{6i}}-1\}*100.$$

To conserve on space, the auxiliary regressions are not reported, however the total effect is given in Table 3 for 1981 and 1988. In general, these total effects mirror the direct effect. The total effect, especially for 1981, almost always magnifies the direct effect. If the direct effect is positive the total effect tends to be larger. If the direct effect is negative the total effect tends to be more negative. While the qualitative results are the comparable, direct effects appear to dominate any indirect effects. Thus, while deregulation may well have influenced ALH, AL, and DENSITY, the largest effect seems to be captured in the direct effect, which likely reflects changes in pricing and technological progress.

CROSS COMMODITY LINKAGES

In an effort to evaluate whether the price effects from regulation have a systematic relationship across commodities, I estimated a varying coefficients model. In the model above, the effects of deregulation were estimated by commodity classification. In the restricted model below, the coefficients on the dummy variables are taken as a function of observed commodity characteristics. These include average length of haul, average load, density, and a trend (YR). As discussed earlier, these variables are commonly ought to have been important dimensions of regulatory policy. In terms of equation (12) the coefficients on the deregulation intercept dummy (β_{1i}) and the interactive dummy are[17]

$$\beta_{1i} = \alpha_0 + \alpha_1 \log(ALH_{it}) + \alpha_2 \log(AL_{it}) + \alpha_3 \log(DENSITY_{it}) + \alpha_4 \log(YR_t)$$

(14)

$$\beta_{2i} = \delta_0 + \delta_1 \log(ALH_{it}) + \delta_2 \log(AL_{it}) + \delta_3 \log(DENSITY_{it}) + \delta_4 \log(YR_{it}).$$

With these restrictions imposed there are a total of 213 parameters to estimate. The results of the regression are[18]

(15)

$$\beta_{1i} = \underset{(-2.45)}{-1.161} + \underset{(2.11)}{0.115}\log(ALH) + \underset{(2.73)}{0.104}\log(AL) + \underset{(1.10)}{0.008}\log(DENSITY)$$

$$\beta_{2i} = \underset{(2.47)}{0.294} - \underset{(-2.99)}{0.039}\log(ALH) - \underset{(-3.12)}{0.031}\log(AL) + \underset{(1.62)}{0.003}\log(DENSITY) + \underset{(4.26)}{0.0045}YR$$

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[17] It should be noted that α_5 and δ_0 cannot be uniquely identified. The combined effect $\alpha_5+\delta_0$ are reported in the intercept of β_{2i}.

[18] The remaining coefficients are summarized in Appendix A, Table A-1. The R^2 for the restricted model was .9983, while for the unrestricted model .9989. However, an F-test for whether the restrictions are appropriate is $F^S(58,306)=1.08$ which suggests that explanatory power is not lost by imposing the restrictions.

Table 3.—Estimated Effects of Deregulation by Commodity.

	1981				1988			
STCC	$\beta_{1i}+\beta_{2i}YR$	t-value[a]	Direct[b]	Total[c]	$\beta_{1i}+\beta_{2i}YR$	t-value[a]	Direct[b]	Total[c]
1	-0.082	-2.39	-7.87	-9.64	-0.694	-4.94	-50.04	-67.53
8	0.144	3.66	15.54	15.01	0.126	1.44	13.44	5.71
9	-0.045	-0.61	-4.41	-8.80	-0.719	-4.14	-51.30	-62.20
10	0.036	1.01	3.71	14.56	-0.012	-0.20	-1.26	35.44
11	0.042	1.85	4.35	9.00	-0.224	-4.49	-20.11	-35.48
13	-0.063	-1.19	-6.13	-11.66	-0.158	-2.14	-14.68	9.77
14	0.083	2.89	8.66	13.85	-0.326	-6.80	-27.86	-43.80
19	0.006	0.05	0.65	0.81	-0.714	-2.05	-51.07	-36.57
20	0.091	2.59	9.55	17.21	-0.372	-2.75	-31.09	-33.91
21	0.082	2.08	8.55	8.84	-0.004	-0.04	-0.47	1.02
22	0.085	2.74	8.93	16.20	-0.212	-2.87	-19.13	-3.49
23	0.025	0.35	2.61	5.88	0.126	0.79	13.53	35.09
24	0.103	3.21	10.87	19.55	-0.158	-3.29	-14.63	1.59
25	-0.023	-0.37	-2.29	1.72	-0.513	-7.87	-40.14	-36.18
26	0.046	4.27	4.79	16.26	0.018	0.59	1.89	18.37
27	0.080	1.45	8.40	11.13	0.245	1.06	27.77	65.92

[a] The White (1980) consistent covariance matrix was used to calculate the t-statistics.

[b] The direct effect is $(P^N-P^R)/P^R=\{\exp(\beta_{1i}+\beta_{2i}*YR)-1\}*100$.

[c] The indirect effect is $(P^N-P^R)/P^R=\{\exp(\beta_{1i}+\beta_{2i}*YR)(ALH^N/ALH^R)^{\beta_{4i}}(AL^N/AL^R)^{\beta_{5i}}(DENSITY^N/DENSITY^R)^{\beta_{6i}}-1\}*100$.

Table 3.—Estimated Effects of Deregulation by Commodity-continued.

	1981				1988			
STCC	$\beta_{1i}+\beta_{2i}YR$	t-value[a]	Direct[b]	Total[c]	$\beta_{1i}+\beta_{2i}YR$	t-value[a]	Direct[b]	Total[c]
28	0.036	1.47	3.67	9.74	-0.024	-0.22	-2.37	-2.70
29	0.032	1.09	3.25	1.88	-0.236	-2.39	-21.09	-23.48
30	0.107	3.05	11.37	21.90	-0.278	-2.52	-24.29	-9.81
31	-0.318	-5.09	-27.27	-42.01	-0.021	-0.10	-2.11	-44.62
32	0.046	2.04	4.73	8.84	-0.216	-5.51	-19.42	-24.16
33	0.011	0.51	1.14	4.97	-0.294	-9.35	-25.49	-26.03
34	-0.025	-0.98	-2.49	2.74	-0.180	-1.54	-16.53	6.47
35	0.008	0.28	0.84	3.82	-0.285	-4.44	-24.79	-22.02
36	0.020	0.60	2.05	2.15	-0.075	-0.41	-7.22	28.56
37	0.017	0.80	1.74	5.90	-0.059	-1.20	-5.74	-3.95
38	0.126	1.01	13.53	53.99	-1.324	-5.76	-73.40	-82.65
39	0.039	0.32	4.05	16.82	-0.469	-1.85	-37.47	-22.41
40	-0.317	-3.67	-27.20	-34.49	0.063	0.89	6.51	17.94
41	-0.023	-0.60	-2.27	-3.72	-0.639	-4.60	-47.23	-36.25
42	-0.414	-4.28	-33.90	-44.57	-0.254	-0.96	-22.43	-14.23
44	0.057	0.94	5.87	-2.33	-0.128	-0.42	-12.08	-39.04
45	-0.061	-1.41	-5.97	-19.09	-0.616	-10.41	-45.99	-62.15
46	-0.002	-0.11	-0.24	-4.34	-0.359	-4.67	-30.20	-51.24

[a] The White (1980) consistent covariance matrix was used to calculate the t-statistics.

[b] The direct effect is $(P^N-P^R)/P^R=\{\exp(\beta_{1i}+\beta_{2i}*YR)-1\}*100$.

[c] The indirect effect is $(P^N-P^R)/P^R=\{\exp(\beta_{1i}+\beta_{2i}*YR)(ALH^N/ALH^R)^{\beta_{4i}}(AL^N/AL^R)^{\beta_{5i}}(DENSITY^N/DENSITY^R)^{\beta_{6i}}-1\}*100$.

As an indicator of fit, I calculated the correlation of the "restricted" estimated effects (given by equation (15)) and the unrestricted estimated effects (given in Table 2). The resulting correlation is .47 and indicates a strong positive fit. From the results reported in equation (15), the influence of deregulation can be evaluated across observable dimensions. First, the initial effects of deregulation tend to be positive for commodities with long and heavy hauls and negative for commodities with short and light hauls. However, commodities with long and heavy hauls tend to gain more from deregulation through cost efficiency gains, while commodities with short and light hauls tend to have smaller effects through time.

In terms of the plausible deregulation effects presented in Section 2, the initial results of deregulation tend to support small cost savings and enhanced market power, especially for the long-haul and heavily-loaded commodities. There are two ways in which positive effects from deregulation can occur. First, cost savings are small and deregulation results in a relaxation of first or second-best regulatory rules in favor of private pricing rules and firms have market power. Second, cost savings are small, deregulation is from an ineffective price regulation, and market power is higher under the deregulated state than in the regulated state. The data do not support a more competitive marketplace and do not support large cost savings in the immediate periods of deregulation, especially for the long-haul and large-load commodities.

The dynamic effects captured in β_{2i}, however, suggest that deregulation has resulted in efficiency gains for the commodities that experienced higher prices initially.[19]

[19] Large loads and long distances typically have lower costs. Under deregulation there have been a number of innovations that favor large loads and long hauls. For example, soon after deregulation there were dramatic increases in the number of contracts formed between individual railroads and shippers. In general, these

In particular, the coefficients on average length of haul and average load were negative and significant. In the unrestricted model, most of the dynamic effects of deregulation were negative (based on the coefficient on the interactive regulation dummy variable with time). These results suggest that through time costs have been falling. These results, together with the results in equation (15), suggest that those savings are more dramatic for the long-haul and heavily-loaded commodities. The coefficient on density is positive but is not statistically significant, suggesting there are not dramatic effects across commodities on density dimensions. Finally, the intertemporal effect of deregulation is increasing (becoming less negative) in time. This finding suggests there were efficiency gains from deregulation that increased over time but the rate of increase is becoming smaller.

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contracts favored larger shippers shipping long distances. More recently, Certificates of Transportation (COTS) and similar programs, which allow shippers to bid for transportation services, have tended to be used by large shippers shipping long distances. See Wilson (1988) and MacDonald (1990) for a complete and thorough review of deregulation and these advances.

SUMMARY

This paper develops a model that nests a variety of regulated and non-regulated market outcomes. The model is novel in its ability to represent a variety of plausible deregulation outcomes. The effects of deregulation depend on the nature of pricing in regulated and deregulated states, the level of cost savings, and the elasticity of demand. In general, deregulation negatively influences rates if cost savings are achieved with no or little increase in markup parameters. Deregulation may, however, occur under a variety of plausible pricing rules including first and second-best pricing as well as captive regulatory pricing. Deregulation then results in tradeoffs between cost savings and increased markups over marginal costs. The resulting tradeoffs produce price effects that vary across commodities, and are lost in aggregate studies of rates.

An analysis of deregulation outcomes on 34 different commodity classifications over a 17 year period suggests dramatic differences across commodity classifications not only in terms of magnitudes of effects, but also in terms of direction. The evidence suggests that the majority of commodities prices initially rose under deregulation, reflecting greater market power and modest costs savings. By 1988, however, deregulation produced lower prices in most commodity classifications and did not increase prices in the other classifications, suggesting that advances in productivity have dominated any adverse market power effects. Variations in the effects of deregulation are partially explained by differences in the characteristics of commodities. In general, initial effects tended to be positive and significant for long-hauls and heavily-loaded commodities, while these same commodities also appear to be the recipients of the cost efficiencies gained through deregulation.

Deregulation of the railroad industry remains controversial, and proposals to reregulate the industry continue to attract attention. This study suggests that while differences exist across commodities (especially in the early periods of deregulation) the effect of deregulation on prices is generally to lower them. With price decreases and cost savings from deregulation, welfare gains from deregulation are likely positive. Whether reregulation can maintain cost efficiencies gained by the Stagger's Rail Act but remove any unwarranted allocative inefficiencies is an important focus of future research in this area.

APPENDIX

Table A-1.—Coefficient Estimates-Restricted Model

	Variable[a]					
STCC	ONE	YR	DENS	ALH	AL	GNP
1	-0.8589 (-0.3169)	-0.0677 (-5.6631)	0.0341 (0.3339)	-0.8957 (-5.5912)	0.2560 (1.4324)	0.7208 (2.0625)
8	10.3771 (1.4025)	-0.0367 (-1.9001)	0.0096 (0.0660)	-0.5100 (-2.5727)	-1.0206 (-4.6478)	-0.2505 (-0.3157)
9	-4.1731 (-0.9989)	-0.0183 (-1.0789)	0.1132 (2.0605)	-0.2169 (-3.5889)	-0.1787 (-2.0332)	0.8966 (1.7712)
10	20.8544 (2.6807)	0.0323 (1.4848)	-0.0517 (-0.3733)	-0.4670 (-1.8852)	-1.0707 (-1.1099)	-1.5690 (-1.6201)
11	22.4154 (2.9574)	0.0224 (0.9909)	0.2246 (2.1516)	-0.7003 (-2.4644)	-2.4661 (-2.7570)	-1.0168 (-2.1276)
13	-10.2146 (-1.8434)	-0.0372 (-2.5022)	-0.2403 (-6.4363)	-0.0295 (-0.2916)	-0.6900 (-2.9839)	1.7955 (3.0131)
14	-11.6832 (-1.3007)	-0.0538 (-1.8382)	-0.7741 (-3.2088)	-0.0693 (-0.3034)	0.2980 (0.3245)	1.9018 (2.2590)
19	-12.6417 (-1.1275)	-0.0946 (-2.4733)	-0.1976 (-2.9185)	-0.0815 (-0.2777)	-0.5645 (-1.3841)	2.1150 (1.4251)
20	-1.4743 (-0.5112)	-0.0491 (-4.8260)	0.0192 (0.0979)	-0.2558 (-0.8103)	0.6985 (1.7452)	0.1441 (0.4288)
21	-3.6822 (-0.8379)	-0.0678 (-5.5961)	-0.1151 (-1.7230)	0.0707 (0.5949)	-0.3533 (-0.8266)	0.7009 (1.6018)
22	-9.1841 (-1.7346)	-0.0670 (-4.3911)	-0.0795 (-0.8116)	-0.0301 (-0.2900)	0.3034 (1.4448)	1.2393 (2.1281)
23	-3.4183 (-0.4824)	-0.0189 (-0.8908)	-0.0486 (-0.4380)	-0.4079 (-2.6304)	-0.3462 (-1.1557)	1.1122 (1.4097)
24	2.8787 (0.3617)	-0.0244 (-0.7947)	-0.0547 (-0.2685)	-0.3274 (-2.0550)	-0.2636 (-0.3702)	0.1615 (0.2141)

[a] The White (1980) consistent covariance matrix was used to calculate the t-statistics in ().

Table A-1.—Coefficient Estimates-Restricted Model-continued.

	Variable[a]					
STCC	ONE	YR	DENS	ALH	AL	GNP
25	-21.4890 (-3.3818)	-0.1541 (-5.3955)	-0.6931 (-5.5623)	0.0183 (0.1481)	0.2525 (1.1306)	2.9574 (3.9742)
26	5.0010 (1.0440)	-0.0028 (-0.1505)	-0.3299 (-2.7798)	-0.1830 (-0.7386)	-1.0797 (-1.1558)	0.3874 (1.1083)
27	-0.3732 (-0.1085)	-0.0584 (-4.4408)	-0.1004 (-2.1042)	-0.3065 (-1.8877)	-0.1938 (-1.9044)	0.5303 (1.3180)
28	14.9904 (2.9576)	0.0114 (0.8740)	-0.0188 (-0.1197)	-0.7943 (-3.0873)	-1.6531 (-6.2813)	-0.1917 (-0.3409)
29	3.9590 (0.8628)	-0.0041 (-0.2724)	-0.4985 (-5.1908)	-0.2907 (-1.1068)	-0.2557 (-0.6670)	0.2854 (0.6996)
30	-12.3727 (-1.4276)	-0.0963 (-3.5740)	-0.5631 (-3.2516)	-0.2324 (-1.2462)	0.3615 (1.0533)	1.9579 (2.0919)
31	-16.5525 (-2.0968)	-0.1281 (-5.1306)	0.0840 (0.8790)	-0.1340 (-1.1115)	-0.5109 (-6.3424)	2.5216 (2.6176)
32	-1.3230 (-0.2545)	-0.0367 (-2.0553)	-0.1543 (-0.9523)	-0.7322 (-4.4788)	0.2450 (0.7919)	0.8069 (1.3293)
33	10.3497 (2.4030)	-0.0114 (-0.8520)	0.0829 (1.4017)	-0.4528 (-3.0909)	-0.8302 (-4.1627)	-0.4221 (-0.8110)
34	4.7184 (1.2017)	-0.0353 (-2.5483)	-0.2381 (-4.2245)	-0.7294 (-3.9284)	-0.1284 (-0.8602)	0.3222 (0.7820)
35	5.3048 (1.9599)	-0.0354 (-3.1154)	-0.0626 (-1.4173)	-0.2938 (-2.1923)	0.0562 (0.5151)	-0.2109 (-0.6952)
36	-0.0797 (-0.0278)	-0.0483 (-3.9955)	-0.2146 (-4.1532)	-0.1144 (-0.5832)	-0.0281 (-0.2583)	0.4059 (1.4127)
37	9.4104 (3.0237)	-0.0059 (-0.6297)	0.0226 (0.3829)	-0.5677 (-3.4222)	-1.1796 (-5.1544)	-0.0053 (-0.0159)

[a] The White (1980) consistent covariance matrix was used to calculate the t-statistics in ().

Table A-1.—Coefficient Estimates-Restricted Model-continued.

	Variable[a]					
STCC	ONE	YR	DENS	ALH	AL	GNP
38	-1.3156 (-0.1361)	-0.0696 (-2.4096)	-0.2853 (-3.1041)	-0.1069 (-0.6404)	-0.3232 (-1.5153)	0.5082 (0.4668)
39	-8.4353 (-0.9757)	-0.0994 (-3.7073)	-0.2617 (-3.1851)	-0.2226 (-0.7789)	-0.1799 (-1.5993)	1.5145 (1.6644)
40	-6.5043 (-1.5747)	-0.0555 (-4.0489)	-0.2127 (-1.4641)	-0.0381 (-4.5932)	-0.7580 (-0.8781)	1.4568 (4.1810)
41	12.1040 (2.1070)	-0.0150 (-0.9574)	0.1653 (2.1499)	-0.7921 (-4.2504)	-0.7207 (-4.6248)	-0.3718 (-0.5348)
42	-26.2450 (-2.7455)	-0.1079 (-4.4801)	-0.3132 (-1.8414)	-0.0356 (-0.0814)	-0.1459 (-0.6012)	3.5366 (2.9858)
44	-5.1209 (-1.1662)	-0.0643 (-2.9159)	-0.1559 (-4.4421)	0.0397 (0.4842)	-0.2810 (-1.5497)	0.8873 (1.5225)
45	0.1239 (0.0301)	-0.0542 (-3.2045)	-0.0295 (-0.4379)	0.2676 (1.2106)	-0.3546 (-1.4925)	0.0163 (0.0316)
46	2.6254 (0.5355)	-0.0289 (-2.0169)	-0.2094 (-2.3117)	-0.5302 (-1.5688)	-0.6178 (-5.3293)	0.6226 (1.6718)

[a] The White (1980) consistent covariance matrix was used to calculate the t-statistics in ().

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