THE EFFECTS OF DEREGULATION UPON RAIL RATES ACROSS COMMODITIES

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Introduction

The Staggers Rail Act significantly changed the regulatory structure of the railroad industry. Prior to the passage of Staggers, railroads were confronted with extensive controls over prices, entry, and exit. After passage of Staggers, many of the rules were removed, replaced or revised in the hopes of significantly improving the economic efficiency of the industry.

Studies of the overall effect of Stagger's on prices suggest no significant differences from effects prior to Staggers. Specifically, McFarland (1989) posed an econometric model of the aggregate level of railroad prices as a function of input prices, traffic characteristics, demand, and technological change. He found deregulation to have no significant effects on the overall level of prices. However, Friedlaender (1981), Boyer (1987) and others suggest that the effects of deregulation may differ significantly across commodities. Specifically, price regulation has been long suspected of keeping rates of low value-low density traffic movements lower than the "free" market level. The "losses" on these movements are then be cross subsidized by the high value-high density traffic movements. Under Staggers, price determination is largely in the marketplace. Thus it is expected that cross-subsidy effects would be removed. In particular, effects of Staggers on prices given cost effects is expected to be positive for low density movements and negative for high density movements. In this paper, we extend McFarland's study to multiple commodities and test whether indeed deregulation has had asymmetric effects.

Literature Review

Three recent studies examine the effects of deregulation. Boyer uses an aggregated system-wide set of data. That is, he considers the effects of Staggers on the overall, or system, level of prices. Boyer obtained results of a 20 percent decline in rates between 1970 and 1984. After controlling for changes in the average weight of trains, which was shown to account for 90 percent of the fluctuation in rail rates, he found no significant trend in the average level of rates. However, Boyer points out that deregulation should have aided in acceleration of train weight reflected by increasing specialization in bulk products or declining service quality. Therefore, although the Staggers Act did not significantly shift intercepts affecting rates, it did allow for greater pricing flexibility which were used to lower rates for larger shipments.

In examining Boyer's results, Barnekov and Kleit propose that deregulation brought upon by the Staggers Act to be much greater than anticipated. They first examine Boyer's (1987) model, and maintain three main criticisms. First, it lacks all demand-side variables. Secondly, the use of a dummy variable suggests that the full effects of deregulation occurred instantaneously with the passing of the Staggers Act. Finally, by using the dummy variables, Boyer also ignores the effects that are borne by changes in traffic composition. Barnekov and

Kleit's model includes these omissions and finds that the Staggers Act reduced rates substantially by 1987 under the use of both GNP and PPI deflators.

McFarland reviews the economic effects of railroad deregulation upon shippers, labor and railroad profits. Relevant to the examination of rates before and after deregulation is the effect upon shippers and the behavior of rates since the Staggers Act. McFarland attempts to reconcile Boyer and Barnekov and Kleit by using a specification which sets each rate equal to a markup factor multiplied by marginal cost. Marginal cost in turn is a function of traffic characteristics, technological change and input prices. In his specified log-linear equation, McFarland uses both a dummy variable that is 0 up until 1980 and 1 thereafter. He also interacts the dummy with time to allow for the possibility that deregulation allowed railroads to increase cost savings innovations. Neither Boyer nor Barnekov and Kleit used both types of variables and thus obtained conflicting results on rate behavior after deregulation. This paper concludes that the total effect on rates is not statistically significant and thus, deregulation either slightly reduced rates or had no effect upon them. McFarland includes, however, that even though he found no net effect on the general level of rates, specific commodities did witness rate increases because their traffic had a more idealistic demand, although he did not examine such commodities in great detail.

MacDonald summarizes and criticizes each of the above studies and points out that such aggregated sets of data generate difficulties in examining the true effects of deregulation because of such broad cost and quality control variable involved in these models. Therefore, he suggests that instead of more aggregate analyses, we need detailed studies on specific commodities, railroads, or regions to uncover specific effects of the Staggers Act. I follow his lead in this paper by examining the effect of Staggers on specific commodities using McFarland's general framework.

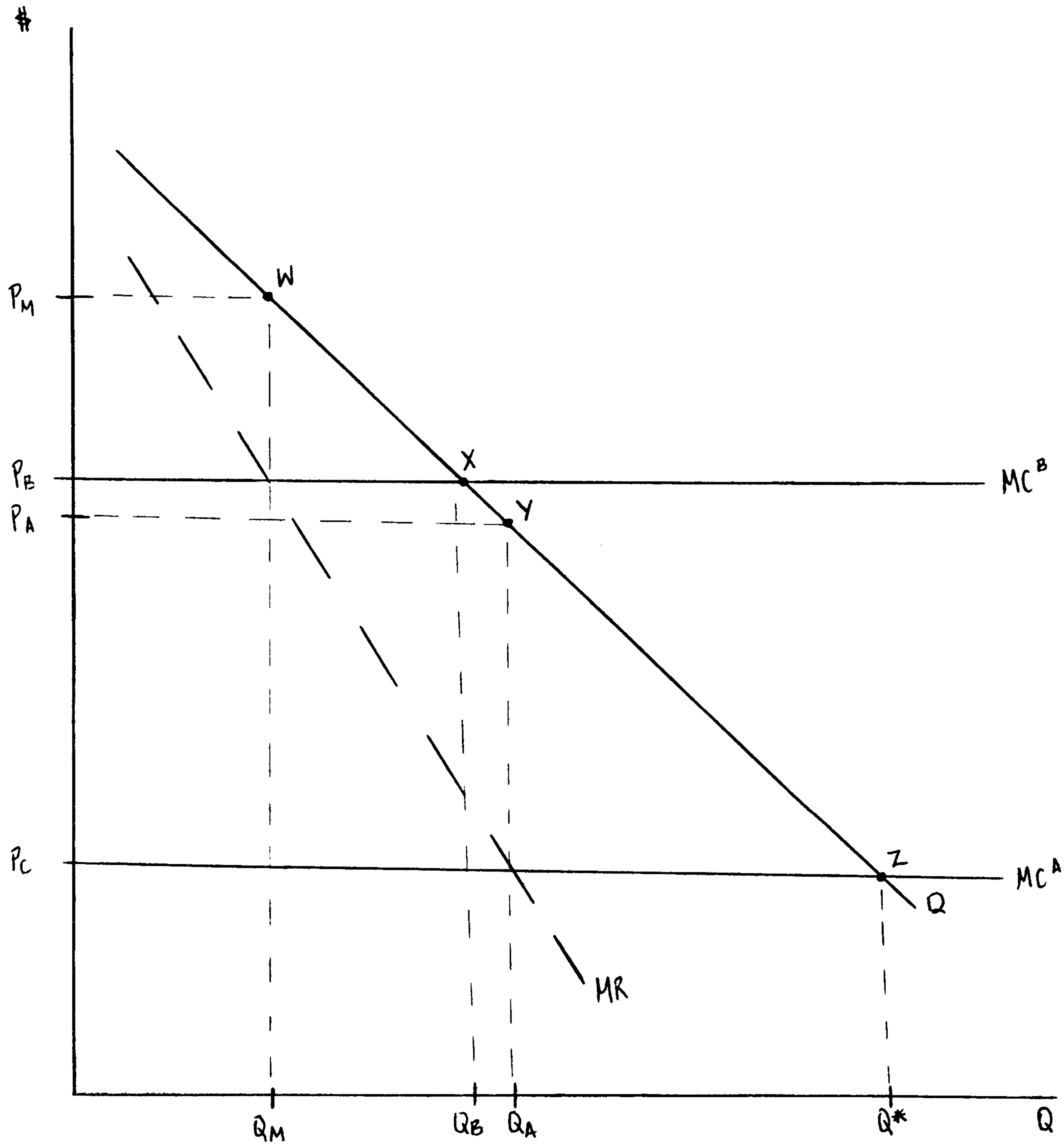
Following Friedlaender's research, we expect Staggers to have asymmetric effects on prices across commodities. In examining the nature of rail-truck competition in a deregulated environment, Friedlaender considers bulk (high-density) and manufactured (low-density) traffic. Her findings support that the price-MC ratios were higher for bulk commodities than for manufactured commodities and also that in the case of manufactured commodities, rail rates were actually below marginal cost. And since truck rates for both goods were above marginal cost with price-MC ratios also being higher for bulk than for manufactured commodities, under regulation, manufactured goods appeared to be favored over bulk on both modes of transportation. With regard to the cross-subsidy hypothesis then, bulk movements may "cross-subsidize" manufactured movements. However, it is pointed out that she found no significant evidence to suggest low-density rural traffic was subsidized by high-density urban traffic. Once again, these two categories are broad enough that perhaps results represent the net effects of general levels of aggregated sets and therefore do not necessarily conclude an absense of price movements across specific commodities.

Theory

The previous literature have examined the change in overall efficiency brought upon by the Staggers Act. While Boyer (1987) found that shipper rates rose slightly after deregulation, Barnekov and Kleit (1988), after critical examination of Boyer's model, generated their own model to find that rates were significantly reduced. They also suggested a shift from higher costs and lower firm profits during regulation to lower costs and higher profits after deregulation.

By using the Williamson model in Figure 1, we recognize several different pricing positions and analyze which ones represent regulation and deregulation. Let D be demand and MC and MC represent marginal costs before and after deregulation. There are four possible outcomes. First at point W, we have the case of railroads exercising monopoly power with an inefficient (regulated) technology. This could very well represent a position for those high-density goods which cross-subsidized lower-grade goods. A second outcome at point X represents efficient allocation by definitions since $P^B=MC^B$ but as with the period of regulation, MC^B before the Staggers Act was too high. Passage of the Staggers Act may have given railroads more freedom

FIGURE 1



in pricing yet at the same time allowed cost savings innovations and changes in technology to lower MC represented by a shift from MC^B to MC^4. A third outcome following a decrease in marginal cost is at point Z. Here, a competitive equilibrium is represented where $P^c = MC^4$. However, it is argued that a fourth outcome at point Y could very well represent pricing after deregulation since railroads enjoyed the ability to raise prices by a markup of marginal cost. Therefore, a movement from W or X toward Y represents the results of deregulation over pricing[1]. However, depending upon the actual demand and marginal revenue curves, slopes and positions, such price differentials in Figure 1 may be over or understated. Furthermore, the price of Y could be drawn to exceed X which would lead us to conclude that as a result of deregulation, prices actually increased rather than decreased. However, regardless of the sole effect upon prices, deregulation reduced inventory-related costs, led to higher profits to the railroads and a decrease in government subsidies, representing significant savings to the tax payers.

Empirical Model

In an attempt to resolve the discrepancies found between Boyer and Barnekov and Kleit, McFarland examined both models and created his own revised model and equation of rail rates. Basically, rates (p) are equal to:

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[1] Friedlaender and Spady (1981), in assessing the possible effects of deregulation, suggest a movement from point W during regulation under the original Interstate Commerce Act of 1887 toward a competitive equilibrium at point Z as a result of Staggers rather than toward point Y.

(1) p=mC(A, t, x),

where m = a markup factor and C = marginal cost which is taken as a function of: A = traffic characteristics, t = a time trend for technology and x = input prices.

Using a log-linear form of equation (1), McFarland estimates

(2) P_i = Log p_i = $B_o + \Sigma_j B_j X_{ji}$ + C*REG_i + D*REG_i*$TREND_i$ + ϵ_i

where log p is ...., the X's are defined below, REG is a dummy variable taking a value of 1 after 1980 and a value of zero before 1981, and TREND is a linear trend line (1972=1, 1973=2, ...). The B's, C, and D are parameters to be estimated ϵ_i represents the disturbances. The X's include DENS = revenue ton miles per total miles operated, ALH = average length of haul, BULK = share of traffic consisting of bulk commodities, GNP = gross national product, T = time trend for technological change.

In this specification of the general pricing relation, traffic characteristics are represented by variables DENS, ALH, and BULK. Each of these are expected to reduce marginal cost and therefore prices. Density (DENS) is ton-miles (output) of road operated (capacity). As density increases, output per unit of capacity increases and therefore marginal costs are expected to fall. Average length of haul (ALH) is the average distance per shipment. Shipments require "line-haul" expenses. As ALH increases, line-haul expenses (that vary with distance) may increase, but in general, the fixed expenditures per ton-mile is expected to fall by a greater magnitude. Therefore, increases in ALH are likely to reduce marginal costs and price. Finally, bulk commodities (BULK) generally require less handling costs and have greater weight transported by greater tons per carload, each reducing marginal costs. Thus, an increase in the share of bulk traffic should result in a decrease in costs. The variable T in (2) represents the time trend factor in (1) and should be negatively related to marginal cost since an increase in technological change would serve to reduce costs.

The markup factor contains demand-side conditions and market power effects. Since real GNP measures changes in demand, we would expect a positive relationship between rates and GNP. The variables DR and TR represent the effects of Staggers on prices.

These variables as used in McFarland's study, examined railroad rates as an aggregated system (all commodity) value per year and his study concluded no significant change in the general level of rates. However, it is expected that deregulation had different effects on the rates of different commodities. Therefore, in order to examine the possible influence of cross-subsidization among commodities, we extend equation 2 to reflect commodity differences in the intercepts and in an interaction term with deregulation.

The result is

$$(3)\ P_i = B_o + \Sigma_j B_j X_{ji} + C*REG_i + D*REG_i*TREND_i$$
$$\Sigma_c E_c DUM_{ci} + \Sigma_c F_c DUM_c REG_{ic} + \epsilon_i$$

where DUM_{ci} is a dummy variable taking a value of 1 for the cth commodity (C=1,2, ..., C) and a value of zero otherwise, and E_c and F_c represent additional coefficients to estimate representing the effect of commodity differences in the intercept and the influence of commodity specific effects of deregulation on the intercept. Specifically, equation (3) acknowledge the fact that different commodities influence rates individually and not necessarily in the same way. Further, deregulation is allowed to have asymmetric effects across commodities.

All variables influencing marginal cost, the markup factor, as well as the various commodities are assumed to be determined outside of the model and are known with certainty. The disturbances, are assumed to be independent and distributed normally with a common variance. An examination of residuals did not indicate the presence of any heteroskedasticity or autocorrelation. Given the specification in (3) and these assumptions, we use ordinary least squares to estimate the behavior of railroad rates by commodities before and after deregulation.

Data

In examining McFarland's study and extending it across different commodities, we used two main sets of data, that which McFarland used in creating his revised econometric model and commodity specific data which we obtained through the TD-1 reports of the Federal Railroad Administration (FRA) of the U.S. Department of Transportation.

McFarland's study used data obtained from the Association of American Railroads' (AAR) publication, Railroad Facts. His data included only Class I railroads which account for over 90 percent of the industry's revenue and employment. The deflator McFarland used upon railroad rates was the AAR index of labor, fuel, and material prices. In his model, the variable, BULK, represents coal, grain, metallic ores, and crushed stone gravel and sand. GNP was obtained from the Economic Report of the President and expressed in 1982 dollars.

The commodity data obtained through the TD-1 documents represent railroad carload waybill statistics. These are the results of a sample of audited revenue waybills collected for the FRA by 77 line-haul operating railroads, each having $3 million or more average operating revenues over a period of three years.

Our data examines 35 different commodities, classified by their Standard Transportation Commodity Code (STCC level 2) over 15 years from 1972-1974, 1976-1979, and 1981-1988. Despite our efforts, the 1975 and 1980 volumes were not available. Furthermore, the 1989-1990 volumes are not yet available. The result is a total of 517 observations to estimate 76 parameters. Each commodity is listed in Table 1 by its STCC number and descriptions of the commodities are also included. The variables used in our equation - DENS, ALH, BULK, GNP, T, DR, TR - are described in the empirical model.

EMPIRICAL RESULTS

The results of the entire model are reported in the appendix. There were 517 observations and 76 variables. The overall measure of fit was quite high (R =.9819) as was the adjusted R-squared (.9788) despite the large number of coefficients. The F-test for fit was 318.582. In general, the majority of the coefficients conform with a priori expectations and previous research and were significant and the 5 and 10% levels. DENS and BULK, although not very significant, both have a negative effect upon prices. GNP significantly affects prices positively. T is shown to have a negative effect as we expected, although not significantly. The only anomaly we found deals with ALH. Our results suggest a significantly positive effect upon prices while our expectations mandate a significantly negative effect. It may be that a better measure (i.e., commodity specific) needs to be collected and used in place of the system-wide measure employed.

Overall F-tests of the intercept dummies and the intercept-regulation dummies indicate significant differences across commodities ($F_{34,441}$=93.59) and asymmetric differences of regulation ($F_{34,441}$=6.45). In each case, the critical F-value at the 5% level was around 1.46. Each F-value was considerably larger than its critical F-value.

Table 2 shows the effects of regulation on the commodities. By examining the column of p-values, we are able to observe those commodities that have been significantly affected by regulation. The commodities with asterisks beside them have p-values that fall below the 5 and 10 percent levels. In these cases we reject the null hypothesis that regulation had no significant effect upon the commodity.

Summary

In this paper, we reviewed previous research analyzing the influence of deregulation in the railroad industry. We found that many of these papers have focussed on overall level of rates. Yet, much of regulation and many effects of regulation are lost in the aggregation of rates across many commodities. As a result much of the previous research has mixed results.

In this paper we clarify these results by extending the research to multiple commodities. We find there are significant differences in the effects of deregulation across commodities. These results generally find that deregulation has had a significant negative effect on high density commodities (e.g., farm products) and a smaller effect (closer to zero and sometimes not significant) on low density commodities (e.g., apparel, chemical products, etc.).

Table 1

Commodity Classifications

STCC Code	Description
1	Farm Products
8	Forest Products
9	Fresh Fish or Other Marine Products
10	Metallic Ores
11	Coal
13	Crude Petroleum, Natural Gas or Gasoline
14	Nonmetallic Minerals
19	Ordinance 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, Glass, Concrete or Stone Products
33	Primary Metal Products
34	Fabricated Metal Products
35	Machinery
36	Electrical Machinery or Equipment
37	Transportation Equipment
38	Instruments of 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	Misc. Mixed Shipments
49	Hazardous Materials

Table 2

Regulation Effects across Commodities

Commodity	Coef	F-Value	P-Value
Farm Products	-.47	11.4498	.0008*
Forest Products	-.45	11.1155	.0009*
Fresh Fish/Other	-.44	10.4481	.0013*
Metallic Ores	-.09	0.4868	.4857
Coal	-.19	2.0014	.1519
Crude Petroleum/Natural Gas	.02	0.0202	.8870
Nonmetallic Minerals	.11	0.6808	.4097
Ordinance or Accessories	-.48	11.8405	.0006*
Food or Kindred Products	-.27	3.7173	.0545**
Tobacco Products	-.35	6.3126	.0123*
Textile Mill Products	-.30	4.6332	.0319*
Apparel	.06	0.1713	.6791
Lumber or Wood Products	-.18	1.6577	.1986
Furniture or Fixtures	-.50	13.0954	.0003*
Pulp, Paper or Allied Products	-.17	1.5341	.2212
Printed Matter	-.28	4.0217	.0455*
Chemicals or Allied Products	-.17	1.5341	.2162
Petroleum or Coal Products	-.09	0.4088	.5229
Rubber or Misc. Plastic Products	-.39	7.8996	.0052*
Leather or Leather Products	-.48	11.8238	.0006*
Clay, Glass, Concrete, Stone	-.21	2.3321	.1274
Primary Metal Products	-.37	7.1359	.0078*
Fabricated Metal Products	-.32	5.3645	.0210*
Machinery	-.39	7.8438	.0053*
Electrical Machinery or Equipment	-.28	4.0358	.0452*
Transportation Equipment	-.08	0.3331	.5641
Instruments of Photographic Goods	-.50	12.7999	.0004*
Misc. Products or Manufacturing	-.49	12.2964	.0005*
Waste or Scrap Materials	-.36	6.6220	.0104*
Misc. Freight Shipments	-.28	4.1832	.0414*
Empty Shipping Containers	-.47	11.6456	.0007*
Freight Forwarder Traffic	-.13	0.8605	.3541
Shipper Association	-.30	4.6420	.0317*
Misc. Mixed Shipments	-.29	4.7780	.0392*
Hazardous Materials	-.14	0.6740	.4121

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$$P = \alpha_0 + \alpha_1 D + \alpha_2 R + \alpha_3 RD$$

Appendix

Table A-1

Coefficient Estimates, t-values, and Commodity Identifications

Commodity	Coefficient	Estimate	t-value
Farm Products	INTERCEPT	-21.4047	-6.545
	REG	-0.4746	-3.384
Forest Products	INTERCEPT	0.0331	4.329
	REG	0.0162	1.546
Fresh Fish/Other	INTERCEPT	0.0022	0.328
	REG	0.0293	3.146
Metallic Ores	INTERCEPT	0.0404	0.660
	REG	0.3767	4.495
Coal	INTERCEPT	-0.2544	-4.155
	REG	0.2762	3.295
Crude Petroleum/Nat. Gas	INTERCEPT	-0.0797	-1.301
	REG	0.4946	5.900
Nonmetallic Minerals	INTERCEPT	-0.0373	-0.609
	REG	0.3589	4.282
Ordinance or Accessories	INTERCEPT	0.9006	14.711
	REG	-0.0080	-0.096
Food or Kindred Products	INTERCEPT	0.2131	3.480
	REG	0.2042	2.436
Tobacco Products	INTERCEPT	0.5482	8.955
	REG	0.1222	1.458
Textile Mill Products	INTERCEPT	0.7653	12.501
	REG	0.1727	2.060
Apparel	INTERCEPT	0.9636	15.740
	REG	0.5327	6.355
Lumber or Wood Products	INTERCEPT	0.0775	1.267
	REG	0.2940	3.508
Furniture or Fixtures	INTERCEPT	1.3883	22.679
	REG	-0.0329	-0.393
Pulp/Paper/Allied Products	INTERCEPT	0.2459	4.016
	REG	0.3027	3.612
Printed Matter	INTERCEPT	0.3499	5.716
	REG	0.1933	2.307
Chemicals/Allied Products	INTERCEPT	0.2166	3.538
	REG	0.3009	3.590
Petroleum or Coal Products	INTERCEPT	0.2660	4.346
	REG	0.3849	4.592
Rubber/Misc. Plastic	INTERCEPT	0.9279	15.157
	REG	0.0803	0.959
Leather/Leather Products	INTERCEPT	0.7673	12.036
	REG	-0.0104	-0.122
Clay/Glass/Concrete/Stone	INTERCEPT	0.2110	3.447
	REG	0.2604	3.107

Table A-1-Continued

Coefficient Estimates, t-values, and Commodity Identifications.

Commodity	Coefficient	Estimate	t-value
Primary Metal Products	INTERCEPT	0.3805	6.215
	REG	0.0999	1.192
Fabricated Metal Products	INTERCEPT	0.7605	12.423
	REG	0.1497	1.787
Machinery	INTERCEPT	0.9587	15.661
	REG	0.0817	0.976
Electrical Machinery	INTERCEPT	1.0933	17.860
	REG	0.1928	2.301
Transportation Equipment	INTERCEPT	1.1529	18.833
	REG	0.3936	4.697
Photographic Instruments	INTERCEPT	0.8152	13.317
	REG	-0.0272	-0.325
Misc. Prods./Manufacturing	INTERCEPT	1.0489	17.134
	REG	-0.0172	-0.206
Waste or Scrap Materials	INTERCEPT	0.5918	9.668
	REG	0.1136	1.356
Misc. Freight Shipments	INTERCEPT	1.1531	18.837
	REG	0.1877	2.240
Empty Shipping Containers	INTERCEPT	0.6117	9.993
	REG	-0.0040	-0.048
Freight Forwarder Traffic	INTERCEPT	0.3554	5.576
	REG	0.3434	4.007
Shipper Association	INTERCEPT	0.4086	6.675
	REG	0.1724	2.057
Misc. Mixed Shipments	INTERCEPT	0.3319	5.423
	REG	0.1845	2.201
Hazardous Materials	INTERCEPT	0.3004	2.434
	REG	0.3337	2.453

Continuous Variable and Interactions

DENSITY	-0.2622	-1.283
BULK	-0.2407	-0.710
GNP	1.5644	2.662
ALH	1.7489	3.360
TREND	-0.2027	-13.331
REG*TREND	0.0285	3.112

Summary Statistics

R-square	0.9819
Adj R-sq	0.9788
SSE	0.11453