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Authors

Ying, John S.
Keeler, Theodore E.

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UNIVERSITY OF CALIFORNIA, BERKELEY

Department of Economics

Berkeley, California 94720

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**Pricing in a Deregulated Environment:
The Motor Carrier Experience**

John S. Ying and Theodore E. Keeler

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Key words: Trucking, freight, transportation, regulatory policy.

Abstract

A major policy goal of the Motor Carrier Act of 1980 was to provide the shipping public with more efficient truck freight rates. Unlike previous studies which have focused on intrastate reforms, this paper analyzes dynamically the effects of the Act on the freight rates of Class I and II common carriers of general freight. The estimated rate equation explicitly includes marginal cost, along with variables expected to affect market power and demand elasticity. Simulations indicate that deregulation has reduced rates from the very beginning, and that the effect has grown over time. By 1983, prices are nearly 22 percent lower. Besides this direct effect, indirect effects occurring through other variables seem to go in the opposite direction, but are so small as to hardly offset the direct effects. Overall, the effects of deregulation become more pronounced with time and rates have fallen 18 percent by 1983.

JEL Classification: 615

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John S. Sing
Department of Economics
University of Delaware

Theodore E. Keeler
Department of Economics
University of California, Berkeley

PRICING IN A DEREGULATED ENVIRONMENT:

THE MOTOR CARRIER EXPERIENCE

John S. Ying and Theodore E. Keeler¹

October, 1988

If the Motor Carrier Act of 1980 had a purpose, it was to provide the shipping public with more efficient truck freight rates. According to many studies, rates prior to the 1980 Act were inefficient primarily because they were considered too high for several reasons.² First, route restrictions gave truck firms monopoly power, thereby enabling them to extract higher rates than competitive markets would permit. Rate bureaus served as cartels, which facilitated the use of this market power. Furthermore, the value-of-service pricing structure encouraged by the Interstate Commerce Commission entailed high rates relative to costs for many commodities. Second, route restrictions also prevented firms from operating as efficiently as they could, thus raising costs. For example, such restrictions prevented rates from falling on backhauls so as to fill the trucks, thereby leading to empty trucks which might in fact be full with competitive markets. Third, the Teamster's Union seemed to exploit the above-mentioned monopoly power from truck deregulation to extract some monopoly rents for organized labor, so the effect was to raise wages above equilibrium levels (perhaps with inefficient work rules, as well).

It is now some years past the passage of the Motor Carrier Act of 1980, and there has been a reasonable length of time over

which to observe the actual effects of truck deregulation, and to compare them with the theoretical expectations of economists and policy-makers before the 1980 Act was passed.

There have been some studies of the effects of truck deregulation on rates, most especially the works by Beilock and Freeman (1987) and Blair, Kaserman, and McClave (1986). But these studies have been concerned solely with the effects of deregulation on intrastate routes in Florida and Arizona, and those models have not attempted to link prices, costs, and market variables with regulatory policies in the way the present paper does. Previous studies have also failed to build estimates of marginal cost for relevant commodities into their calculations, and there are also indirect effects to account for. The desirability and method for incorporating these effects are discussed below.

In the present paper, we analyze dynamically³ the effects of deregulation on truck rates for the 1975-83 period, using observations on a panel of 61 firms. The statistical analysis is based on a combination of a rate equation and a cost equation. The conceptual rationale for the models estimated here is discussed in the next section. The following section sets forth the details of the specification of the rate equation estimated here as well as the indirect effects. The third section discusses the data set used and presents the statistical results. The fourth and fifth sections deal with simulating the direct and indirect effects, respectively. In the final section, we discuss

the implications of our results regarding the effects of deregulation in the trucking industry.

I. Conceptual Motivation

It is a basic precept of microeconomic theory that the price a firm charges in the marketplace is a function of marginal costs and its perceived demand elasticity. The relationship, seen many times in microeconomic theory textbooks, is

$$P = MC/[1-(1/e)]$$

where P is the price charged, MC is a measure of marginal cost, and e is the price elasticity of demand as perceived by the firm.

Conceptually, our model is based on this relationship. Using the results of some earlier work by Ying (1987), we provide estimates of marginal cost for a typical commodity trip for a typical commodity for each firm in a panel of 61 firms over the 1975-83 period. For each commodity, then, we have an estimate of marginal cost. For our estimate of price, we use the average revenue per ton-mile. The rate equation then includes three types of variables: first, those theoretically expected to affect the degree of market power of a given firm, and hence likely to influence the demand elasticity. Second, the estimate of the long-run marginal cost of shipping a typical commodity on a given carrier, estimated from a translog cost equation, originally used in Ying (1987). Finally, we include deregulation itself as a variable to explain truck rates. The rationale for this is that it is only with deregulation that market forces

should determine prices as described above--before deregulation, market forces might play a role in determining prices, but, one would expect, less so than before. Furthermore, one might well expect deregulation to reduce price-cost margins, all other things equal.

To determine the effects of deregulation on truck rates, we need to calculate two types of effects: direct and indirect effects. Direct effects are those which are estimated directly from the rate equation, as briefly described above (and described in more detail below). Indirect effects are those which occur not directly through the deregulation variable, but indirectly through other variables. Suppose, for example, that wages were affected by deregulation. This would not be picked up by the rate equation directly--it analyzes the effects of deregulation holding such variables constant. But, if deregulation reduces wages, that requires estimating a separate equation showing the effects of deregulation on wages. The effect of deregulation on rates through wages can then be found by simulating the effects of the change in wages caused by deregulation on rates. The chart shown in figure 1 shows conceptually how the components of the model fit together to estimate the various effects of deregulation.

Note, specifically, that in Figure 1, the path marked I represents direct effects, and the paths marked II and III represent indirect effects. The last two sets of effects require more explanation. Path II represents effects of deregulation on the structural variables, such as market share and firm size, and

on marginal cost, in the rate equation. These variables, in turn, have an effect on rates. Path III represents the effects of deregulation on the structural variables in the cost function; price is then affected by marginal cost. In subsequent parts of this paper, we label effects working through path I direct effects, the effects working through path II indirect effects, and the effects working through path III secondary indirect effects.

II. Econometric Models for Rates and Indirect Effects

To analyze the impact of motor carrier deregulation on rates, we estimate a rate equation of the following general form

$$R = R(m, e, d, t)$$

where R represents rates, m is marginal cost, e is a vector of characteristics affecting the price elasticity of demand, d is a deregulation variable, and t is a time trend variable.

The marginal cost variable is derived from previously estimated cost functions, based on work done by Ying (1987), and the deregulation and time trend variables are straightforward in conceptual motivation.

However, some motivating discussion is appropriate regarding those variables expected to affect market power. There is ample evidence⁴ that the trucking industry has many competitive traits: without government regulation, entry is easy (both by new firms and by existing firms into new markets), and the size of our sample alone indicates that, over the U. S., the industry

is atomistic, as well. Moreover, long-run evidence from interstate markets in Australia indicates that price coordination is rare and that profit margins are quite small--competitive in the opinion of most.⁵

Does this mean that any possible accounting for market power in our equation is inappropriate? The work of Daughety and Forsythe (1987) suggests that it is at least appropriate to test for some possible existence of market power in the period following deregulation. Specifically, they show, in experimental simulations of games in some ways relevant to the trucking industry, that after deregulation of entry and rates, the residuum of market power from firms with either reputations or large route networks can be considerable and long-lasting: "When industries are deregulated, the past is more than a prologue: the reputation capital formed under regulation is available for use by the deregulated firm. . . . its use (independent of whether or not the users are successful in achieving a collusive solution) affects the deregulated industry equilibrium, even with entry."

To account for this effect, we are including in our equation structural variables to reflect the residuum of market power suggested by Daughety and Forsythe. The first and most obvious market power variable is the regional market share of the relevant firm. Clearly, a large market share could be an indicator of this residuum of market power in the period after deregulation. Furthermore, because of the very effects suggested by Daughety and Forsythe, the market share variable can best be

treated as exogenous, even after deregulation. That is because all the firms in this sample are ones which existed before deregulation, and all can be expected to benefit to some extent from the hypothesized reputation effect. On this basis, market share could be considered exogenous, at least in rough, broad terms.

The other variables which we include in this group are commodity attribute variables (described below) which reflect the market niches which the firms occupy at a given time.

To some degree, specification of a functional form for this analysis is arbitrary. To maximize generality and minimize that arbitrariness, we utilize a second-order approximation to an admittedly unknown functional rate equation. The translog rate equation can be written as

$$\begin{aligned}
 \ln R = & a_0 + a_m \ln m + \sum_i a_{i1} \ln e_i + a_d d + a_t t + & (1) \\
 & 1/2 a_{mm} (\ln m)^2 + 1/2 \sum_i \sum_j a_{ij} \ln e_i \ln e_j + \\
 & 1/2 a_{tt} (t)^2 + \sum_i a_{mi} \ln m \ln e_i + a_{md} \ln m d + \\
 & a_{mt} \ln m t + \sum_i a_{id} \ln e_i d + \sum_i a_{it} \ln e_i t + \\
 & a_{dt} d t + \epsilon_r
 \end{aligned}$$

where ϵ_r is a disturbance term, and all variables except d and t are divided by their sample mean. This equation is estimated using ordinary least squares (OLS).

Since our deregulation variable is not a continuous variable, the direct effects of reform can be calculated as a percent change in rates resulting from a unit change in d .

$$(R_1 - R_0)/R_0 \times 100 = \exp (a_d + a_{md} \ln m + \sum_i a_{id} \ln e_i + a_{dt} t) - 1 \quad (2)$$

In addition to these direct effects, deregulation can also affect rates through its effect on the right-hand-side variables in (1). These indirect effects can be captured by a series of regressions where the right-hand-side variables are the dependent variables and deregulation is one of the explanatory variables.

Following Ying (1988), we apply a uniform specification across all the variables except for marginal cost, and estimate log-linear and translog equations, with deregulation, a lagged dependent variable, and time serving as the independent variables. For example, the log-linear equation for any given characteristic variable is

$$\ln e_i = b_0 + b_{-1i} \ln e_{-1i} + b_{id} d + b_{it} t + \epsilon_i$$

where the subscript -1 refers to the one period lag. F-tests are conducted to determine which specification is more appropriate. This estimation approach is not necessary for marginal cost since it can be directly simulated from the estimated total cost function in Ying (1988). Once the effect of deregulation on the right-hand-side variables is known, their indirect effect on rates can be determined by combining it with the derivative of the rate equation with respect to the relevant variable.

In estimating these indirect effects, the inclusion of a lagged dependent variable in pooled cross section time series data causes OLS parameter estimates to be inconsistent. Thus, a two-stage least squares procedure is necessary to ensure consistent

estimates. Each of the lagged variables is projected into the linear space spanned by a set of exogenous variables and their one period lags. Using the predicted values, a first-order autoregressive estimation procedure is employed for better efficiency.

Yet another indirect effect which we account for is the effect of deregulation on the right-hand-side variables in the previously estimated cost function, and its subsequent effect on rates through marginal cost. This secondary indirect effect is similarly estimated as the indirect effect. In this case, the effect of deregulation on the variables in the cost function are taken from Ying (1988). Next, their effect on marginal cost are simulated over 1980-83. Lastly, the effect of marginal cost on rates can be calculated from the rate equation.

III. Data and Variables

Based on those firms reporting the necessary variables and data continuity over the sample period, the data set comprises 61 Class I and II common carriers of general freight, over 1975 to 1983. The data is taken from Trinc's Blue Book of the Trucking Industry, 1976-1984 editions. Although more current data is available, this particular publication was discontinued in 1984, which effectively limited the time series since it is the only source for one of the variables in the rate equation. The resulting number of observations is 548.

Rather than analyzing rates for specific shipments, we choose to study the effect of deregulation on rates at the firm level. To calculate such rates, the operating revenues are divided by total ton-miles. Because a total cost function has been estimated in Ying (1988), the marginal cost (MC) can be simulated directly. Details on the specification, variables, and estimation of the cost function are available in that paper.

The vector of characteristics affecting demand elasticity includes average length of haul (AH), percent less-than-truckload traffic (TL), revenue ton-miles (RT), average load (AL), average shipment size (AS), regional market share (RM), capital share of total cost (KS), and average cargo loss-and-damage insurance expenditures per dollar of cost (IN).

The remaining two variables in the rate equation are deregulation (DEREG) and a time trend (T). The deregulation variable is a dummy variable, having value 0 for 1975-97 and value 1 for 1980-83, whereas t is simply 1 in year 1975, 2 in year 1976, etc.

The instruments for the lagged dependent variables are largely statewide data which have been aggregated to the a firm's region of operation, as specified in Trinc's. Excluding time and deregulation, the exogenous set of ten variables are value-added in manufacturing, highway capital stocks, Federal-aid highway system mileage, average hourly earnings, unemployment rates, the ratio of retail sales to value added, crime burglary rates, producer fuel prices, truck price indices, and U.S. Treasury Bill rates. Please refer to Ying (1988) for a full discussion of these

variables and their data sources.

IV. Estimation Results

The results of the least squares estimation procedure are shown in Table 1. Although not all the first-order terms are significant, use of an F-test indicates that all variables are significant in that collectively, the polynomial expansion of each term is significantly different from zero (the one exception to this is the DEREG variable, for which the significance was judged great enough only to include the primary term and an interactive term with time).

At the mean values of the variables,⁶ many of the coefficients have expected signs and plausible values. For example, a longer length of haul reduces the cost per ton-mile of a shipment. A higher propensity to handle less-than-truckload traffic implies a higher rate. A larger or more capital-intensive firm seems to be able to collect a higher rate (this presumably reflects the higher value of service resulting from more capital-intensive equipment or a more extensive and integrated route network). A higher average vehicle load corresponds to a lower rate (this variable could, theoretically, go either way, though). Perhaps most plausibly of all, a higher long-run marginal cost results in a higher rate. The only things here of surprise are, first, the low significance of the variable at the mean value and, second, the relatively low observed elasticity of price with respect to marginal cost at that mean value. Nevertheless, as

previously stated, the MC variable is highly significant taken in all its polynomial expansions, and there is reason to believe that the elasticity of price with respect to marginal cost is much higher evaluated at some other points in the data sample.⁷

Estimated at the mean values of the equations, the other variables, i.e., insurance expense, time, deregulation, and regional market share, would seem to be implausible.

Here too, however, especially in the case of the time, deregulation, and market share variables, values away from the mean would seem to tell a different story.

Specifically, during the years of deregulation, when one would most expect market share to have an effect on rates, it appears that market share indeed had a positive effect on rates. Similarly, it appears that during the later years of deregulation, rates fell in a way that they did not in earlier years, and this decline from deregulation was greater than it would have been with the estimated time trend under regulation: that deregulation reduced rates over time is indicated by the negative and significant value for the interaction term between time and deregulation.

This last result is an important one; we shall discuss why it happened after we have considered all the results from the simulations of the direct effects of deregulation; that is done in the next section.

V. The Direct Effects of Deregulation on Rates

Table 2 shows the results of our simulations of the direct effects of deregulation on rates. They show that deregulation reduced rates from the very beginning, and that the effect got stronger over time, ultimately causing a reduction of rates by 22 per cent compared with what they would have been without deregulation. This is certainly consistent with the view held by economists of what truck deregulation should do. It also implies that while there have been some market lags in pricing from market competition, the lags have not been extremely long.

The direct effects considered here are important, but it is also important to consider indirect effects. That is done in the next section.

VI. The Indirect Effects of Deregulation on Rates

Also included in Table 2 are the simulation results for the indirect and secondary indirect effects. Because of space considerations, details of this analysis are not presented but are available upon request. Of the right-hand-side variables in the rate equation, only average length of haul was not affected by deregulation in a statistically significant manner in either the log-linear or translog specifications.

Summing the indirect effect of deregulation across all the variables shows that the effect on rates follows a pattern similar to that of the direct effect. Regulatory reform throughout the sample period causes rates to be slightly higher than otherwise, ranging between 1.5 percent to 4.5 percent higher.

However, over time, this rise in rates is decreasing. It suggests that truckers are continuing to adjust their costs and operations to compete more effectively in the new deregulated environment, where rates have gained in relative importance.

Interestingly, the secondary indirect effect of deregulation on rates not only results in higher prices but is increasing between 1980 and 1983. Nevertheless, the magnitude of the changes is still quite small, from less than 1 percent to about 2 percent. Recall that this effect examines in part the impact of reform on the right-hand-side variables in the cost function. The results indicate that changes in firm operating characteristics such as smaller average shipment sizes since deregulation are contributing to some indirect increases in marginal cost. As suggested in Ying (1988), considerations besides cost such as filling a backhaul could be more important to truckers. While such actions may indirectly increase rates, the overall effect is still to lower them.

This fact is confirmed in the last column of Table 2, which calculates the overall effect of deregulation of rates. While the indirect and secondary indirect effects are significant conceptually, in the case of trucking, they have little actual impact. The indirect effects are sufficiently large in the early stage of deregulation to lead to 4 percent higher rates. But, by the second year, the direct effect begins to predominate the other effects to cause nearly 5 percent lower prices. For the last year in our study, rates are almost 18 percent less as a consequence of regulatory reform.

VII. Conclusions

From our analysis, several important conclusions follow. First, it seems quite clear that the overwhelmingly most important part of the effect of deregulation on truck rates occurs directly, rather than indirectly through the rate function. That appears to be true, principally because, by our calculations, rates under deregulation appear to be much more responsive to direct structural variables than they do to our estimates of long-run marginal cost.

Second, it appears that rates have indeed fallen substantially as a result of the Motor Carrier Act of 1980. By our calculations, based on the direct effects, by 1983, deregulation had reduced truck rates, on the average, by over 20 per cent. The indirect effects, on the other hand, seemed to go in the opposite direction, raising rates slightly. But the amount was so small as to hardly offset the direct effects at all.

Third, the time pattern of the effects of deregulation on truck rates is important, as well. Our results show that the first effects were either small or even perverse (i.e., raising rates). But, as time went on, the response was a greater and greater decrease in rates, all things equal. Interestingly, this pattern is similar to that found by Ying (1988) for productivity: for the same panel of firms, deregulation first seemed to reduce productivity, then it increased it, so that by 1984, productivity was well ahead of where it would have been had the pre-1980 regulatory regime persisted.

As to why these effects are occurring, we can only speculate. But it is quite possible that for the panel of firms under consideration here, it took time to adjust to deregulation, both in operations (and hence efficiencies) and pricing policies. Furthermore, it is likely that the competitive effects of deregulation (i.e., entry on to new routes) took time to occur, as well.

It is of course worth asking to what extent the trend observed here of rates being below what they otherwise would have been under regulation has continued over the middle and late 1980's. That issue, plus the question of the underlying causes of the rate changes observed here, must be left to further research.

Figure 1. Structure of the Models

TABLE 1. Estimates of Parameters for Rate Equation

PARAMETER	ESTIMATE	APPROX. STD ERROR	'T' RATIO	APPROX. PROB> T
INTERCEPT	-0.91845	0.15363	-5.98	0.0001
AH	-0.73210	0.16985	-4.31	0.0001
TL	0.20287	0.12799	1.59	0.1136
KS	0.32262	0.16174	1.99	0.0466
RT	0.04307	0.04531	0.95	0.3422
IN	-0.07464	0.07388	-1.01	0.3129
AL	-0.05383	0.14894	-0.36	0.7179
DEREG	0.45478	0.15236	2.99	0.0030
T	0.09276	0.03068	3.02	0.0026
MC	0.03947	0.21371	0.18	0.8536
RM	-.0023569	0.04182	-0.06	0.9551
AS	-0.26380	0.13434	-1.96	0.0501
1/2 AH	-0.12646	0.15059	-0.84	0.4015
1/2 TL ²	-.0022478	0.07366	-0.03	0.9757
1/2 KS ²	-0.71126	0.15002	-4.74	0.0001
1/2 RT ²	0.04836	0.01291	3.75	0.0002
1/2 IN ²	-0.15857	0.03461	-4.58	0.0001
1/2 AL ²	0.31294	0.11787	2.66	0.0082
1/2 T ²	.00426808	.00630047	0.68	0.4985
1/2 MC ²	-0.09056	0.17714	-0.51	0.6094
1/2 RM ²	0.01133	.00932882	1.21	0.2253
1/2 AS ²	0.05097	0.07936	0.64	0.5211

AH*TL	0.02359	0.09442	0.25	0.8028
AH*KS	-0.05885	0.12123	-0.49	0.6276
AH*RT	-0.01741	0.03644	-0.48	0.6330
AH*IN	0.06343	0.05149	1.23	0.2185
AH*AL	-0.14610	0.10021	-1.46	0.1455
AH*T	0.02708	0.01606	1.69	0.0924
AH*MC	-0.34532	0.13135	-2.63	0.0088
AH*RM	0.01954	0.02544	0.77	0.4428
TL*KS	0.03148	0.09618	0.33	0.7436
TL*RT	-0.01871	0.03201	-0.58	0.5592
TL*IN	0.13287	0.03994	3.33	0.0009
TL*AL	0.11131	0.11189	0.99	0.3203
TL*T	.00610022	0.01181	0.52	0.6057
TL*MC	-.0035464	0.10677	-0.03	0.9735
TL*RM	0.02612	0.02604	1.00	0.3163
KS*RT	.00496075	0.03703	0.13	0.8935
KS*IN	0.21812	0.07000	3.12	0.0019
KS*AL	0.07459	0.10388	0.72	0.4730
KS*T	-0.01507	0.01483	-1.02	0.3100
KS*MC	0.28850	0.12649	2.28	0.0230
KS*RM	0.06545	0.03382	1.94	0.0535
RT*IN	.00122226	0.01617	0.08	0.9398
RT*AL	-0.06073	0.03022	-2.01	0.0450
RT*T	.00258613	.00388726	0.67	0.5062
RT*MC	.00050041	0.03477	0.01	0.9885
RT*RM	-0.03337	.00798695	-4.18	0.0001
IN*AL	-.0078602	0.05059	-0.16	0.8766

IN*T	.00782951	.00670697	1.17	0.2436
IN*MC	-0.03504	0.05910	-0.59	0.5536
IN*RM	-0.06075	0.01470	-4.13	0.0001
AL*T	-.0076293	0.01263	-0.60	0.5462
AL*MC	0.11389	0.11827	0.96	0.3361
AL*RM	0.12064	0.02305	5.23	0.0001
DEREG*T	-0.07757	0.02806	-2.76	0.0059
T*MC	0.03017	0.01904	1.58	0.1137
T*RM	-0.001652	.00356337	-0.46	0.6431
MC*RM	0.03932	0.03209	1.23	0.2211
AS*AH	-0.02139	0.10222	-0.21	0.8344
AS*TL	-0.03046	0.07119	-0.43	0.6690
AS*KS	0.12384	0.07716	1.60	0.1092
AS*RT	-0.01312	0.02953	-0.44	0.6572
AS*IN	0.07160	0.04235	1.69	0.0915
AS*AL	-0.01572	0.09802	-0.16	0.8726
AS*T	0.01405	0.01144	1.23	0.2202
AS*MC	-0.06660	0.09965	-0.67	0.5043
AS*RM	-.0030734	0.02539	-0.12	0.9037

NUMBER OF OBSERVATIONS

548

Table 2. Direct and Indirect Effects of Truck Deregulation
(per cent)

Year	Direct	Indirect	Secondary Indirect	Total
1980	- 1.058	4.268	0.844	4.054
1981	-8.443	2.521	1.167	-4.756
1982	-15.277	1.870	1.603	-11.803
1983	-21.600	1.738	2.024	-17.839

Source: See text.

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FOOTNOTES

1. Department of Economics, University of Delaware, and Department of Economics, University of California, Berkeley, respectively. Ying gratefully acknowledges support from the University of Delaware General Research Fund.

2. For a summary of earlier studies on the effects of truck regulation, see Moore (1986).

3. Most previous studies of deregulation (with the exception of the work of Keeler, 1986, Caves, Christensen, Tretheway, and Windle, 1987, and Ying, 1988) have been of a comparative-static nature: they have looked at how rates, efficiency, and similar traits of an industry have changed before and after deregulation. The present study considers whether previous trends have accelerated or decelerated as a result of deregulation.

4. See Keeler (1983) and Moore (1986).

5. See Joy (1964) and Keeler (1983).

6. The two variables which do not have 0 values for their means are DEREK, which takes on the value 0 before 1980 and 1 after, and T, which is 1 for the first year, 2 for the second, and so on. So the elasticities shown by the first-order terms in Table 1 are with DEREK = 0 (i. e., with regulation), and with T = 0, i.e., the year 1974. So technically, especially for later years under deregulation, it can be misleading to refer to the first-

order terms as holding for sample mean values.

7. If the specification is done in the log-linear manner, with no polynomial expansions, then the marginal cost variable has a t-statistic of over 18, and the estimated elasticity is much higher.

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