STRUCTURAL CHANGE IN THE U.S. FREIGHT RAILROAD INDUSTRY AS A RESULT OF THE STAGGERS RAIL ACT OF 1980

by

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(ABSTRACT)

Many observers feel that the Staggers Rail Act of 1980 is responsible for a "renaissance" in the U.S. freight railroad industry. Prior to the passage of the Staggers Act, railroads had to petition for government approval for nearly every business decision. The ability of the railroad industry to enter and exit certain lines of business was strictly controlled, as was the ability of the industry to rationalize their physical plant. The Staggers Act removed most, but not all, of these regulatory restrictions. But is the popular perception correct? By using an *F* test to compare a series of regressions, this thesis argues that Staggers did produce a structural change in the industry. Moreover, this thesis asserts that the changes noted in the results are consistent with the view that deregulation has been a success — that the industry is more efficient and that the benefits of deregulation have been shared between the railroads and the public.

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I. Introduction

Background

By some accounts, the U.S. freight railroad industry is entering a second "Golden Age." Indeed by almost any measure, the nation's freight railroads are enjoying a period of boom-like growth. And yet, fifteen years ago the nation's freight railroads stood on the edge of a financial abyss. Nearly a quarter of the nation's trackage had fallen into bankruptcy during the 1970s, and given the chronic inability of the industry to earn its cost of capital, it seemed likely that the remaining railroads might eventually be forced out of business as well. Legislative efforts to reform the industry (Passenger Act of 1970, the 3R Act of 1973, the 4R Act of 1976) had produced few measurable results. Some politicians even talked of nationalizing the railroad industry. Fortunately, Congress resisted this temptation and instead passed the Staggers Rail Act of 1980 (Staggers, or Staggers Act). This piece of legislation may prove to be one of the most important domestic legacies of the Carter Administration.

Many knowledgeable observers point to the Staggers Act as the single event most responsible for changing the nature of the railroad industry. Indeed, they seem to divide modern railroad history into two periods: *Before Staggers* and *After Staggers.* But is the popular perception correct — can we, using standard statistical methods, actually determine whether a structural change occurred in the railroad industry subsequent to the passage of the

Staggers Act and, if so, can we determine the nature of the change? That is the question that this thesis will address.

I will show that, in fact, a structural change did occur in the railroad industry and that the timing of this change is closely linked to the effects of the Staggers Act. In addition, I will show that the effects of this change have been largely beneficial to the U.S. economy.

The Staggers Rail Act of 1980

The Staggers Act of 1980 is a complex piece of legislation. (See Appendix D for a list of the basic provision of the Act). Among the key provisions of Staggers were a lessening of ICC jurisdiction of rail rates, allowing railroads to enter into contract rates with shippers, and liberalizing the procedures for abandoning light-density branch lines. These three provisions represented a fundamental modification in the railroad industy's *requirement to serve.* Railroads are considered *common carriers* and have an obligation to provide service upon request to any shipper on "reasonable" terms. Before Staggers, contracts which granted preferential prices to large shippers were outlawed on the grounds that, as a common carrier, a railroad should not be able to discriminate between shippers. But, of course, some shippers are more equal than others. Staggers permitted railroads to enter into contracts with shippers and thus enabled railroads were able to offer volume discounts, dedicated services, and a host of other service enhancements that would not have been previously permitted.

Much of the Staggers Act had to do with ratemaking. Staggers liberalized the ability of railroads to set rates: nearly two-thirds of all railroad rates were freed from maximum rate regulation. Staggers also limited the ability of shippers to challenge those rates by granting jurisdiction to the Interstate Commerce Commission (ICC) only on those rates where railroads exercise "market dominance" and charge a rate above a threshold level determined by the ICC.

The Staggers Act also did away with the practice of "general rate increases." Because shippers could easily challenge rate increase before passage of the Staggers Act, it was necessary to occassionally petition the ICC for a general rate increase in order to pass along inflationary cost increases. It often took months before the Commission would rule on these petitions, which, during the inflationary 1970s, imposed a heavy burden on the industy as its costs continued to escalate, but its ability to pass along those costs was seriously handicapped. On those rates which remained under the ICC's jurisdiction after the Staggers Act, the Commission allowed railroads to raise rates each quarter by a small factor, called the Rail Cost Adjustment Factor, which measured the industry's inflationary cost increases.

The Staggers Act also liberalized abandonment procedures. Before Staggers "there were many instances where railroads proposed to abandon light-density lines, only to have these proposals tied up in regulatory proceedings for many years. In a number of cases, a single

shipper... could delay, or stop the proposed abandonment even though the railroad was clearly losing money on providing the service."[1] The Stagger Act directed the ICC to approve proposed railroad abandonments within 30 days, assuming no protest was offered. In the event there was a protest, the Commission was instructed to expedite its procedures and permit abandonment if the line in question could not earn enough revenue to cover its avoidable costs, *including* its opportunity cost.

Each of these provision listed above represented a significant and welcome change in the way railroads were regulated. The Staggers Act removed much of the regulatory detritus that had accumulated over the decades in the hope that, absent these obstacles, railroad service and profitability would improve. The Staggers Act was designed to produce a structural change in the industry, and it did just that.

II. Materials and Methods

The Theoretical Model

Railroads, like all other forms of transportation, add value to the economy by creating what can be called "geographic utility." Crops in the field are not as valuable as crops at the mill. Coal in the mine is less valuable than coal at the power plant or the coking furnace. But the demand for transportation services is a derived demand. That is to say, no one purchases transportation services for their own sake, but to carry out some other economic activity. Therefore, the demand for transportation services is dependent on the demand for goods produced by the economy.

Ton-miles are used to logically measure geographic utility. Simply, a ton-mile is created when one ton is moved one mile. We can model the creation of ton-miles as follows: *Ton-Miles are a function of Industrial Production*, or

$$1)\ TM = a + c(IP).$$

Of course, to create ton-miles, the railroads must expend resources. Using a very simple production function we could say that *Ton-Miles are a function of Hours Worked and Locomotives in Service*. Or,

$$2)\ TM = a + d(Hours) + e(Loco).$$

A reduced form of these equations can be derived and we can develop the following model:

Ton-Miles are a function of a Constant, Industrial Production, Time, Hours Worked by Railroad Employees, and Locomotives in Service. Or,

$$3)\ TM = A1 + B2(Time) + C3(Industrial\ Production) + D4(Hours) + E5(Locomotives).$$

The variable "Time" is included in Equation No. 3 to ensure that any structural change we detect in the estimated parameters is the result of the structural change associated with the Staggers Act and not simply the passage of time.

Using this model of geographic utility, we can test for structural change by applying an *F* test, or Chow test,[2] to the model. The *F* test compares two (or more) regressions. In this case, a number of time periods will be compared sequentially. This comparison will determine if there is a structural change, and, if so, whether the timing of that change is consistent with the deregulatory impetus of the Staggers Act.

The Hypotheses

Our hypotheses can be stated as follows:

H_0: *After passage of the Staggers Rail Act in 1980, no structural change took place in the U.S. freight railroad industry.*
$F(5,16)<=4.438$ (99 percent confidence interval).

H_1: *A structural change has taken place in the U.S. freight railroad industry after passage of the Staggers Rail Act of 1980.*
$F(5,16)>4.438$ (99 percent confidence interval).

The Test

To test the null hypothesis, the first step is to pool all 26 observations and run a regression based on the model we specified earlier. This regression will yield an RSS (Sum of the Squared Residuals), called S_0. S_0 has 21 degrees of freedom (df = $N_1 + N_2 - 2k$.), where N_1 equals the observations found in Period 1, N_2 equals the observations in Period 2, and k represents the number of parameters being estimated.

Next, two individual regressions are calculated, one for Period 1 and the other on the corresponding Period 2. Each of these regressions will yield an RSS, say S_1 and S_2, with df = $N_1 - k$ and $N_2 - k$, respectively. When these two RSS are added together we obtain $S_3 = S_1 + S_2$ with df = $N_1 + N_2 - 2k$. We can then obtain $S_4 = S_0 - S_3$.

Finally, we can apply the F test as follows:

$$F = (S4/k) / [S3/(N1+N2-2k)], \text{ with } df = k, N1 + N2 - 2k.$$

In our case, the test will yield an F statistic with df (5,16). If the computed F is greater than the critical value for F, we can reject the hypothesis that the two regressions are the same (our null hypothesis) and conclude that a structural change has indeed taken place.

The Chow test depends on two assumptions. First that there must be sufficient degrees of freedom for each of the regressions. (That is, the degrees of freedom are always greater than zero). That assumption is met in our test. Second, the Chow test assumes homoscedasticity among the residuals. If, in fact, the residuals are heteroscedastic, the *F* test we are using may not be valid. Heteroscedasticity is more likely to be a problem for cross-sectional data than for time-series data, but we must look for evidence of heteroscedasticity among the residuals in our regressions to insure the Chow test can be applied.

Visually, we can plot the squared residuals against our fitted-Y and each of the explanatory variables. Upon examination, an obvious example of heteroscedasticity is not apparent. (See Appendix C for graphical presentation).

The Computer Program

All calculations for this thesis were conducted on *ET - The Econometics Toolkit,* 1990 Econometric Software, Inc.

III. Results

The results from the test are summarized below. As Table No. 1 makes plain, there is overwhelming evidence that a structural change in the railroad system took place subsequent to the passage of the Staggers Act. It is also apparent that the timing of this change is consistent with our belief that it was the Staggers Act which wrought the change. Notice how the *F* statistic marches steadily higher, finally peaking in the time period 1981-1982, after which it falls off rapidly. Since the Staggers Act was passed in late 1980, it is natural that the change occurs shortly after that time.

Table 1: Results from Chow Tests for Structural Change

Period 1	Period 2	F Statistic	Significance F(5,16)
1968-1977	1978-1993	4.923014	.006
1968-1978	1979-1993	5.108105	.005
1968-1979	1980-1993	5.257425	.005
1968-1980	1981-1993	6.102876	.002
1968-1981	1982-1993	9.071898	.000
1968-1982	1983-1993	9.041509	.000
1968-1983	1984-1993	5.242348	.005
1968-1984	1985-1993	4.749427	.008

IV. Discussion

Evidence from the Regressions

How are we to account for the structural change that occurred following the passage of the Staggers Act? By allowing railroads greater freedom to provide and price their services, the railroads were able to take steps that any profit-maximizing entity would have taken long before: they abandoned thousands of miles or road; sold off thousands more to new regional and local railroads; and reduced their workforces. In short, the railroads dramatically boosted their multifactor productivity. (See Figure 1).

Indeed, the evidence from our regressions bolsters the belief that multifactor productivity increased for the railroad industry. As shown below in Tables 2 and 3, the coefficient for both locomotives and hours worked is lower in Period 2 in the critical 1968-1981,1982-1993 regressions, indicating that fewer units of capital and labor were needed to produce a ton-mile. In other words, an increase in multifactor productivity *was* achieved. We need to be cautious, however, in interpreting the results from these regressions. The reduced form model we have developed is designed to identify whether or not a structural change has occurred, but the nature of the *reduced* form equation makes it difficult to analyze the dynamic nature of the changes in the industry.

Additional evidence from the regressions bolsters the view that the timing of the structural change coincided with passage of the Staggers Act. Look, for example at Table 5. If a structural change occurred in the industry we would expect that the variable *Time* would be significant if the period being estimated overlaps the structural change. In the first four observations for Period 1 (all of which pre-date Staggers), *Time* is not significant. However, for the same four observations in Period 2 (which mingles the before and after Staggers period) *Time* is significant. When the structural change is correctly identified in observations 5 and 6 (which are shaded), *Time* no longer is significant.

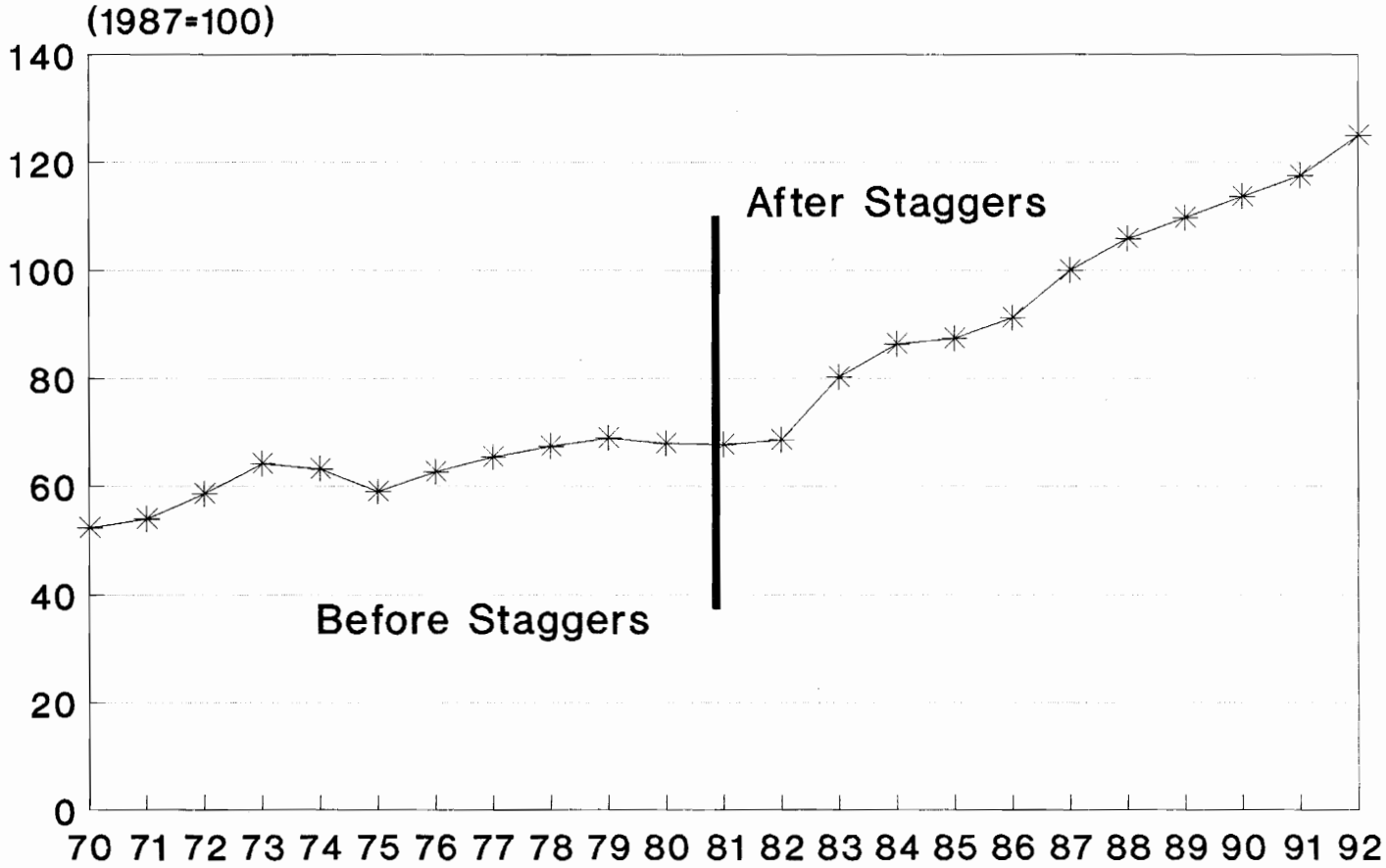

Figure 1: Multifactor Productivity for Railroad Transportation (SIC 4011)
Source: U.S. Department of Labor

Table 2: Regression Results for Locomotive Variable

Period 1	Coefficient	Std. Error	T-ratio	Period 2	Coefficient	Std. Error	T-ratio
1968-77	35.3101	24.73	1.428	1978-93	11.9099	7.750	1.537
1968-78	41.6649	21.87	1.905	1979-93	14.6007	8.587	1.700
1968-79	41.6975	20.24	2.060	1980-93	12.1490	10.33	1.176
1968-80	47.8950	14.90	3.214	1981-93	16.4878	10.87	1.517
1968-81	49.6225	14.46	3.431	1982-93	26.0788	10.16	2.567
1968-82	48.0790	12.25	3.926	1983-93	26.2584	11.59	2.266
1968-83	23.7713	14.14	1.681	1984-93	45.0057	23.28	1.933
1968-84	4.2987	12.04	.357	1985-93	19.3919	14.70	1.319

Table 3: Regression Result for Hours Worked Variable

Period 1	Coefficient	Std. Error	T-ratio	Period 2	Coefficient	Std. Error	T-ratio
1968-77	.432811	.3569	1.213	1978-93	.524610	.1306	4.017
1968-78	.354486	.3226	1.099	1979-93	.491586	.1393	3.529
1968-79	.341592	.2229	1.532	1980-93	.546679	.1858	2.942
1968-80	.378630	.1991	1.902	1981-93	.384526	.2325	1.654
1968-81	.357299	.1935	1.846	1982-93	-.263132	.3633	-.724
1968-82	.330510	.1485	2.226	1983-93	-.276980	.4863	-.570
1968-83	.111803	.1895	.590	1984-93	-1.06757	.9806	-1.089
1968-84	.178523	.2114	.845	1985-93	-.662670	.5510	-1.203

Table 4: Regression Results for Industrial Production

Period 1	Coefficient	Std. Error	T-ratio	Period 2	Coefficient	Std. Error	T-ratio
1968-77	8519.86	2256	3.776	1978-93	10588.0	3018	3.508
1968-78	8475.22	2153	3.937	1979-93	11015.8	3118	3.553
1968-79	8510.09	1920	4.433	1980-93	10773.1	3286	3.278
1968-80	8480.51	1824	4.648	1981-93	11211.6	3260	3.440
1968-81	8610.18	1782	4.830	1982-93	10848.6	2730	3.974
1968-82	8627.76	1695	5.091	1983-93	10909.8	3211	3.398
1968-83	9651.18	2355	4.098	1984-93	10034.5	3380	2.969
1968-84	9683.96	2665	3.634	1985-93	8797.99	1890	4.655

Table 5: Regression Result for Time Variable

Period 1	Coefficient	Std. Error	T-ratio	Period 2	Coefficient	Std. Error	T-ratio
1968-77	5188.34	13690	.379	1978-93	25065.6	6938	3.613
1968-78	2130.59	12350	.173	1979-93	25333.8	7067	3.585
1968-79	1663.19	8878	.187	1980-93	25715.0	7402	3.474
1968-80	2875.75	8099	.355	1981-93	23292.5	7598	3.066
1968-81	2414.75	7924	.305	1982-93	13153.5	7964	1.652
1968-82	1807.23	7123	.254	1983-93	12799.8	11310	1.132
1968-83	-5305.42	9623	-.551	1984-93	3553.23	15140	.235
1968-84	-3149.28	10830	-.291	1985-93	5862.28	8346	.702

General Comments

Graphically, the pre-Staggers period could be characterized as shown in Figure 2. This figure displays an industry supply-demand curve for railroad ton-miles. The equilibrium price and quantity position would occur at *A*, where the P' and Q' lines intersect. However, government regulations effectively imposed a price ceiling on the industry. Standard microeconomic analysis shows that a price ceiling set below the equilibrium price results in a dead weight loss to society. As Figure 2 shows, in response to a price ceiling of P", railroads scale back quantity supplied to Q". The dead-weight loss in this graph is the shaded triangle *ABC*.

Graphically, the post-Staggers period could also be displayed in a similar manner. The passage of the Staggers Act removed the price ceiling confronting the industry. More importantly, though, Staggers removed many of the impediments to cost-effective production. So we could expect the supply curve to the right, say to S'. Figure 3 demonstrates that a tremendous increase in consumer surplus would result from this increase in multifactor productivity.

Indeed, the sorts of changes implied by Figure 3 did, in fact, occur. As Figure 4 shows, the railroad industry's profitability increased (as measured by the industry's rate of return on net investment) and the gap between the rate of return and the regulatory cost of capital narrowed. At the same time, real rates paid by shippers fell. (See Figure 5).

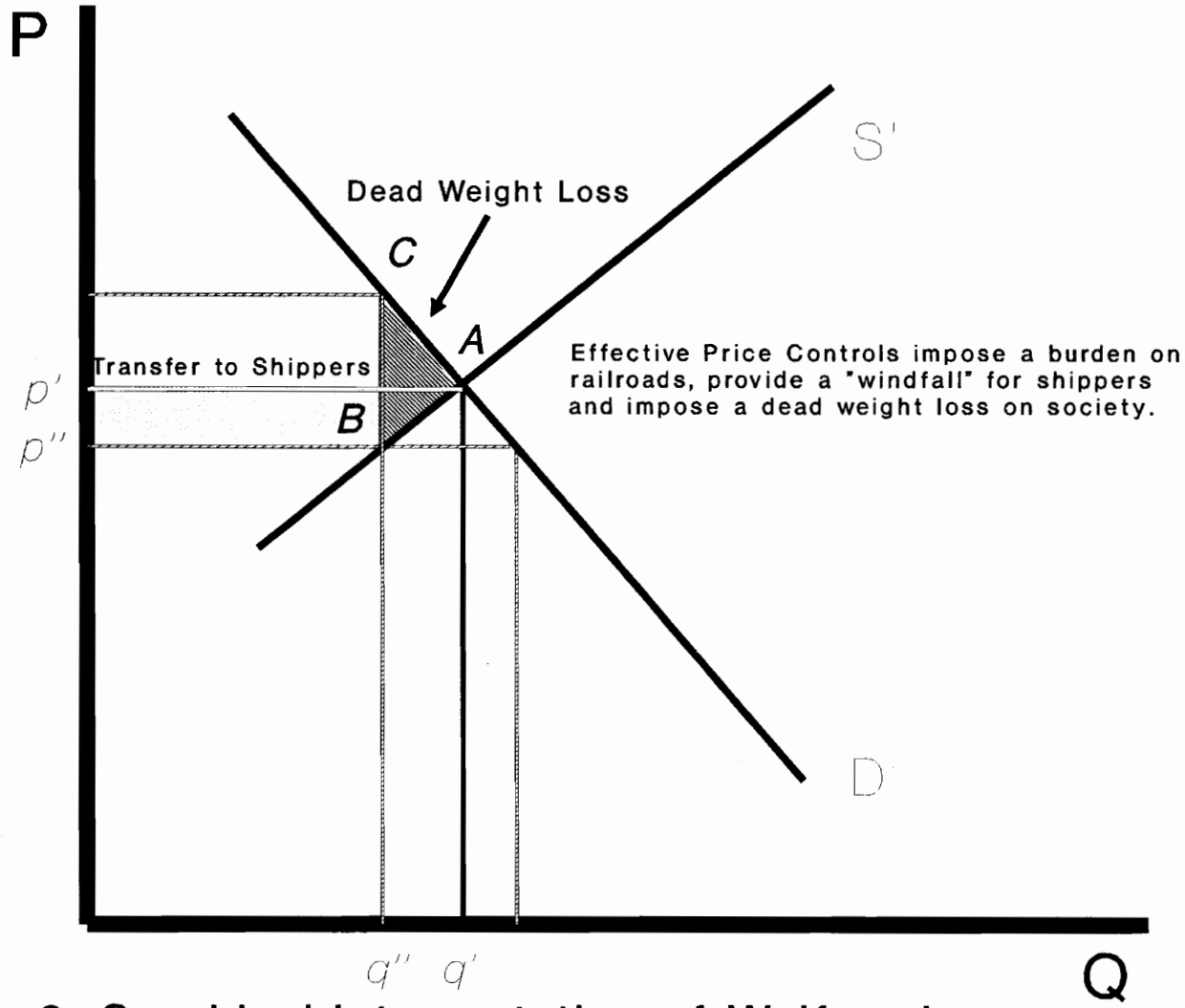

Figure 2: Graphical Interpretation of Welfare Losses in the Pre-Staggers Period

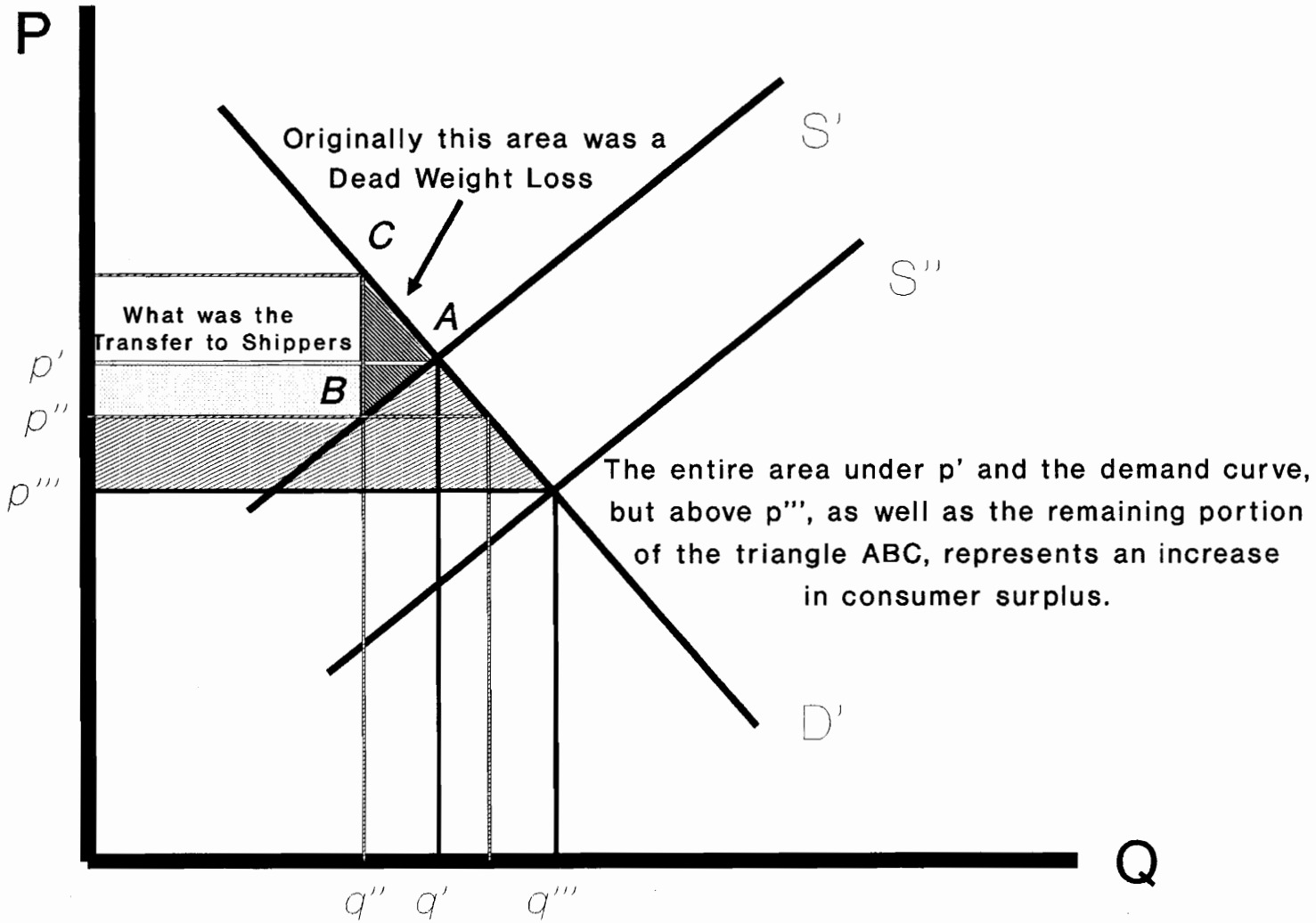

Figure 3: A Graphical Interpretation of Welfare Gains In the Post Staggers Period

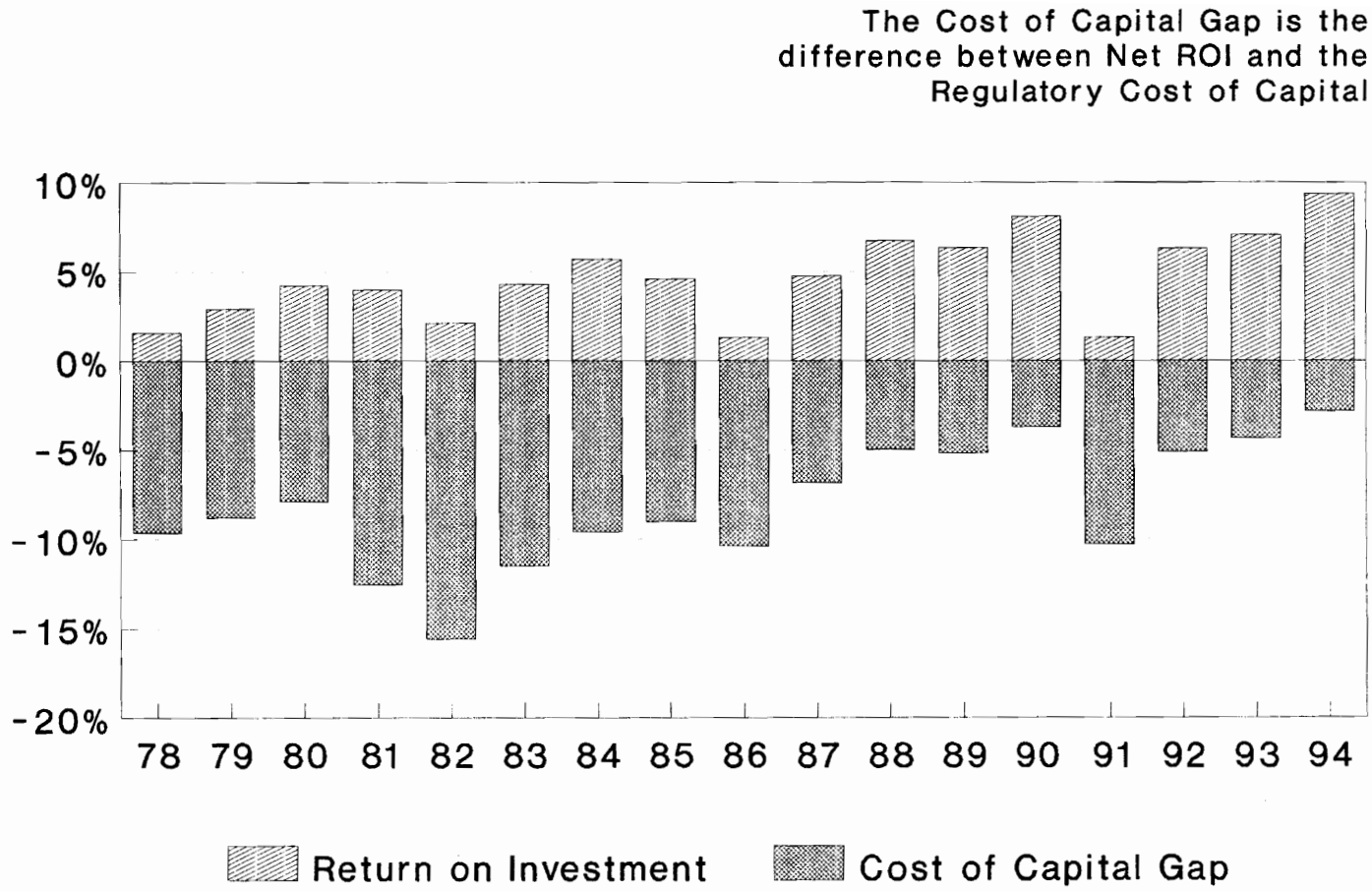

Figure 4: A Comparison of the Rate of Return on Net Investment and the Regulatory Cost of Capital (Source: AAR)

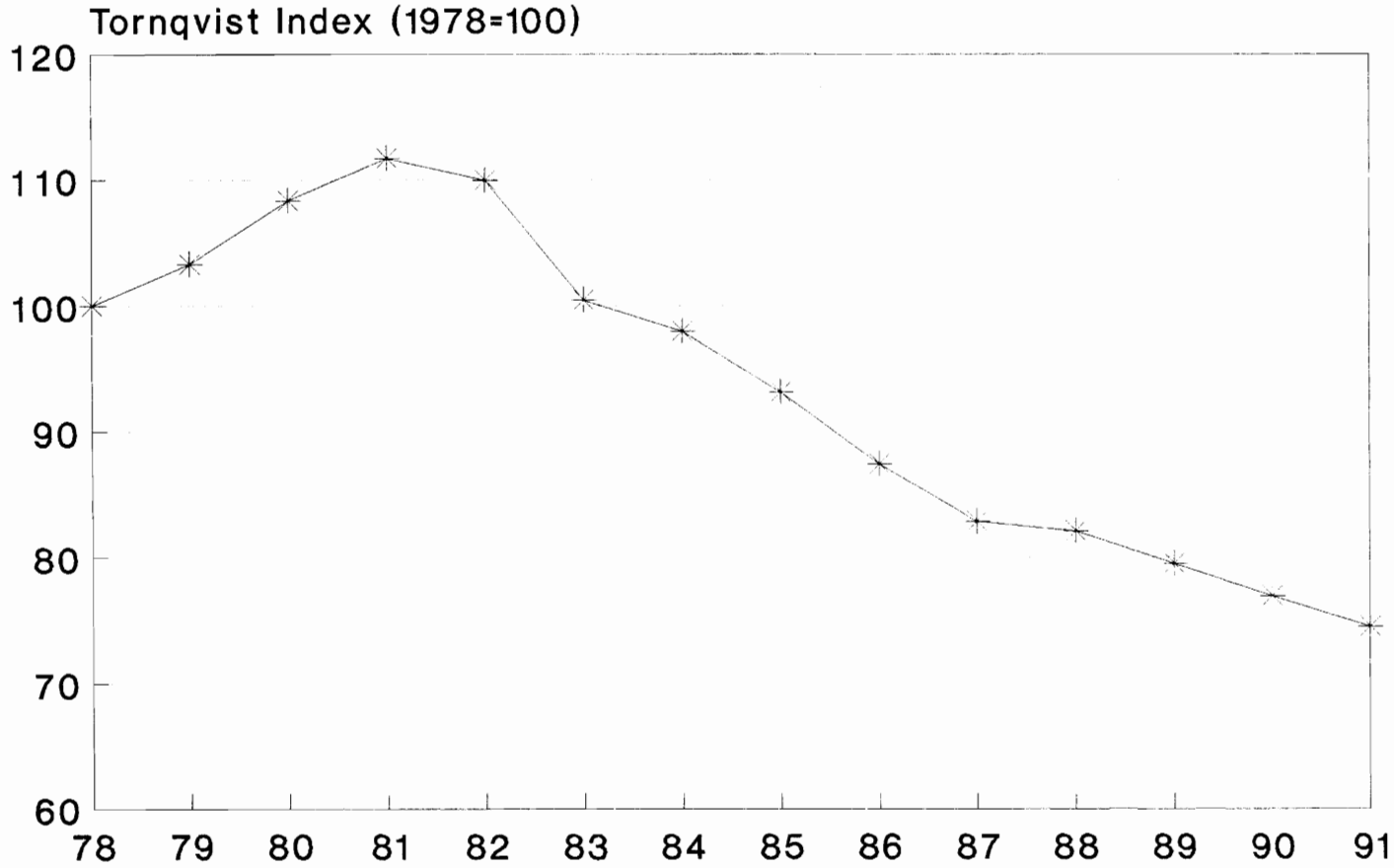

Figure 5: Average U.S. Rail Rate Adjusted for Inflation
(Source: Interstate Commerce Commission)

Ultimately, much of this decline in transportation costs was passed on to the general public in the form of lower prices. Barnekov and Kleit (1988) estimated that the welfare gain from the Staggers Act was in the neighborhood of $9-15 billion annually.[3] These benefits outweighed the loss of employment opportunities among railroad workers.

V. Conclusions

Using an econometric technique, the Chow test, we have found evidence supporting the view that a structural change in the U.S. freight railroad industry occurred after passage of the Staggers 1980. Moreover, the evidence supports the view that the operating efficiency of U.S. railroads improved rapidly in the post-Staggers period, allowing railroads to increase their profits while lowering their prices. Finally, we have argued that the benefits of deregulation were, on the whole, shared between railroads, shippers, and the general public.

VI. Appendixes

Appendix A: The Data

The Data, 1968-1981

Year	Ton-Miles (Billions)	Hours Worked (Millions)	Locomotives	Industrial Production
1968	744.02	1,200.51	27,376	60.7
1969	767.84	1,173.50	27,033	63.5
1970	764.81	1,146.45	27,086	61.4
1971	739.74	1,082.64	27,189	62.2
1972	776.75	1,051.77	27,073	68.3
1973	851.81	1,041.21	27,453	73.8
1974	850.96	1,042.12	27,627	72.7
1975	754.25	947.28	27,846	66.3
1976	794.06	948.73	27,215	72.4
1977	826.29	940.43	27,283	78.2
1978	858.11	933.81	27,017	82.6
1979	902.06	957.81	27,043	85.7
1980	918.96	892.72	27,977	84.1
1981	910.17	837.55	27,693	85.7

The Data, 1982-1993

Year	Ton-Miles (Billions)	Hours Worked (Millions)	Locomotives	Industrial Production
1982	797.76	708.22	27,045	81.9
1983	828.28	610.04	25,707	84.9
1984	921.54	621.86	24,382	92.8
1985	876.98	576.63	22,816	94.4
1986	867.72	526.31	21,045	95.3
1987	939.67	481.63	19,623	100.0
1988	996.18	460.22	19,645	104.4
1989	1,013.84	438.43	19,381	106.0
1990	1,033.97	413.74	19,232	106.0
1991	1,038.86	390.97	18,756	104.1
1992	1,066.78	378.55	18,411	106.5
1993	1,109.31	378.65	18,566	111.0

Appendix B: Regression Results

Regression Results: 1968-1993

Ordinary Least Squares			
Dependent Variable	TM	Number of Observations	26
Mean of Dep. Variable	882720.3438	Std. Dev. of Dep. Var.	107388.666116
Durbin Watson statistic	1.1049	Estimated Autocorrelation	.44755
Std. Error of Regr.	27406.7633	Sum of Squared Residuals	.157737E+11
Total Variation	.28831E+12	Regression Variation	.27253E+12
R - squared	.94529	Adjusted R - squared	.93487
F(4, 21)	90.7081	Prob. Value for F	.00000
Akaike Information	20.60813	Amemiya Prediction	895578881.52518

Variable	Coefficient	Std. Error	T-ratio	Prob|t|>x	Mean of X	Std.Dev.of X
ONE	-.425349E+08	.1459E+08	-2.916	.00826	1.00000	.00000
YEAR	21632.1	7420.	2.915	.00827	1980.50000	7.64853
IP	4666.99	2146.	2.174	.04125	84.80385	16.12170
LOCO	-14.1181	4.147	-3.404	.00267	24520.00000	3711.75121
HOURS	.677230	.1462	4.631	.00014	776221.31971	282977.86257

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1	-2820.6	.74684E+06
2	-256.85	.76810E+06
3	3951.6	.76086E+06
4	-1817.2	.74156E+06
5	4354.6	.77239E+06
6	44631.	.80718E+06
7	29128.	.82183E+06
8	7977.2	.74627E+06
9	-12210.	.80627E+06
10	-22092.	.84838E+06
11	-31718.	.88982E+06
12	-39753.	.94181E+06
13	20251.	.89871E+06
14	15712.	.89446E+06
15	-22158.	.81992E+06
16	20328.	.80795E+06
17	28383.	.89316E+06
18	-36751.	.91374E+06
19	-62772.	.93049E+06
20	-24212.	.96388E+06
21	4947.9	.99123E+06
22	4538.5	.10093E+07
23	17648.	.10163E+07
24	18491.	.10204E+07
25	17103.	.10497E+07
26	19116.	.10902E+07

```
Calculating -> EE=SUMSQDEV
>>> EE       =     .1577374E+11 <<<
Calculating -> K=KREG
>>> K        =     5.000000     <<<
```

Regression: 1968-1977

```
==============================================================================
Ordinary    Least Squares
Dependent Variable          TM          Number of Observations              10
Mean of Dep. Variable  787053.3813      Std. Dev. of Dep. Var.    42166.525584
Durbin Watson statistic      1.1895     Estimated Autocorrelation       .40526
Std. Error of Regr.     17298.7228      Sum of Squared Residuals   .149623E+10
Total Variation         .16002E+11      Regression Variation        .14506E+11
R - squared                  .90650     Adjusted R - squared            .83170
F( 4,   5)                  12.1187     Prob. Value for F               .00873
Akaike Information        19.82363      Amemiya Prediction     448868715.48311
==============================================================================
Variable  Coefficient  Std. Error  T-ratio Prob|t|>x   Mean of X  Std.Dev.of X
------------------------------------------------------------------------------
ONE       -.114481E+08  .2721E+08   -.421   .69138      1.00000        .00000
YEAR       5188.34      .1369E+05    .379   .72028   1972.50000       3.02765
IP         8519.86      2256.       3.776   .01294     67.95000       6.08116
LOCO       35.3101      24.73       1.428   .21269  27318.10000     262.34051
HOURS      .432811      .3569       1.213   .279431057463.61250   94675.03600
```

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1968	-21868.	.76589E+06
1969	-3295.5	.77114E+06
1970	16215.	.74859E+06
1971	3121.9	.73662E+06
1972	423.07	.77632E+06
1973	14590.	.83722E+06
1974	11389.	.83957E+06
1975	-2665.2	.75692E+06
1976	1633.4	.79243E+06
1977	-19543.	.84583E+06

```
Calculating -> E0E0=SUMSQDEV
>>> E0E0     =     .1496229E+10 <<<

Calculating -> N0=NREG
>>> N0       =     10.00000     <<<
```

Regression: 1978-1993

```
==============================================================================
Ordinary    Least Squares
Dependent Variable          TM          Number of Observations              16
Mean of Dep. Variable  942512.1875      Std. Dev. of Dep. Var.    90768.305660
Durbin Watson statistic      1.9774     Estimated Autocorrelation       .01128
Std. Error of Regr.     20709.4900      Sum of Squared Residuals   .471771E+10
Total Variation         .12358E+12      Regression Variation        .11887E+12
R - squared                  .96183     Adjusted R - squared            .94794
F( 4,  11)                  69.2879     Prob. Value for F               .00000
Akaike Information        20.12700      Amemiya Prediction     562908905.40551
==============================================================================
Variable  Coefficient  Std. Error  T-ratio Prob|t|>x   Mean of X  Std.Dev.of X
------------------------------------------------------------------------------
ONE       -.504208E+08   .1357E+08  -3.715   .00341      1.00000        .00000
YEAR       25065.6       6938.       3.613   .00408   1985.50000       4.76095
IP         10588.0       3018.       3.508   .00490     95.33750      10.16221
LOCO       11.9099       7.750       1.537   .15259  22771.18750    3799.83214
HOURS      .524610       .1306       4.017   .00203 600444.88672  205898.28602
```

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1978	12998.	.84511E+06
1979	-13839.	.91590E+06
1980	17960.	.90100E+06
1981	-513.39	.91068E+06
1982	-22189.	.81995E+06
1983	18941.	.80933E+06
1984	13077.	.90846E+06
1985	-31107.	.90809E+06
1986	-27475.	.89520E+06
1987	10016.	.92965E+06
1988	5849.8	.99033E+06
1989	-3921.2	.10178E+07
1990	5865.8	.10281E+07
1991	23439.	.10154E+07
1992	11492.	.10553E+07
1993	-20592.	.11299E+07

```
Calculating -> E1E1=SUMSQDEV
>>> E1E1      =      .4717713E+10 <<<

Calculating -> N1=NREG
>>> N1        =      16.00000     <<<

Calculating -> F=((EE-E0E0-E1E1)/K)/((E0E0+E1E1)/(N0+N1-2*K))
>>> F         =      4.923014     <<<
```

Regression: 1968-1978

```
==============================================================================
Ordinary    Least Squares
Dependent Variable          TM          Number of Observations              11
Mean of Dep. Variable  793512.6591      Std. Dev. of Dep. Var.    45377.960117
Durbin Watson statistic      1.3829     Estimated Autocorrelation       .30856
Std. Error of Regr.     16510.8986      Sum of Squared Residuals   .163566E+10
Total Variation         .20592E+11      Regression Variation        .18956E+11
R - squared                  .92057     Adjusted R - squared            .86761
F( 4,   6)                 17.3838      Prob. Value for F               .00189
Akaike Information        19.72651      Amemiya Prediction     396523303.54711
==============================================================================
Variable  Coefficient  Std. Error  T-ratio Prob|t|>x   Mean of X  Std.Dev.of X
------------------------------------------------------------------------------
ONE       -.550522E+07  .2460E+08   -.224   .83035      1.00000        .00000
YEAR       2130.57      .1235E+05    .173   .86869   1973.00000       3.31662
IP         8475.22      2153.       3.937   .00765     69.28182       7.26592
LOCO       41.6649      21.87       1.905   .10537  27290.72727     264.91927
HOURS      .354486      .3226       1.099   .313921046222.05114   97247.75534
```

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1968	-24348.	.76837E+06
1969	-2527.9	.77037E+06
1970	17490.	.74732E+06
1971	1839.1	.73790E+06
1972	789.48	.77596E+06
1973	15018.	.83679E+06
1974	13791.	.83717E+06
1975	-6311.4	.76056E+06
1976	5441.1	.78862E+06
1977	-13501.	.83979E+06
1978	-7680.0	.86579E+06

```
Calculating -> E0E0=SUMSQDEV
>>> E0E0     =     .1635659E+10 <<<

Calculating -> N0=NREG
>>> N0       =     11.00000     <<<
```

Regression: 1979-1993

```
==============================================================================
Ordinary    Least Squares
Dependent Variable          TM          Number of Observations              15
Mean of Dep. Variable  948139.3042      Std. Dev. of Dep. Var.    91019.547983
Durbin Watson statistic      1.9223     Estimated Autocorrelation        .03884
Std. Error of Regr.     21070.9429      Sum of Squared Residuals   .443985E+10
Total Variation         .11598E+12      Regression Variation        .11154E+12
R - squared                 .96172      Adjusted R - squared            .94641
F( 4,  10)                 62.8085      Prob. Value for F               .00000
Akaike Information        20.17250      Amemiya Prediction     591979515.61354
==============================================================================
Variable  Coefficient  Std. Error  T-ratio Prob|t|>x   Mean of X  Std.Dev.of X
------------------------------------------------------------------------------
ONE       -.510369E+08  .1383E+08  -3.690   .00418      1.00000        .00000
YEAR       25333.8      7067.       3.585   .00497   1986.00000       4.47214
IP         11015.8      3118.       3.533   .00542     96.18667       9.91391
LOCO       14.6007      8.587       1.700   .11992  22488.13333    3754.54150
HOURS      .491586      .1393       3.529   .00545 578220.78333  192237.38630
```

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1979	-6329.6	.90839E+06
1980	21223.	.89774E+06
1981	739.32	.90943E+06
1982	-22106.	.81986E+06
1983	17830.	.81045E+06
1984	12274.	.90927E+06
1985	-30143.	.90713E+06
1986	-24060.	.89178E+06
1987	13502.	.92616E+06
1988	6419.5	.98976E+06
1989	-4313.5	.10182E+07
1990	4791.1	.10292E+07
1991	23438.	.10154E+07
1992	10714.	.10561E+07
1993	-23977.	.11333E+07

```
Calculating -> E1E1=SUMSQDEV
>>> E1E1     =     .4439846E+10 <<<

Calculating -> N1=NREG
>>> N1       =     15.00000     <<<

Calculating -> F=((EE-E0E0-E1E1)/K)/((E0E0+E1E1)/(N0+N1-2*K))
>>> F        =     5.108105     <<<
```

Regression: 1968-1979

```
==============================================================================
Ordinary    Least Squares
Dependent Variable          TM            Number of Observations              12
Mean of Dep. Variable  802558.1458        Std. Dev. of Dep. Var.    53421.090708
Durbin Watson statistic      1.4395       Estimated Autocorrelation        .28023
Std. Error of Regr.     15290.3591        Sum of Squared Residuals   .163657E+10
Total Variation         .31392E+11        Regression Variation        .29755E+11
R - squared                  .94787       Adjusted R - squared            .91808
F( 4,   7)                  31.8178       Prob. Value for F               .00014
Akaike Information        19.56429        Amemiya Prediction     331209698.79364
==============================================================================
Variable  Coefficient  Std. Error  T-ratio Prob|t|>x   Mean of X  Std.Dev.of X
------------------------------------------------------------------------------
ONE       -.457295E+07   .1767E+08   -.259   .80328      1.00000         .00000
YEAR       1663.19       8878.        .187   .85672   1973.50000       3.60555
IP         8510.09       1920.       4.433   .00303     70.65000       8.39388
LOCO       41.6975       20.24       2.060   .07838  27270.08333     262.51873
HOURS      .341592       .2229       1.532   .169331038854.28125   96170.65871
```

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1968	-24347.	.76837E+06
1969	-2494.3	.77034E+06
1970	17714.	.74709E+06
1971	1676.1	.73807E+06
1972	486.88	.77626E+06
1973	14842.	.83697E+06
1974	14127.	.83683E+06
1975	-6514.7	.76077E+06
1976	5531.8	.78853E+06
1977	-13255.	.83955E+06
1978	-7196.3	.86530E+06
1979	-570.83	.90263E+06

```
Calculating -> E0E0=SUMSQDEV
>>> E0E0     =     .1636566E+10 <<<

Calculating -> N0=NREG
>>> N0       =     12.00000     <<<
```

Regression: 1980-1993

Ordinary Least Squares			
Dependent Variable	TM	Number of Observations	14
Mean of Dep. Variable	951430.7902	Std. Dev. of Dep. Var.	93524.451256
Durbin Watson statistic	1.7768	Estimated Autocorrelation	.11162
Std. Error of Regr.	21938.4838	Sum of Squared Residuals	.433167E+10
Total Variation	.11371E+12	Regression Variation	.10938E+12
R - squared	.96191	Adjusted R - squared	.94497
F(4, 9)	56.8137	Prob. Value for F	.00000
Akaike Information	20.26445	Amemiya Prediction	653188882.95646

Variable	Coefficient	Std. Error	T-ratio	Prob|t|>x	Mean of X	Std.Dev.of X
ONE	-.517462E+08	.1448E+08	-3.574	.00598	1.00000	.00000
YEAR	25715.0	7402.	3.474	.00700	1986.50000	4.18330
IP	10773.1	3286.	3.278	.00956	96.93571	9.83781
LOCO	12.1490	10.33	1.176	.26967	22162.78571	3670.29050
HOURS	.546679	.1858	2.942	.01644	551107.35268	167100.60814

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1980	15567.	.90339E+06
1981	-2566.3	.91274E+06
1982	-21179.	.81894E+06
1983	21233.	.80704E+06
1984	13314.	.90823E+06
1985	-30443.	.90743E+06
1986	-26093.	.89381E+06
1987	11204.	.92846E+06
1988	6042.0	.99014E+06
1989	-4130.4	.10180E+07
1990	5587.6	.10284E+07
1991	23480.	.10154E+07
1992	10795.	.10560E+07
1993	-22811.	.11321E+07

```
Calculating -> E1E1=SUMSQDEV
>>> E1E1     =     .4331674E+10 <<<

Calculating -> N1=NREG
>>> N1       =     14.00000     <<<

Calculating -> F=((EE-E0E0-E1E1)/K)/((E0E0+E1E1)/(N0+N1-2*K))
>>> F        =     5.257425     <<<
```

Regression: 1968-1980

```
==============================================================================
Ordinary    Least Squares
Dependent Variable          TM            Number of Observations              13
Mean of Dep. Variable  811511.9904        Std. Dev. of Dep. Var.    60483.237774
Durbin Watson statistic      1.4601       Estimated Autocorrelation       .26993
Std. Error of Regr.     14539.8434        Sum of Squared Residuals   .169126E+10
Total Variation         .43899E+11        Regression Variation        .42207E+11
R - squared                 .96147        Adjusted R - squared            .94221
F( 4,   8)                 49.9125        Prob. Value for F               .00001
Akaike Information        19.45302        Amemiya Prediction     292717447.93095
==============================================================================
Variable  Coefficient  Std. Error  T-ratio Prob|t|>x   Mean of X  Std.Dev.of X
------------------------------------------------------------------------------
ONE       -.717094E+07  .1601E+08   -.448   .66612      1.00000        .00000
YEAR       2875.75      8099.        .355   .73171   1974.00000       3.89444
IP         8480.51      1824.       4.648   .00165     71.68462       8.86010
LOCO       47.8950      14.90       3.214   .01235  27324.46154     318.76941
HOURS      .378630      .1991       1.902   .093711027612.95673  100602.37835
```

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1968	-25010.	.76903E+06
1969	-1160.9	.76900E+06
1970	18447.	.74636E+06
1971	2944.4	.73680E+06
1972	2585.4	.77416E+06
1973	13927.	.83788E+06
1974	10855.	.84011E+06
1975	-9033.4	.76329E+06
1976	5837.8	.78822E+06
1977	-14104.	.84040E+06
1978	-7233.8	.86534E+06
1979	-2779.2	.90484E+06
1980	4725.2	.91423E+06

```
Calculating -> E0E0=SUMSQDEV
>>> E0E0     =     .1691256E+10 <<<

Calculating -> N0=NREG
>>> N0       =     13.00000     <<<
```

Regression: 1981-1993

```
==============================================================================
Ordinary    Least Squares
Dependent Variable          TM          Number of Observations              13
Mean of Dep. Variable  953928.6971      Std. Dev. of Dep. Var.    96856.038497
Durbin Watson statistic      1.9543     Estimated Autocorrelation        .02287
Std. Error of Regr.     21606.1063      Sum of Squared Residuals   .373459E+10
Total Variation         .11257E+12      Regression Variation        .10884E+12
R - squared                  .96683     Adjusted R - squared            .95024
F( 4,   8)                  58.2867     Prob. Value for F               .00001
Akaike Information        20.24519      Amemiya Prediction     646371457.21109
==============================================================================
Variable  Coefficient  Std. Error  T-ratio Prob|t|>x   Mean of X  Std.Dev.of X
------------------------------------------------------------------------------
ONE       -.469860E+08  .1487E+08  -3.161   .01338      1.00000        .00000
YEAR       23292.5      7598.       3.066   .01545   1987.00000       3.89444
IP         11211.6      3260.       3.440   .00883     97.92308       9.49010
LOCO       16.4878      10.87       1.517   .16784  21715.53846    3399.97477
HOURS      .384526      .2325       1.654   .13675 524829.68269  140629.55801
```

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1981	14230.	.89594E+06
1982	-18454.	.81621E+06
1983	14950.	.81333E+06
1984	13654.	.90789E+06
1985	-28922.	.90591E+06
1986	-23018.	.89074E+06
1987	13565.	.92610E+06
1988	5328.5	.99085E+06
1989	-5511.3	.10194E+07
1990	3272.9	.10307E+07
1991	22793.	.10161E+07
1992	10962.	.10558E+07
1993	-22850.	.11322E+07

```
Calculating -> E1E1=SUMSQDEV
>>> E1E1     =     .3734591E+10 <<<

Calculating -> N1=NREG
>>> N1       =     13.00000     <<<

Calculating -> F=((EE-E0E0-E1E1)/K)/((E0E0+E1E1)/(N0+N1-2*K))
>>> F        =     6.102876     <<<
```

Regression: 1968-1981

```
==============================================================================
Ordinary    Least Squares
Dependent Variable          TM          Number of Observations              14
Mean of Dep. Variable  818558.9375      Std. Dev. of Dep. Var.    63812.638610
Durbin Watson statistic      1.4424     Estimated Autocorrelation       .27880
Std. Error of Regr.     14260.1251      Sum of Squared Residuals   .183016E+10
Total Variation         .52937E+11      Regression Variation        .51107E+11
R - squared                  .96543     Adjusted R - squared            .95006
F( 4,   9)                  62.8304     Prob. Value for F               .00000
Akaike Information        19.40290      Amemiya Prediction     275976584.24163
==============================================================================
Variable  Coefficient  Std. Error  T-ratio Prob|t|>x   Mean of X  Std.Dev.of X
------------------------------------------------------------------------------
ONE       -.629472E+07  .1567E+08   -.402   .69722      1.00000        .00000
YEAR       2414.75      7924.        .305   .76748   1974.50000       4.18330
IP         8610.18      1782.       4.830   .00093     72.68571       9.30019
LOCO       49.6225      14.46       3.431   .00750  27350.78571     321.71253
HOURS      .357299      .1935       1.846   .097971014037.23214  109190.27733
```

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1968	-23517.	.76754E+06
1969	446.70	.76739E+06
1970	20119.	.74469E+06
1971	3434.9	.73631E+06
1972	2287.7	.77446E+06
1973	12495.	.83931E+06
1974	9746.0	.84121E+06
1975	-11253.	.76551E+06
1976	4409.2	.78965E+06
1977	-16118.	.84241E+06
1978	-9039.3	.86714E+06
1979	-4058.7	.90612E+06
1980	1112.3	.91785E+06
1981	9935.3	.90023E+06

```
Calculating -> E0E0=SUMSQDEV
>>> E0E0     =     .1830161E+10 <<<

Calculating -> N0=NREG
>>> N0       =     14.00000     <<<
```

Regression: 1982-1993

```
==============================================================================
Ordinary    Least Squares
Dependent Variable          TM          Number of Observations              12
Mean of Dep. Variable  957575.3177      Std. Dev. of Dep. Var.   100226.399629
Durbin Watson statistic      2.4067     Estimated Autocorrelation       -.20333
Std. Error of Regr.     18059.3269      Sum of Squared Residuals   .228298E+10
Total Variation         .11050E+12      Regression Variation        .10822E+12
R - squared                  .97934     Adjusted R - squared            .96753
F( 4,   7)                  82.9520     Prob. Value for F               .00001
Akaike Information         19.89717     Amemiya Prediction     462030657.89446
==============================================================================
Variable  Coefficient  Std. Error  T-ratio Prob|t|>x   Mean of X  Std.Dev.of X
------------------------------------------------------------------------------
ONE       -.266804E+08  .1572E+08  -1.698   .13341      1.00000        .00000
YEAR       13153.5      7964.       1.652   .14261   1987.50000       3.60555
IP         10848.6      2730.       3.974   .00537     98.94167       9.13977
LOCO       26.0788      10.16       2.567   .03719  21217.41667    3015.27009
HOURS     -.263132      .3633       -.724   .49241 498769.42188  109284.72771
```

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1982	541.87	.79722E+06
1983	-5582.1	.83386E+06
1984	26491.	.89505E+06
1985	-19640.	.89662E+06
1986	-18873.	.88660E+06
1987	14255.	.92541E+06
1988	3677.4	.99250E+06
1989	-8024.3	.10219E+07
1990	-3659.4	.10376E+07
1991	15127.	.10237E+07
1992	9572.3	.10572E+07
1993	-13886.	.11232E+07

```
Calculating -> E1E1=SUMSQDEV
>>> E1E1      =      .2282975E+10 <<<

Calculating -> N1=NREG
>>> N1        =      12.00000     <<<

Calculating -> F=((EE-E0E0-E1E1)/K)/((E0E0+E1E1)/(N0+N1-2*K))
>>> F         =      9.071898     <<<
```

Regression: 1968-1982

```
==============================================================================
Ordinary    Least Squares
Dependent Variable          TM          Number of Observations              15
Mean of Dep. Variable  817172.2458      Std. Dev. of Dep. Var.    61725.486110
Durbin Watson statistic      1.4887     Estimated Autocorrelation       .25563
Std. Error of Regr.     13569.1959      Sum of Squared Residuals   .184123E+10
Total Variation         .53340E+11      Regression Variation        .51499E+11
R - squared                  .96548     Adjusted R - squared            .95167
F( 4,  10)                  69.9251     Prob. Value for F               .00000
Akaike Information         19.29232     Amemiya Prediction     245497435.02604
==============================================================================
Variable  Coefficient  Std. Error  T-ratio Prob|t|>x   Mean of X  Std.Dev.of X
------------------------------------------------------------------------------
ONE       -.502695E+07  .1399E+08   -.359   .72677      1.00000        .00000
YEAR       1807.23      7123.        .254   .80485   1975.00000       4.47214
IP         8627.76      1695.       5.091   .00047     73.30000       9.27231
LOCO       48.0790      12.25       3.926   .00284  27330.40000     319.90597
HOURS      .330510      .1485       2.226   .05016 993649.48333  131551.55967
```

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1968	-22349.	.76637E+06
1969	919.85	.76692E+06
1970	20593.	.74422E+06
1971	2952.7	.73679E+06
1972	1299.8	.77545E+06
1973	12322.	.83949E+06
1974	10492.	.84047E+06
1975	-11989.	.76624E+06
1976	3238.3	.79082E+06
1977	-16901.	.84319E+06
1978	-9880.0	.86799E+06
1979	-3663.2	.90572E+06
1980	1841.3	.91712E+06
1981	9327.6	.90084E+06
1982	1795.8	.79596E+06

```
Calculating -> E0E0=SUMSQDEV
>>> E0E0     =     .1841231E+10 <<<

Calculating -> N0=NREG
>>> N0       =     15.00000     <<<
```

Regression: 1983-1993

Ordinary Least Squares			
Dependent Variable	TM	Number of Observations	11
Mean of Dep. Variable	972104.1136	Std. Dev. of Dep. Var.	90903.961817
Durbin Watson statistic	2.3984	Estimated Autocorrelation	-.19920
Std. Error of Regr.	19502.6305	Sum of Squared Residuals	.228212E+10
Total Variation	.82635E+11	Regression Variation	.80353E+11
R - squared	.97238	Adjusted R - squared	.95397
F(4, 6)	52.8149	Prob. Value for F	.00008
Akaike Information	20.05956	Amemiya Prediction	553240139.28362

Variable	Coefficient	Std. Error	T-ratio	Prob|t|>x	Mean of X	Std.Dev.of X
ONE	-.259805E+08	.2234E+08	-1.163	.28897	1.00000	.00000
YEAR	12799.8	.1131E+05	1.132	.30081	1988.00000	3.31662
IP	10909.8	3211.	3.398	.01453	100.49091	7.75931
LOCO	26.2584	11.59	2.266	.06402	20687.63636	2509.22945
HOURS	-.276980	.4863	-.570	.58966	479728.36932	91387.37698

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1983	-5443.0	.83372E+06
1984	26902.	.89464E+06
1985	-19319.	.89630E+06
1986	-18632.	.88635E+06
1987	14198.	.92547E+06
1988	3404.2	.99278E+06
1989	-8296.2	.10221E+07
1990	-3892.7	.10379E+07
1991	15134.	.10237E+07
1992	9676.0	.10571E+07
1993	-13731.	.11230E+07

```
Calculating -> E1E1=SUMSQDEV
>>> E1E1      =      .2282116E+10 <<<

Calculating -> N1=NREG
>>> N1        =      11.00000     <<<

Calculating -> F=((EE-E0E0-E1E1)/K)/((E0E0+E1E1)/(N0+N1-2*K))
>>> F         =      9.041509     <<<
```

Regression: 1968-1983

Ordinary Least Squares			
Dependent Variable	TM	Number of Observations	16
Mean of Dep. Variable	817866.1758	Std. Dev. of Dep. Var.	59697.050849
Durbin Watson statistic	1.9251	Estimated Autocorrelation	.03745
Std. Error of Regr.	19151.4392	Sum of Squared Residuals	.403455E+10
Total Variation	.53456E+11	Regression Variation	.49422E+11
R - squared	.92453	Adjusted R - squared	.89708
F(4, 11)	33.6863	Prob. Value for F	.00000
Akaike Information	19.97057	Amemiya Prediction	481395629.16374

Variable	Coefficient	Std. Error	T-ratio	Prob|t|>x	Mean of X	Std.Dev.of X
ONE	.982861E+07	.1878E+08	.523	.61118	1.00000	.00000
YEAR	-5305.42	9623.	-.551	.59245	1975.50000	4.76095
IP	9651.18	2355.	4.098	.00176	74.02500	9.41562
LOCO	23.7713	14.14	1.681	.12091	27228.93750	510.12880
HOURS	.111803	.1895	.590	.56709	969673.82813	159214.96374

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1968	-14335.	.75836E+06
1969	-1062.6	.76890E+06
1970	23243.	.74157E+06
1971	446.38	.73930E+06
1972	-9908.2	.78665E+06
1973	9525.7	.84228E+06
1974	20362.	.83060E+06
1975	-3876.0	.75813E+06
1976	-2798.6	.79686E+06
1977	-21925.	.84822E+06
1978	-20208.	.87831E+06
1979	-4169.7	.90623E+06
1980	18552.	.90041E+06
1981	12546.	.89762E+06
1982	-28022.	.82578E+06
1983	21630.	.80665E+06

Calculating -> E0E0=SUMSQDEV
>>> E0E0 = .4034554E+10 <<<

Calculating -> N0=NREG
>>> N0 = 16.00000 <<<

Regression: 1984-1993

```
==============================================================================
Ordinary    Least Squares
Dependent Variable          TM          Number of Observations              10
Mean of Dep. Variable  986487.0125      Std. Dev. of Dep. Var.    81567.863341
Durbin Watson statistic      2.1005     Estimated Autocorrelation      -.05027
Std. Error of Regr.     19719.7819      Sum of Squared Residuals   .194435E+10
Total Variation         .59880E+11      Regression Variation        .57935E+11
R - squared                  .96753     Adjusted R - squared            .94155
F( 4,   5)                  37.2461     Prob. Value for F               .00065
Akaike Information          20.08561    Amemiya Prediction     583304699.87871
==============================================================================
Variable  Coefficient  Std. Error  T-ratio Prob|t|>x   Mean of X  Std.Dev.of X
------------------------------------------------------------------------------
ONE       -.751338E+07  .3005E+08   -.250   .81250      1.00000        .00000
YEAR       3553.23      .1514E+05    .235   .82373   1988.50000       3.02765
IP         10034.5      3380.       2.969   .03119    102.05000       6.09813
LOCO       45.0057      23.28       1.933   .11105  20185.70000    1979.02648
HOURS     -1.06757      .9806      -1.089   .32596 466697.30625   84877.41501
```

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1984	20650.	.90089E+06
1985	-21325.	.89831E+06
1986	-17183.	.88490E+06
1987	20342.	.91932E+06
1988	5307.0	.99088E+06
1989	-8025.6	.10219E+07
1990	-11098.	.10451E+07
1991	6432.9	.10324E+07
1992	8972.3	.10578E+07
1993	-4073.1	.11134E+07

```
Calculating -> E1E1=SUMSQDEV
>>> E1E1     =     .1944349E+10 <<<

Calculating -> N1=NREG
>>> N1       =     10.00000     <<<

Calculating -> F=((EE-E0E0-E1E1)/K)/((E0E0+E1E1)/(N0+N1-2*K))
>>> F        =     5.242348     <<<
```

Regression: 1968-1984

Ordinary Least Squares			
Dependent Variable	TM	Number of Observations	17
Mean of Dep. Variable	823964.7316	Std. Dev. of Dep. Var.	63033.917684
Durbin Watson statistic	1.4955	Estimated Autocorrelation	.25224
Std. Error of Regr.	21672.7242	Sum of Squared Residuals	.563648E+10
Total Variation	.63572E+11	Regression Variation	.57936E+11
R - squared	.91134	Adjusted R - squared	.88178
F(4, 12)	30.8362	Prob. Value for F	.00000
Akaike Information	20.20755	Amemiya Prediction	607856083.35736

Variable	Coefficient	Std. Error	T-ratio	Prob|t|>x	Mean of X	Std.Dev.of X
ONE	.603360E+07	.2116E+08	.285	.78037	1.00000	.00000
YEAR	-3149.28	.1083E+05	-.291	.77613	1976.00000	5.04975
IP	9683.96	2665.	3.634	.00343	75.12941	10.19061
LOCO	4.29868	12.04	.357	.72723	27061.47059	848.96099
HOURS	.178523	.2114	.845	.41485	949214.01471	175730.85754

Calculating -> E0E0=SUMSQDEV
>>> E0E0 = .5636484E+10 <<<

Calculating -> N0+NREG
>>> Result = 33.00000 <<<

LISTING OF RAW DATA (Current sample)

Observation	RESID	YFIT
1968	-11615.	.75564E+06
1969	-5468.1	.77331E+06
1970	19588.	.74522E+06
1971	871.14	.73887E+06
1972	-12039.	.78878E+06
1973	13163.	.83865E+06
1974	25207.	.82575E+06
1975	9614.8	.74464E+06
1976	-4048.2	.79811E+06
1977	-23642.	.84993E+06
1978	-28964.	.88707E+06
1979	-16279.	.91834E+06
1980	26870.	.89209E+06
1981	16805.	.89336E+06
1982	-29783.	.82754E+06
1983	-1889.6	.83016E+06
1984	21609.	.89993E+06

Regression: 1985-1993

```
==============================================================================
Ordinary    Least Squares
Dependent Variable          TM          Number of Observations              9
Mean of Dep. Variable  993703.1667      Std. Dev. of Dep. Var.    83061.188052
Durbin Watson statistic      2.7153     Estimated Autocorrelation      -.35764
Std. Error of Regr.     10838.9684      Sum of Squared Residuals   .469933E+09
Total Variation         .55193E+11      Regression Variation        .54723E+11
R - squared                  .99149     Adjusted R - squared            .98297
F( 4,   4)                  116.4493    Prob. Value for F               .00022
Akaike Information          18.88199    Amemiya Prediction     182751701.42958
==============================================================================
Variable  Coefficient  Std. Error  T-ratio Prob|t|>x   Mean of X  Std.Dev.of X
------------------------------------------------------------------------------
ONE       -.116578E+08  .1656E+08   -.704   .52021      1.00000        .00000
YEAR       5862.28      8346.        .702   .52115   1989.00000       2.73861
IP         8797.99      1890.       4.655   .00963    103.07778       5.47284
LOCO       19.3919      14.70       1.319   .25750  19719.44444    1400.15313
HOURS     -.662670      .5510      -1.203   .29540 449457.34028   69000.09221


 Calculating -> E1E1=SUMSQDEV
 >>> E1E1      =     .4699329E+09 <<<

 Calculating -> N1=NREG
 >>> N1        =     9.000000     <<<

 Calculating -> F=((EE-E0E0-E1E1)/K)/((E0E0+E1E1)/(N0+N1-2*K))
 >>> F         =     4.749427     <<<
                        LISTING OF RAW DATA (Current sample)

   Observation   RESID       YFIT
    1985        7299.6      .86968E+06
    1986       -14743.      .88247E+06
    1987        7952.9      .93171E+06
    1988        5282.1      .99090E+06
    1989       -6319.6      .10202E+07
    1990       -5522.5      .10395E+07
    1991        4377.9      .10345E+07
    1992        3767.3      .10630E+07
    1993       -2094.7      .11114E+07
```

Appendix C: Examination for Heteroscedasticity

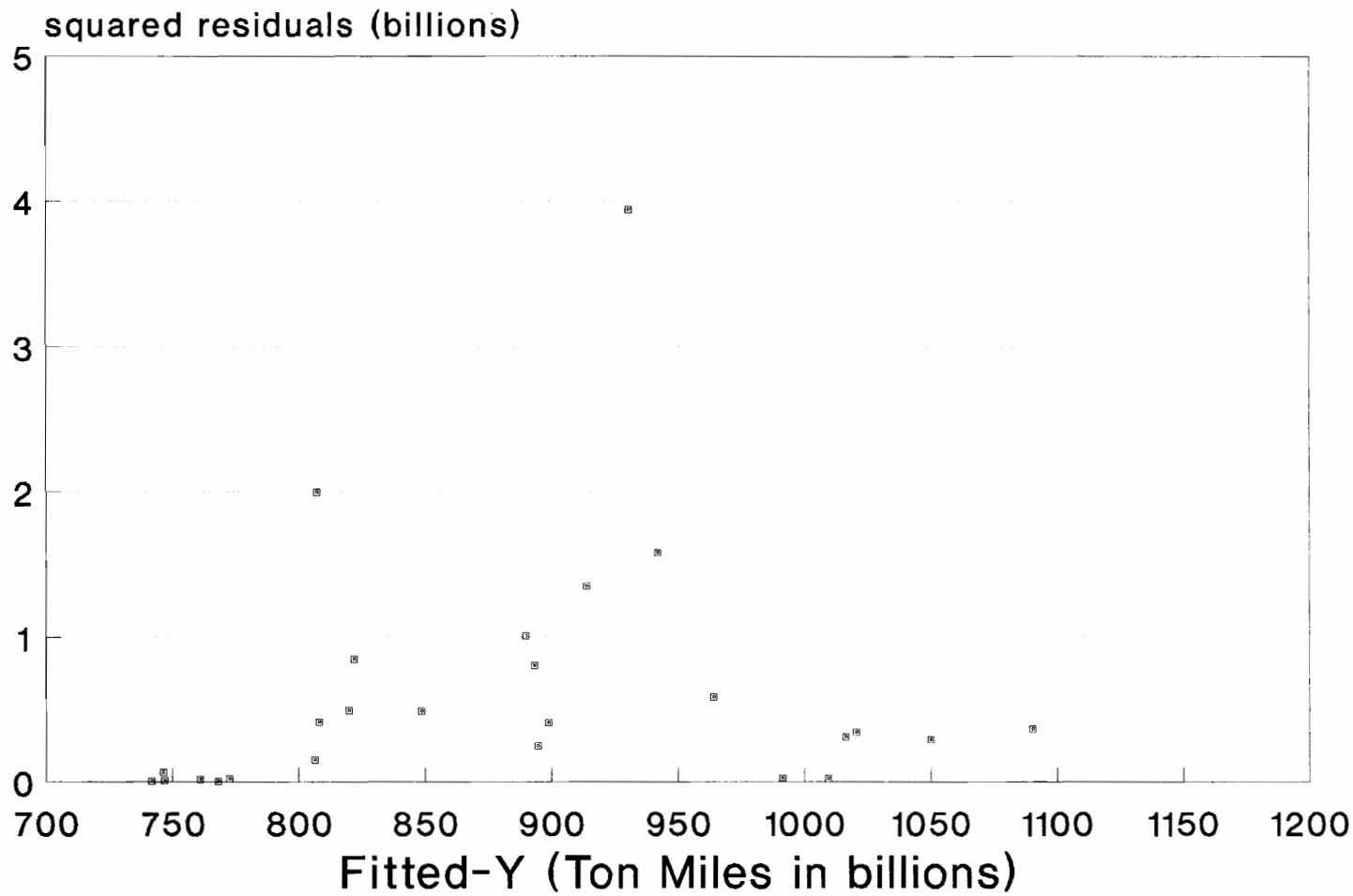

Figure 6: Examination for Heteroscedasticity on Fitted-Y

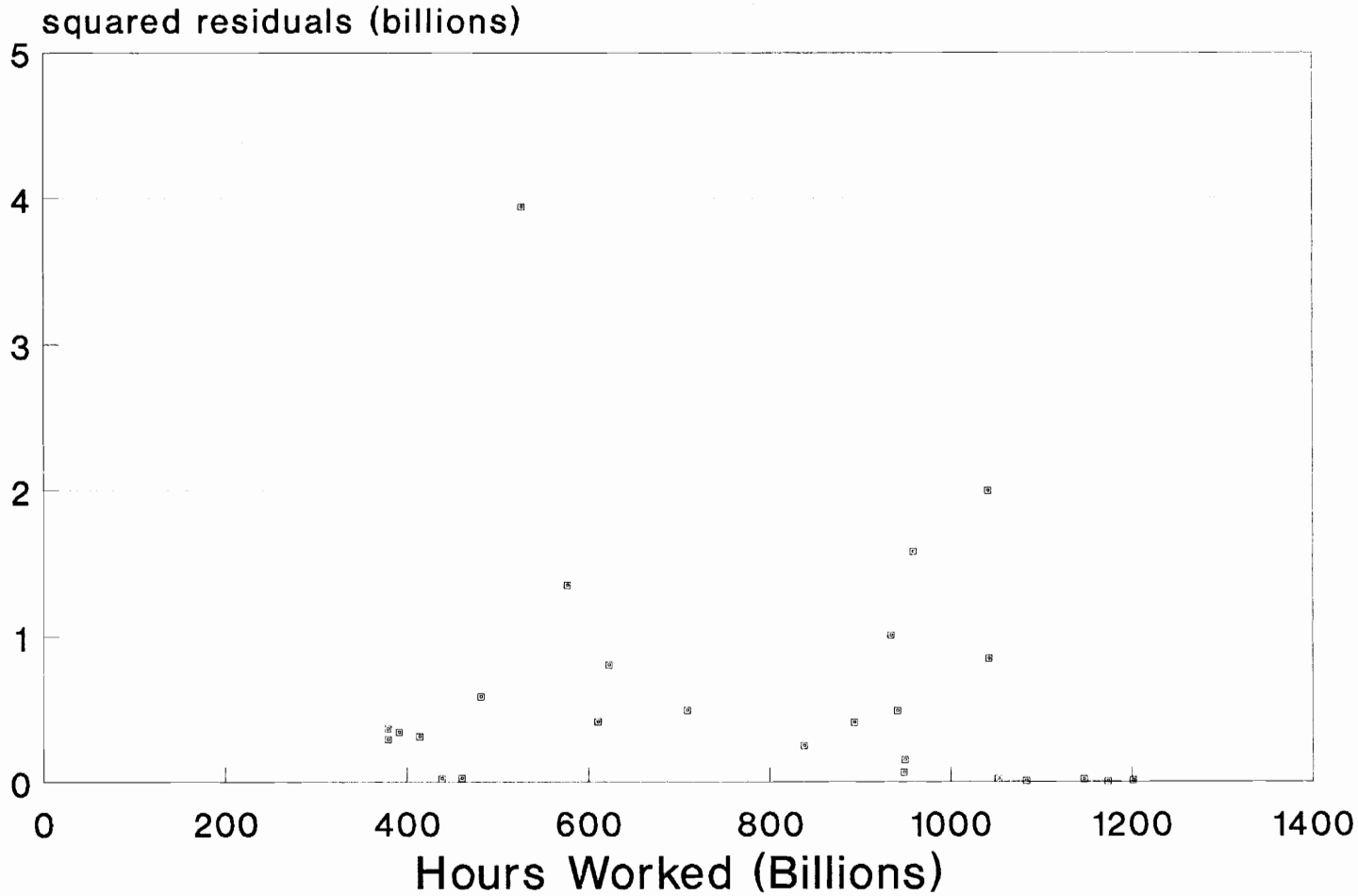

Figure 7: Examination for Heteroscedasticity on Hours Worked

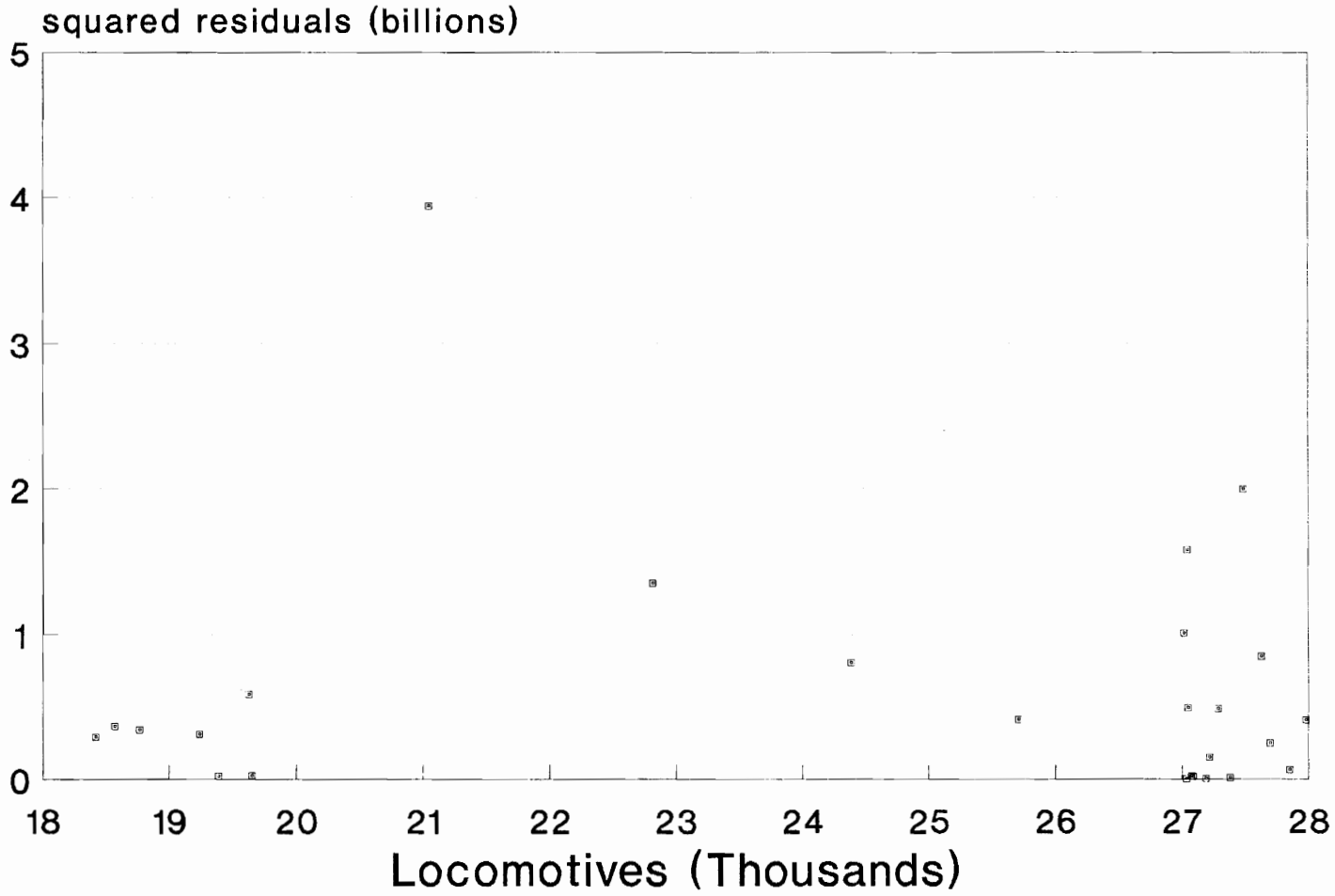

Figure 8: Examination for Heteroscedasticity on Locomotives

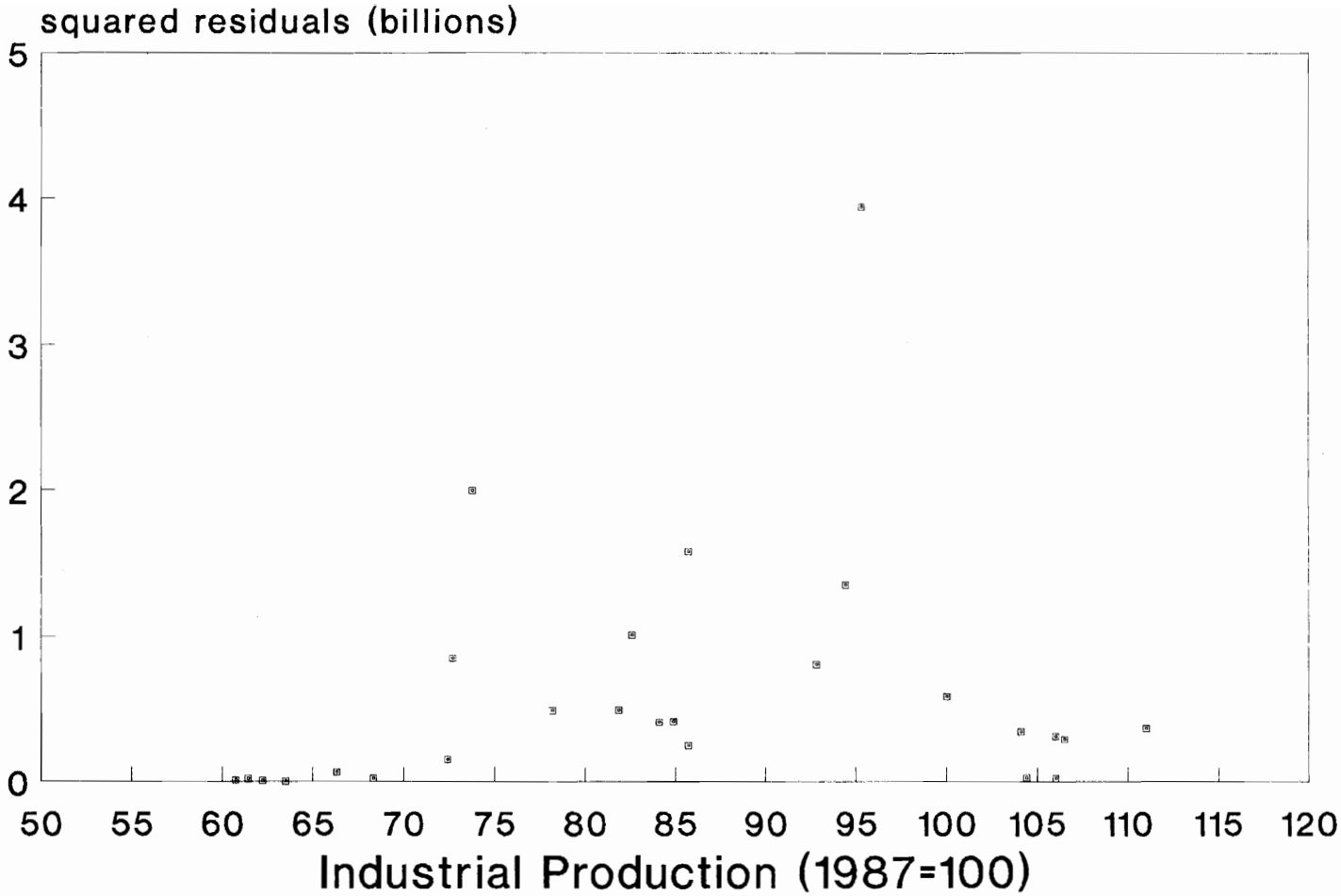

Figure 9: Examination for Heteroscedasticity on Ind. Prod.

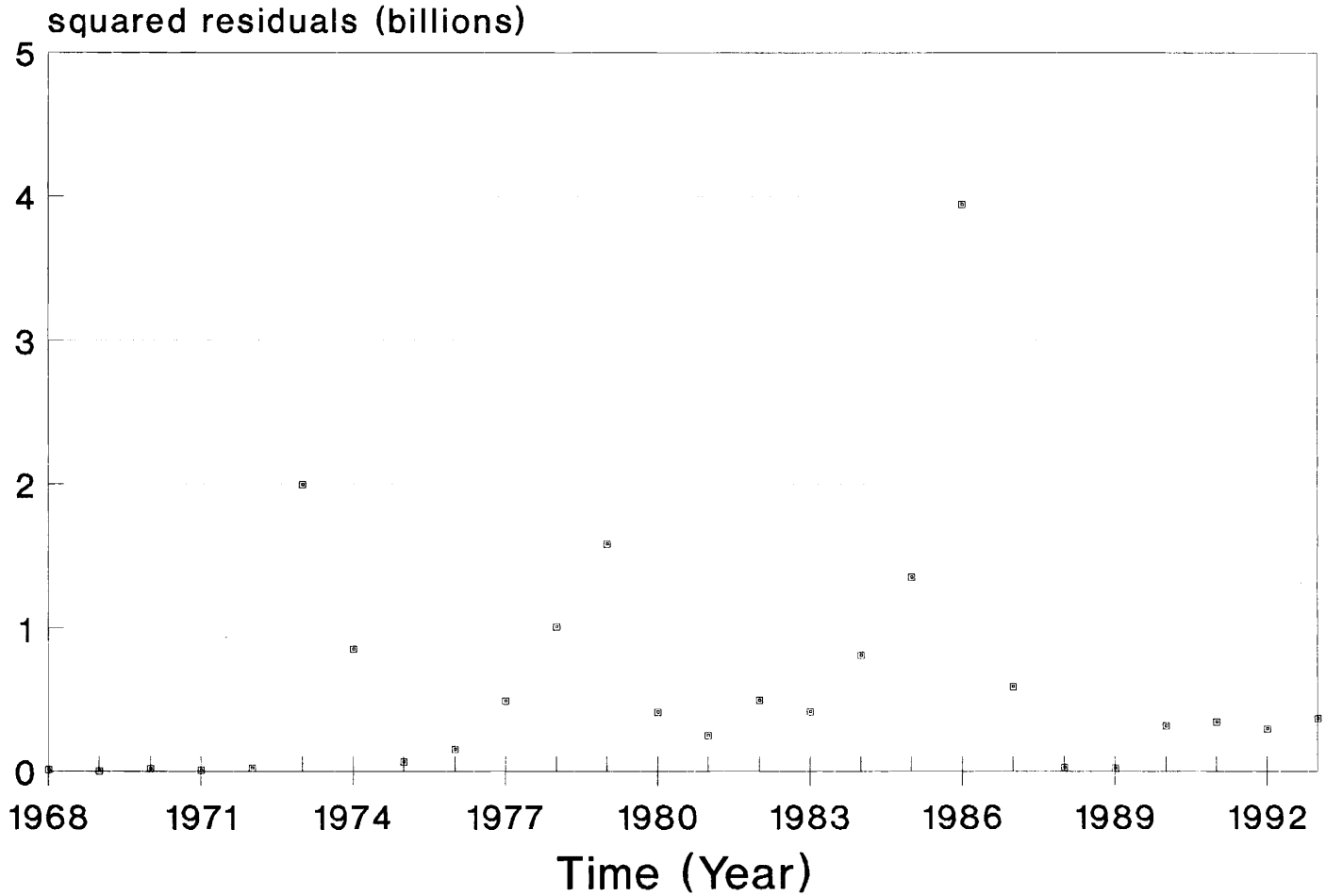

Figure 10: Examination for Heteroscedasticity on Time

Appendix D: Basic Provisions of the Staggers Act[4]

The Staggers Rail Act of 1980 was signed into law by President Carter on October 14. The new law, while short of wholesale deregulation, nevertheless substantially eases the regulatory burden on the railroad industry, providing significant changes in the rules governing rate making, car control and other areas of railroading.

Here is a summary of the law's key points:

Ratemaking

Perhaps the most extensive changes in regulation provided by the rail act are in the provision on railroad ratemaking. While protection for rail-dependent shippers was retained, the Congress clearly intended that the discipline of the competitive marketplace would control most ratemaking. The new rate provisions curtail activities of rate bureaus and move to phase out general rate increases, but also offer a new measure of flexibility in the setting of rates and in the marketing of rail services.

• **Maximum Rates** — Nearly two-thirds of all railroad rates will be freed from maximum rate regulation under a provision that limits ICC jurisdiction to those rates where railroads exercise "market dominance" and charge a rate above a threshold level set initially at 160 percent of variable costs. That will rise 5 percentage points a year until 1984 when it will be dependent on a "cost recovery percentage" to be determined by the ICC. That percentage can vary from 170 to 180 percent of variable costs.

• **Zone of Rate Flexibility** — A carrier can raise any rate by the percentage increase in the railroad cost index (which will be published quarterly by the ICC). For the first four years after enactment, rates can be raised up to 6 percent a year above the cost recovery index (with a cumulative maximum of 18 percent). After that, annual increases will be limited to four percent and be restricted largely to carriers not earning adequate revenues.

Shippers can still bring a complaint case on the 6 percent and 4 percent increases after the rate has gone into effect. But the ICC cannot suspend these increases and can only investigate those more than 20 percentage points above the threshold, subject to a maximum of 190 percent of variable cost. In a shipper-initiated complaint, the burden of proof is on the shipper. In an ICC investigation, the burden of proof is on the carrier.

• **Minimum Rates** — Railroads will be permitted to reduce rates more easily to meet motor and water carrier competition under a provision that any rate that contributes to the "going concern value" shall be considered reasonable. Going concern value has been defined as a rate that equals or exceeds variable cost.

• **General Rate Increases** — General rate increases are limited to joint rates and are to be eliminated completely by January 1, 1984, unless the ICC finds that the elimination is not feasible. The ICC cannot eliminate them before April 1, 1982, but until they are, general rate increases are to be limited to recovery of inflation costs.

The ICC may institute an index system to supplant evidentiary requirements in a general rate increase. After the elimination of the general rate increases, the ICC could prescribe a percentage increase that individual carriers could accept or "flag-out."

The percentage prescribed by the ICC may be for a range broad enough to allow carriers to differentiate between commodities as necessary to recover inflationary cost increases.

• **Rate Bureaus** — There can be no discussion of, or voting on, single line rates and no discussion of, or voting on, joint line rates unless a carrier can "practicably participate in the movement." The definition "practicably participate" will be left to ICC discretion.

No later than January 1, 1984, discussion of joint line rates will be limited to carriers forming part of a particular route. Transcripts or recordings of

meetings and records of votes must be submitted to the ICC.

Protection will be granted from "parallel action" anti-trust allegations where a carrier has a single line rate and participates in a competing joint rate.

• **Surcharges and Cancellations** — For the next 3 years, carriers may apply a surcharge to any joint rate that does not yield 110 percent of variable cost. Any surcharge must apply equally in dollar amounts to all routes between the points to which the surcharge applies to prevent predatory discrimination between routes.

Unless affected shippers and carriers consent, a carriers revenues cannot exceed 110 percent of Rail Form A costs as a result of the surcharge, except that carriers with inadequate revenues may apply a surcharge to cover all costs of service on lines carrying less that 3,000,000 gross ton-miles (1,000,000 gross ton-miles if an adequate revenue carrier). Carriers earning adequate revenues may not surcharge traffic on lines carrying over 3,000,000 gross ton-miles per year.

Carriers may cancel the application of a joint rate to any route not providing 110 percent Rail Form A costs. The ICC may reopen the route if shippers or carriers provide the canceling carrier revenue equal to 110 percent of variable costs through a new rate, division, or surcharge.

• **Divisions** — ICC proceedings will be expedited, with a 9-month limit for taking of evidence. Final action must be taken within 180 days after completion of a proceeding.

• **Contracts** — Contract rate agreements are specifically legalized, and all contracts must be filed with the ICC. Grounds for shipper complaints against a contract are severely restricted.

Service under contract shall be separate and distinct from common carriage by rail. Once approved, the ICC cannot require a carrier to violate the contract. Contract enforcement is restricted to the courts.

• **Discrimination** — Under the new law, the existing discrimination provision of the Interstate Commerce Act does not apply to contracts, surcharges or cancellations of routes, separate rates for distinct services, rail rate applications to different routes, or business entertainment and solicitation expenses.

• **Investigation and Suspension of Rates** — Proceedings are reduced from seven months to five. To get a suspension, a shipper must show likelihood it will prevail on the merits; that it will suffer substantial injury, and that a refund is inadequate protection. If a suspended rate is finally approved, the shipper will be required to pay any undercharges resulting from the suspension, plus interest.

• **Notice** — The notice period is reduced from 30 days to 20 days for rate increases and to 10 days for rate decreases.

• **Recyclables** — With the exception of iron and steel, rates for recyclables are to be limited to the average ratio of revenue to variable costs necessary for railroads to cover all costs and earn a reasonable return on investment.

• **Released Value Rates** — A carrier may establish deductibles and limit liability to pre-established values.

• **Savings Provisions** — Any rate in effect on the date of enactment that is not challenged within 180 days and found to be unreasonable shall be deemed to be lawful and may not thereafter be challenged. A rate may not be challenged within the 180 day period unless the carrier has market dominance.

• **Intrastate Rates** — Federal standards and procedures will apply to intrastate rate cases.

• **Miscellaneous** — Existing law is repealed with regard to demand-sensitive and capital intensive rates.

Management

Railroads have been restricted, far more than many other businesses, by regulations concerning their business practices and day-to-day management of their companies. The Staggers Act moves to alter some of these restrictions and return decision-making to management.

• **Car Service** — ICC car service orders will be restricted to emergencies having regional or national significance, but the ICC's authority to require joint use of terminals during emergencies will be expanded to include all facilities. Emergency services are to be performed by employees who would otherwise have performed the service if there had been no emergency.

Premium charges may be imposed for special services to improve car utilization.

Shippers are authorized to seek approval for new agreements among themselves with respect to private car compensation. Approval having been received, they may negotiate with the railroads and, if they fail to agree, any party may petition the ICC to set compensation levels.

Incentive per-diem is eliminated.

• **Cost Accounting** — A new board with a three-year life will be created to establish new cost accounting principles which will be implemented by the ICC. Carriers can adopt their own accounting systems as long as they meet the standards, but carrier systems must be certified by the ICC.

• **Business Entertainment** — Railroads may entertain customers on the same basis as other businesses. Previously, railroads were prohibited from engaging in normal business solicitation activities.

Other Provisions

• **Abandonments** — Abandonment standards will remain unchanged, but proceedings will be speeded up with unprotested abandonments permitted 75 days after application. Protested but uninvestigated abandonments will be permitted 120 days after application. The final decision on protested and investigated applications must be made within 255 days of filing.

The maximum time limit to effective date of a permitted abandonment is set at 330 days. The Act creates a mechanism that requires a railroad to sell a line approved for abandonment to responsible persons offering either to subsidize or acquire the line. If parties fail to agree on an offer for subsidy or purchase of the abandoned line, the ICC can establish terms and conditions.

[Note: In a rule-making proceeding initiated as a result the Exemption provisions (see below), the ICC subsequently loosened the abandonment requirements even further. - WJB]

• **Mergers** — A merger application between two Class I carriers is expedited without changing the current substantive standards. However, the ICC must consider whether the transaction would have an adverse effect on competition among rail carriers in the region. Substantive standards for mergers not involving two Class I carriers are reduced.

• **Entry** — The standard for granting a permit for construction and operation of extensions or additions of railroad lines is eased. Once a permit is granted by the ICC, a railroad cannot refuse permission to another railroad to cross its lines. The ICC may order reciprocal switching agreements.

• **Exemptions** — Existing ICC authority to grant an exemption from regulation when the transportation or service is of limited scope is broadened.

VII. Literature Cited

1. Levine, Harvey A., course notes, "The Economic Evolution of the Railroad Industry in the United States," Association of American Railroads, Washington, DC, 1993.

2.Gregory C. Chow, "Test of Equality Between Sets of Coefficients in Two Linear Regressions," *Econometrica*, vol 28, no. 3, 1960.

3. C. Barnekov and Andrew N. Kleit, "The Costs of Railroad Deregulation: A Further Analysis," (1988), paper available in the Information Resource Center of the Association of American Railroads, Washington, DC.

4.Levine, Harvey A., course notes, "The Economic Evolution of the Railroad Industry in the United States," Association of American Railroads, Washington, DC, 1993.

VIII. Selected Bibliography

America's Railroads After Staggers: An Economic Prospectus, Association of American Railroads, June, 1987

Analysis of Class I Railroads, Association of American Railroads, Annual Publication.

Barnekov, Christopher C., "Railroad Deregulation in the United States: An Assessment of the Early Results," (Unpublished paper available in the Information Resource Center of the Association of American Railroads), August, 1986.

Barnekov, Christopher C., and Kleit, Andrew N., "The Costs of Railroad Regulation: A Further Analysis," (Unpublished paper available in the Information Resource Center of the Association of American Railroads), May 1988.

Chiang, Alpha C., *Fundamental Methods of Mathematical Economics*, 3rd Ed., McGraw-Hill, New York, 1984.

Chow, Gregory C., "Test of Equality Between Sets of Coefficients in Two Linear Regressions," *Econometrica,* vol. 28, no. 3, 1960.

Greene, William H., *Econometric Analysis*, Macmillan, New York, 1990.

Gujarati, Damodar N., *Basic Econometrics*, 2nd Ed., McGraw- Hill, New York, 1988.

Hage, David, "On the Right Track," *U.S. News & World Report*, March 21, 1994.

Harper, Edwin L., "American Railroads Delivering Lower Prices and Higher Quality Service," *Japan Railway & Transit Review*, July, 1995.

Levine, Harvey A., course notes, "The Economic Evolution of the Railroad Industry in the United States," Association of American Railroads, Washington, DC, 1993.

McFarland, Henry, *The Effect of U.S. Railroad Deregulation on Shippers, Labor, and Capital*, U.S. Department of Justice, Antitrust Division, March, 1989.

Productivity Measures for Selected Industries and Government Services, U.S. Department of Labor, Bureau of Labor Statistics, May, 1995.

"Rail Rates Continue Multi-Year Decline," U.S. Interstate Commerce Commission, Office of Economics, November, 1993.

Railroad Facts, Association of American Railroads, Annual Publication.
Railroad Regulation: Economic and Financial Impacts of the Staggers Rail Act of 1980, U.S. General Accounting Office, May, 1990.

Sidey, Hugh, "Back at Full Throttle," *Time*, August 23, 1993.

Thompson, Stephen J., *Summary of the Staggers Rail Act of 1980*, Congressional Reseach Service, January, 1985.

Thompson, Stephen J., *The Profitability of Railroads After Enactment of the Staggers Rail Act of 1980*, Congressional Research Service, May, 1985.

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