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Transportation Policy Impacts on Railroad and Motor Carrier Market Shares

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ABSTRACT

Public policies enacted in the 1980s have profoundly altered the competitive environment in the transportation market. This fact is widely recognized, but empirical estimation of the impact of transportation policy in specific markets has rarely been attempted. The principal objective of the paper is to illustrate the significance of public policy for rail and truck market shares. This is accomplished by measuring the impact of the following policies.

1. The impact of the Motor Carrier Act of 1980 (MCA80) and the Surface Transportation Assistance Act of 1982 (STAA82) on rail and motor carrier market shares in selected manufactured goods markets.
2. The effect of anti-lock brake systems on motor carrier costs and the motor carrier equipment industry.
3. The impact of the Surface Transportation Assistance Act of 1982 on motor carrier equipment sales.
4. Indicate pricing actions railroads could take to mitigate the effects of post-1980 motor carrier policy.

The first objective of the paper is achieved through the estimation of a time series regression model in which rail market share in a given industry is a function of the following independent variables, (a) rail prices, (b) truck prices, (c) interest rates, (d) motor carrier productivity increases due to STAA82 and (e) a series of dummy variables to estimate the impact of MCA80. The second and third objectives are accomplished through estimation of times series regression models in which truck trailer demand is a function of (a) interest rates, (b) business fixed investment, (c) a dummy variable to measure the "pre buy" effect of anti-lock brake requirements, and (d) a dummy variable to measure the impact of STAA82 on 1984 truck trailer demand. The fourth objective is achieved by estimating rail price elasticities in specific manufactured goods markets.

Empirical results indicate that MCA80 and STAA82 diverted substantial tonnage from railroads to motor carriers and these losses were only partially offset by rail price declines. Other results suggest that about one third of the truck trailer sales in 1974 were "pre buy" sales to avoid the costs of anti-lock brakes. This was followed by depressed sales in 1975 that led to the bankruptcy of many motor carrier equipment manufacturers. The excess capacity caused by the "pre-buy" and the 1975 recession also bankrupted many motor carriers. The same scenario could occur if the Truck and Bus Safety Act ultimately results in anti-lock brake requirements.

Empirical results indicate that about 21% of 1984 truck van trailer sales were due to STAA82. Motor carriers postponed purchases in 1983 to await availability of the larger equipment permitted by STAA82. This led to depressed sales in 1983, artificially higher sales in 1984, and low sales in 1985–86.

TRANSPORTATION POLICY IMPACTS ON RAILROAD AND MOTOR CARRIER MARKET SHARES

Deregulation of the transportation system has created new alternatives for shippers and opened new marketing opportunities for carriers. The Staggers Act granted railroads substantially increased rate flexibility. Section 202 of the act limits ICC jurisdiction to rates where railroads have market dominance and charge above a prescribed threshold level. Minimum rates may be set at variable cost. Railroads gained rate flexibility and other aspects of the Staggers Act had the effect of intensifying rate competition. For example, railroads may not discuss or vote on single line rates in rate bureaus (Section 219). They may also enter into confidential contracts with shippers.

The Motor Carrier Act of 1980 (MCA80) contained a number of provisions that greatly relaxed entry control. This led to a large increase in the number of motor carriers, putting downward pressure on rates. Restrictions on motor carrier rate bureaus had the same effect. Rate decreases produced increases in motor carrier traffic at the expense of railroads. Relaxed regulation of motor carrier backhauls also contributed to increasing motor carrier market share.

The Surface Transportation Assistance Act of 1982 (STAA82) is known as the law that raised motor carrier taxes. The federal diesel fuel tax was raised from $.04 to $.09 per gallon. The act was amended in July, 1984, in order to raise the tax from $.09 to $.15 per gallon. Larger trucks were required to pay an annual tax of $100 plus $22 for each 1000 pounds over 55,000 pounds. However, the act also contained provisions that produced substantial increases in motor carrier productivity. Maximum truck weights were raised to 80,000 pounds. Truck trailer length was increased from 45 feet to 48 feet. Maximum trailer width was increased from 96 inches to 102 inches.

The act also authorized double 28 foot trailers on interstate highways.

The Surface Transportation Assistance Act destabilized the motor carrier equipment manufacturing industry. After passage of the act, motor carriers delayed new equipment purchases, waiting for the new larger vehicles. This artifically depressed 1983 sales and artificaillly stimulated 1984 sales.

Other public policies have the potential to significantly affect carrier costs and market shares. For example the Truck and Bus Safety Act may have the effect of requiring trucks to be equipped with anti-lock brake systems. These are complicated systems that rely on electronics to activate braking during sudden stops. The installation cost of the system can be as high as $6000 for a typical 5 axle tractor-trailer combination. The complicated nature of the system results in high maintenance expenses. Replacement parts are expensive and difficult to install.

From the above examples, it is clear that public policies enacted in the 1980's have profoundly affected the competitive environment in the transportation market. These policies have altered carrier costs and changed the feasible price-service packages that can be offered to shippers. A good case can be made for public policy as the determinant of modal market shares. Accordingly, careful consideration and measurement of the impact of public policy must be a fundamental aspect of the strategic planning process of all carriers.

Several recent studies have emphasized the importance of strategic planning for transportation firms [Baker; Cunningham and Khandekar; Grimm and Smith; Roberts and Mehring; Walters]. However very few studies have attempted to measure the impact of specific policies in commodity specific markets [Babcock (1983, 1984, 1986); German (1977) (1982) (1983a) (1983b)].

The objective of this paper is not to measure the effect of all current and potential public policies on all types of carriers. The primary objective is to illustrate the significance of public policy for rail and truck market shares. This is accomplished by measuring the impact of the following policies.

1. The impact of the Motor Carrier Act of 1980 (MCA80) and the Surface Transportation Assistance Act of 1982 (STAA82) on rail and motor carrier market shares in selected manufactured goods markets.
2. The effect of anti-lock brake systems on motor carrier costs and the motor carrier equipment industry.
3. The impact of the Surface Transportation Assistance Act of 1982 on motor carrier equipment sales.
4. Indicate pricing actions railroads could take to mitigate the effects of post-1980 motor carrier policy.

THE MODELS

Model to Measure the Impact of the Motor Carrier Act of 1980 and the Surface Transportation Assistance Act of 1982

The impact of transportation policy on rail and motor carrier market shares is obtained by estimating a rail demand model. This is because no time series, commodity specific tonnage and price data exists for the entire motor carrier industry. Private and other exempt carriers report no data to regulatory bodies. The ICC collected commodity specific tonnage and revenue data for some motor carriers between 1966 and 1977, (*Freight Commodity Statistics of Class I Motor Carriers*) but has long since discontinued the series. After the rail industry was deregulated in 1980, the Association of American Railroads took over (from the ICC) publication of *Freight Commodity Statistics-Class I Railroads* (although the ICC still collects the data). Thus there is continuous time series, commodity specific tonnage and revenue data for railroads. Therefore if the markets selected for estimation are dominated by rail and truck, and rail tonnage can be measured, the remainder is motor carrier tonnage.

The impact of the Motor Carrier Act of 1980 and the Surface Transportation Assistance Act of 1982 is estimated with the following time series regression model.[1]

$$(1)\quad RS_i = a + b_1 PR^{-1} + b_2 I + b_3 STAA82 + b_4 MCA801 + b_5 MCA802 + b_6 MCA803 + b_7 MCA804 + b_8 MCA805 + b_9 MCA806 + e$$

RS_i — rail market share of industry i
PR^{-1} — rail rate/truck rate in industry i, lagged one year
I — prime interest rate
STAA82 — index of motor carrier productivity equal to the average cubic capacity of truck trailers
MCA801 — dummy variable measuring the effect of the Motor Carrier Act of 1980 in 1981; variable has a value of 1.0 in 1981; 0 in other years
MCA802 — dummy variable measuring the effect of the Motor Carrier Act of 1980 in 1982. Variable has a value of 1.0 in 1982; 0 in other years
MCA803 — dummy variable measuring the effect of the Motor Carrier Act of 1980 in 1983. Variable has a value of 1.0 in 1983; 0 in other years
MCA804 — dummy variable measuring the effect of the Motor Carrier Act of 1980 in 1984. Variable has a value of 1.0 in 1984; 0 in other years
MCA805 — dummy variable measuring the effect of the Motor Carrier Act of 1980 in 1985. Variable has a value of 1.0 in 1985; 0 in other years
MCA806 — dummy variable measuring the effect of the Motor Carrier Act of 1980 in 1986. Variable has a value of 1.0 in 1986; 0 in other years
e — disturbance term

In this model, market shares are *not* measured in percentage terms; e.g. railroads have 30% of the market. This is because we don't know what total truck tonnage is for any of the years in the sample (1964-1986). Assuming that all output is shipped from point of production to point of

consumption, then industrial output can be assumed to represent the total transport market for a given commodity. To get a measure of the total market for a given commodity, rail tonnage is "normalized" by industrial production. For example suppose rail tonnage of chemicals is 100 million tons in 1980. In 1981, assume industrial production of chemicals increases 5%. If railroad tonnage increases 5% to 105 million tons, railroads have kept their share of the market. But suppose rail tonnage of chemicals turns out to be only 100 million tons, though a constant rail share is 105 million tons. If trucks are the only other mode in the market, they must have the 5 million tons. Motor carriers have obtained all of the railroads' tonnage that would have resulted from growth in the transport market (industrial output). Thus motor carriers have increased their share of the market. The diversion of market share (tonnage) from rail to truck is obtained as follows:

[Constant Rail Market Share Tonnage (105 million tons)]— [Actual Rail Tonnage (100 million tons)] = Truck Tonnage Gain (5 million tons).

This all depends on the assumption that rail and truck account for all the tonnage in the market.

Railroad market share for each industry is the ratio of rail tonnage to the index of industrial production. The indexes are those compiled by the Federal Reserve Board for various commodities. If rail tonnage is increasing at the same rate as industrial output, the rail market share is assumed to remain constant. If rail tonnage increases at a faster (slower) rate than industry output, rail market share increases (decreases).

Rail rates are proxied by revenue per ton of originated rail freight.[2] Motor carrier rates are approximated by an index of revenue per ton mile of originated truck traffic.[3] Relative modal rates in equation (1) are lagged since it takes time for shippers to react to changes in the transport market. It takes time to perceive that a change has occurred (recognition lag). Uncertainty about the significance or permanence of the change allows more time to elapse. Convinced of the importance of the change, shippers analyze the financial impact of changing modes (decision lag). Some new investment in facilities may be required. Finally, a new carrier must be selected.

Interest rates are inversely related to rail market share. This is because the cost of a particular mode depends not only on the rate charged but also the inventory costs associated with it. As interest rates increase, the inventory costs entailed in rail transportation increase compared to motor carriers. As a result, the full transportation price of railroads increases relative to trucking, and shippers switch to motor carriers.

There are two reasons why the inventory costs associated with railroads increase as interest rates increase. In general, railroad delivery time is slower than trucking so goods spend a longer time in transit. As a result, the shipper's interest costs are higher. Other things equal, an increase in interest rates will increase this disadvantage of railroads and shift traffic to motor carriers. Also, interest is a direct cost of inventory holding. Thus, as interest rates increase, firms reduce the average size of inventory to reduce costs. This will lead to a reduction in average order size. Since the minimum truck rate is reached at roughly one fourth the shipment size of rail, firms will switch to motor carriers to reduce inventory costs.

The Surface Transportation Assistance Act of 1982 enabled motor carriers to achieve significant productivity increases. This is due to substantial increases in permissible truck trailer length and width as well as the use of double 28 foot trailers on interstate highways. The productivity increases are measured by an index of the cubic capacity of the average truck trailer in a given year. Cubic capacity increased throughout the sample period (1964–1986) but began increasing at a faster rate after 1982. Since the average life of a truck trailer is seven years, the full impact of the 1982 policy change has not yet occurred.

The Motor Carrier Act of 1980 enhanced competition within the trucking industry and between motor carriers and railroads. Free entry, restrictions on motor carrier rate bureaus, and greater flexibility with respect to rates, routes, and commodities carried have all put downward pressure on motor carrier rates. These factors have had a negative impact on rail market share. The impact of the Motor Carrier Act is measured by a series of dummy variables, one for each of the years 1981 to 1986. Each of the dummies has a value of 1.0 for the year it represents and 0 in all other years.[4]

The expected sign of each independent variable in equation (1) is negative. A rise in rail rates relative to motor carrier rates will reduce rail market share. The negative impact on rail market share of high interest rates and post-1980 motor carrier policy have been discussed above.

Model to Measure the Effect of Anti-lock Brake Systems

As noted above, the Truck and Bus Safety Act may have the effect of requiring trucks to be equipped with anti-lock brake systems. These systems were imposed on the trucking industry in the 1970's. In 1973 NHTSA announced Federal Motor Vehicle Safety Standard Number 121 [FMVSS-121]. In effect it required anti-lock brake systems for trucks, truck trailers, and buses. The regulation took effect on January 1, 1975. The potential effect of the current legislation can be measured by assuming the motor carrier industry reacts in the same manner as it did to FMVSS-121.

The model is the following time series regression equation.[5]

$$(2)\quad USTS = a + b_1 I^{-1} + b_2 BFI + b_3 D + e$$

USTS — U.S. total truck trailer shipments
I^{-1} — Prime interest rate, lagged one year
BFI — Business fixed investment in 1982 dollars
D — Dummy variable equal to 1.0 in 1974; 0 in all other years
e — Disturbance term

The model recognizes that truck trailers are an expensive capital good. Like nearly all capital goods, purchase is financed by borrowing. Thus

the timing of trailer purchases will be heavily influenced by the cost of money. A rise in interest rates will have a negative effect on truck trailer sales. Trailers represent a substantial equipment investment for motor carriers. Thus trailer sales are affected by the same factors that determine all business investment. Firms increase investment when they are confident about the economy. Conversely when the economy is in recession, business investment plunges. This is because equipment is durable and purchases of new equipment can be postponed. Thus trailer sales and business fixed investment are positively related. The 1974 dummy variable represents the induced "pre buy" of truck trailers to avoid the costs of trailers equipped with anti-lock brakes (all those purchased after January 1, 1975).

Model to Measure the Effect of the Surface Transportation Assistance Act of 1982 on Truck Trailer Shipments

The 1982 policy change increased the permissible length of van trailers from 45 to 48 feet and width from 96 to 102 inches. The impact of this change is measured by the following time series regression model.[6]

$$(3)\quad USVS = a + b_1 I^{-1} + b_2 BFI + b_3 D + e$$

USVS — Total annual shipments of van truck trailers
I^{-1} — Prime interest rate, lagged one year
BFI — Business fixed investment in 1982 dollars
D — Dummy variable equal to 1 in 1984 and 0 in other years
e — Disturbance term

The model in equation (3) recognizes that the policy change primarily affects sales of van trailers. The rationale for including interest rates and business fixed investment in equation (3) is the same as for equation (2). The policy change is expected to destabilize sales of van trailers. After passage of the 1982 act, motor carriers would postpone equipment acquisitions until supplies of the larger equipment become available. Thus 1983 sales should be well below normal, followed by a surge in demand in 1984 and below normal sales in 1985–86. This effect is measured by the dummy variable.

EMPIRICAL RESULTS OF THE MODELS

The model in equation (1) is estimated with annual data for the 1964–86 time period and for the following transport markets.[7]

Food Products (20)
Lumber and Wood Products (24)
Pulp and Paper Products (26)

As noted above, the model in equation (1) can only be applied to markets where rail and truck market shares exhaust the total market. This is one of the main reasons for selecting the above manufactured goods markets. According to the *1977 Census of Transportation*, rail and truck account for 94.3% of the ton miles of Food Products (20); 97% of the Lumber and Wood Products (24); and 98.7% of the Paper Products (26).[8] These commodities were also selected because they account for a significant part of the traffic base of both modes.

The two digit SIC industries above are aggregations of markets with very similar but somewhat different products. Thus the empirical results for the two digit industries may not apply equally to all the three digit submarkets.

These potential submarket differences are perhaps greatest for Food Products (20). To demonstrate the applicability of the model to all types of manufactured products, equation (1) is also estimated for two contrasting food products. These are:

Preserved Fruits and Vegetables (203)
Grain Mill Products (204)

The estimated equations are displayed in Table 1. In all the equations, the independent variables have the theoretically expected sign and are statistically significant at the .01 level. The interest rate was not significant in any of the equations and was dropped from the analysis.[9] The equations have an excellent fit and there is no significant serial correlation.

Equation (2) is estimated with annual data over the 1960–1975 period.

$$(4)\quad USTS = -15272.4 - 9825.2\ I^{-1}* \quad (6.25)$$
$$+738.8\ BFI* \quad (12.97) \quad + 68897.9\ D* \quad (6.81)$$
$$R^2\ .96 \qquad DW\ 1.25$$

*significant at .01 level
t statistics in parentheses

All the independent variables in equation (4) have the theoretically expected sign and are statistically significant at the .01 level. The fit of the equation is very good and there is no significant serial correlation. The coefficient of the 1974 dummy variable is 68898. This means that motor carriers "pre bought" almost 69 thousand trailers in 1974 to avoid the costs of the FMVSS-121 regulation. Total truck trailer sales in 1974 were 209609. Thus the "pre buy" effect was 32.9% of total trailer sales.

Equation (3) is estimated with annual data over the 1970–86 period.

$$(5)\quad USVS = 60147 - 4485.3\ I^{-1} + 181.6\ BFI* \quad (5.13) \quad (3.71)$$
$$+33313.3\ D* \quad (6.17)$$
$$R^2\ .91 \qquad DW\ 2.44$$

*significant at the .01 level
t statistics in parentheses

All of the independent variables have the expected sign and are statistically significant at the .01 level. The equation has a good fit and there is no significant serial correlation. The coefficient of the 1984 dummy variable is 33313. Total van sales in 1984 were 159,931. Thus 20.8% of 1984 van sales can be attributed to the larger trailers permitted by the Surface Transportation Assistance Act.

TABLE 1

Truck-Rail Market Share Equations-Selected Markets

Food Products (20)

RS 20 − 317.9 − 13.14 PR^{-1}** − 21.9 STAA82** − 3.37 MCA801
(7.49) (7.34) (.83)
− .52 MCA802 − 16.23 MCA803** − 38.18 MCA804**
(.12) (3.64) (6.86)
− 32.96 MCA805** − 45.0 MCA806**
(5.59) (6.18)
R^2 .99 DW 1.86

Lumber and Wood Products (24)

RS 24 = 274.0 − 15.14 PR^{-1}** − 17.95 STAA82**
(5.83) (6.71)
− 13.94 MCA801** − 23.11 MCA802**
(2.49) (3.83)
− 30.65 MCA803** − 32.38 MCA804**
(4.87) (5.32)
− 29.51 MCA805** − 33.83 MCA806**
(4.70) (5.37)
R^2 .97 DW 1.49

Paper Products (26)

RS 26 = 113.7 − 3.21 PR^{-1}** − 7.02 STAA82**
(5.30) (6.99)
− 1.71 MCA801 − 2.73 MCA802 − 3.21 MCA803**
(.92) (1.39) (1.56)
− 7.24 MCA804** − 6.74 MCA805**
(3.57) (3.17)
− 13.38 MCA806**
(5.64)
R^2 .98 DW 2.44

Fruits & Vegetables (203)

RS 203 = 45.65 − 1.33PR^{-1}** − 2.42 STAA82** − 1.08 MCA801
(5.25) (2.70) (.75)
− 1.21 MCA802 − 3.96 MCA803* − 7.56 MCA804**
(.80) (2.45) (4.10)
− 6.54 MCA805** − 8.02 MCA806**
(3.44) (3.90)
R^2 .96 DW 1.62

Grain Mill Products (204)

RS 204 = 87.21 − 3.1 PR^{-1}** − 7.12 STAA82** − 4.61 MCA801**
(7.05) (5.88) (3.87)
− .30 MCA802 − 5.5 MCA803** − 10.63 MCA804**
(.23) (4.27) (7.22)
− 9.46 MCA805** − 11.7 MCA806**
(5.78) (5.94)
R^2 .99 DW 1.44

*significant at .05 level
**significant at .01 level
t statistics in parentheses

IMPACT OF POST 1980 MOTOR CARRIER POLICY

Motor carrier market share gains (railroad losses) in 1985 are measured employing the estimated equations in Table 1. The first step in the process is to compute 1980 Constant Rail Market Share tonnage for 1985. This is obtained by increasing 1980 rail tonnage in each market by the change in industrial production in those markets during the 1980–85 period. As noted above, if railroad tonnage increases at the same rate as industry output, it can be reasonably assumed that railroad market share (and motor carrier share) is unchanged.

The second step is to compare 1980 Constant Rail Market Share tonnage for 1985 to actual rail tonnage in 1985. As Table 2 indicates, railroads lost an estimated 32.5 million tons of Food Products (20) to motor carriers in 1985. Estimated 1985 losses for Lumber and Wood Products (24) and Pulp and Paper Products (26) are 42.4 and 12.3 million tons respectively.

The tonnage loss for Preserved Fruits and Vegetables (203) was 6.8 million tons. The corresponding figure for Grain Mill Products (204) was 12.9 million tons.

The next step is to determine the motor carrier tonnage gains (rail losses) due to various causes. This can be accomplished by using Food Products (20) as an example. Total 1985 tonnage diversion is 32.5 million tons. The coefficients of MCA804, MCA805 and MCA806 are 38.2, 33.0, and 45.0 respectively (see Table 1). These coefficients are averaged to smooth out variation not consistent with actual market conditions. Thus 38.7 million tons were diverted from rail to motor carrier in 1985 as a result of MCA80.

The impact of the Surface Transportation Assistance Act of 1982 (STAA82) on motor carrier market share of Food Products (20) is measured in the following manner:

(1) The coefficient of STAA82 for Food Products (20) is 21.9 (see Table 1). This coefficient is multiplied by the index value of average truck trailer cubic capacity in 1980 (2.848).
(2) Same as (1) only the coefficient is multiplied by the 1985 index value. (3.499)
(3) (1) is subtracted from (2).

In effect this procedure answers the question, "how much tonnage did motor carriers gain (railroads lose) in 1985 as a result of greater trailer capacity compared to the 1980 cubic capacity?" Applying the above procedure to Food Products (20), the motor carrier gain (railroad loss) resulting from STAA82 is 14.3 million tons.

Rail and motor carrier prices declined during the 1980–85 period. However rail rates declined relative to truck rates. This effect is measured as follows:

(1) The coefficient of relative modal prices for Food Products (20) is 13.1 (see Table 1). This coefficient is multiplied by the 1979 value of relative modal prices.[10]
(2) Same as (1) except the coefficient is multiplied by the 1984 value of relative modal rates which affects 1985 tonnage.
(3) (1) is subtracted from (2).

This procedure answers the question "what is the effect on railroad motor carrier tonnage of the relative decline in rail rates?" The answer is 23 million more tons for railroads.

Adding all these impacts (MCA80, STAA82,

TABLE 2

Impact of Post 1980 Motor Carrier Policy on Railroad-Motor Carrier Market Shares[1] Selected Manufactures Markets (Tonnage in Millions)

Commodity	(1) 1985 Actual Rail Tonnage	(2) 1980 Constant Market Share Tonnage[2]	(3) 1985 Tonnage Lost to Motor Carriers[3]	(4) Motor Carrier Act of 1980	(5) Surface Transport Assistance Act—1982	(6) Relative Price Change	(7) Other
Products (20)	73.5	106.0	−32.5	−38.7	−14.3	23.0	−2.5
Lumber & Wood Products (24)	63.2	105.6	-42.4	-31.9	-11.7	2.9	-1.7
Pulp & Paper Products (26)	36.2	48.5	-12.3	-9.1	-4.6	1.9	-0.5
Preserved Fruits & Vegetables (203)	5.1	11.9	-6.8	-7.4	-1.6	3.5	-1.3
Grain Mill Products (204)	29.2	42.1	-12.9	-10.6	-4.6	3.2	-0.9

[1]Figures in columns (4) through (7) are in terms of impacts on railroads. Hence for Food Products (20), railroads lost 38.7 million tons to motor carriers as a result of the Motor Carrier Act of 1980.
[2]Tonnage railroads would have in 1985 if they had maintained the market share they had in 1980.
[3]1985 actual railroad tonnage minus 1980 Constant Rail Market Share tonnage.

Source: (Actual Rail Tonnage) Association of American Railroads, *Freight Commodity Statistics of Class I Railroads 1985*.

Relative Rates, Other) together results in a motor carrier net gain (rail loss) of 32.5 million tons of Food Products (20) in 1985. The same procedures are followed to estimate the impacts on Lumber and Wood Products (24) and Pulp and Paper Products (26). Table 2 indicates 1985 motor carrier gains (rail losses) of 31.9 and 9.1 million tons respectively due to MCA80. The increased cubic capacity permitted by STAA82 produced additional motor carrier gains (rail losses) of 11.7 and 4.6 million tons. Motor carrier losses (rail gains) due to relative rail rate declines were comparatively small in both markets.

Railroads lost 6.8 million tons of Preserved Fruits and Vegetables (203) to motor carriers in 1985. Most of this was due to the Motor Carrier Act of 1980 which caused an estimated loss of 7.4 million tons. The imapct of STAA82 was comparatively small, accounting for a loss of 1.6 million tons. These losses were partially offset by a relative decline in rail rates which produced a gain of 3.5 million tons.

The 1985 railroad loss (motor carrier gain) in the Grain Mill Products (204) market is estimated at 12.9 milllion tons. Most of this is attributable to the Motor Carrier Act of 1980 (10.6 million tons). The productivity gains of motor carriers due to STAA82 produced an additional loss, estimated at 4.6 million tons. These railroad losses were partially offset by a relative decline in rail rates which resulted in a railroad gain of 3.2 million tons.

POTENTIAL IMPACT OF ANTI-LOCK BRAKES REQUIREMENT

As noted previously, the Truck and Bus Safety Act may have the effect of requiring trucks to be equipped with anti-lock brakes. A similar regulation that took effect on January 1, 1975 triggered an enormous "pre-buy" of nearly 69 thousand trailers. When the 1975 recession hit, motor carriers were burdened with excess capacity. Many firms went bankrupt. Others had to sell new equipment on the used equipment market at fire sale prices. Motor vehicle manufacturers saw sales plunge from 209,609 trailers in 1974 to only 77,796 in 1975, nearly a 63% decline. No industry can absorb such a sales decline and many firms were pushed into bankruptcy, others merged to survive. If anti-lock brakes are imposed on the trucking industry again, there is no reason to expect that history won't repeat itself.

EFFECT OF STAA82 ON MOTOR VEHICLE MANUFACTURERS

The motor vehicle manufacturers were also whipsawed by the STAA82. After the law was passed, motor carriers postponed new equipment purchases, waiting for the new larger vehicles. Thus 1983 sales were artifically reduced (only 83375) and 1984 sales artifically increased (159931). As the above analysis indicates, 1984 van sales were 33 thousand higher as a result of STAA82. Van sales then declined to only 126,668 in 1985, a 20.8% decline.

RAILROAD COMPETITIVE PRICING RESPONSE

An examination of Table 2 raises an obvious question. How much of a rail price decrease (relative to motor carriers) would be necessary to avoid the 1985 market share losses? Of course, this is an elasticity question. The Motor Carrier Act of 1980 and STAA82 have affected the rail-truck competitive relationship in many ways. Entry decontrol and increasing truck trailer size have obvious price implications. Thus, the relative price variable may embody these factors as well as all the other supply and demand factors that determine relative rates. In order to reduce this potential bias, relative price elasticities are estimated over the 1964–81 period (instead of 1964–86) in order to mitigate the potential effect of post-1980 motor carrier policy. The resulting estimated relative modal price elasticities are as follows:

Food Products (20)	-2.18
Lumber and Wood Products (24)	-1.43
Pulp and Paper Products (26)	-1.72
Preserved Fruits and Vegetables (203)	-2.61
Grain Mill Products (204)	-1.66

With these elasticities available, it is a straightforward exercise to calculate the necessary price changes. Again, Food Products (20) is used to illustrate the calculation. Table 2 indicates that railroads would have preserved their 1980 market share with 106 million tons in 1985 rather than the actual tonnage of 73.5 million tons. Thus, the required percentage change in Food Products (20) tonnage is 44.2%. Given this and a price elasticity of -2.18, the required relative rail price reduction is 20.3%. The corresponding relative rate cuts for Lumber and Wood Products (24) and Pulp and Paper Products (26) are 46.9% and 19.8% respectively. Since demand is price elastic, these relative rate reductions would not only restore lost market share but raise revenues as well.

In the Preserved Fruits & Vegetables (203) market, railroads would have preserved their 1980 market share with 11.9 million tons in 1985. However actual 1985 tonnage was only 5.1 million tons (see Table 2). To achieve 1980 market share, railroads need 6.8 million additional tons above actual 1985 performance. This amounts to a 133% increase [(11.9/5.1)-1 x 100]. With an estimated price elasticity of -2.61, this would require a 51.1% relative price reduction. A similar anlaysis for Grain Mill Products (204) yields a price cut of 26.6%.

The railroad price cuts are reductions relative to truck rates. This assumes motor carriers are either unwilling or unable to match the railroad price changes. There is ample theoretical support for this assumption. Railroads have many characteristics that are consistent with differential pricing. These include a high percentage of fixed costs, potential excess capacity, a wide variety of commodities in the traffic base (with different elasticities) and they serve large regions. Conversely motor carriers have a very high percentage of variable costs which limits the ability to differential price. In other words, motor carriers can't reduce price very much below fully allocated costs before reaching variable cost. This

limits the ability of motor carriers to match large railroad rate reductions."

CONCLUSION

This paper has demonstrated that public policy has a significant impact on the competitive balance between motor carriers and railroads. Many analysts have made this point, but very few have attempted to measure the impacts. This paper partially fills a large void in this important area. Today's transportation managers confront two important realities. First, market forces determine profitability and market share. Second, public policy profoundly affects market forces. Thus public policies have to be constantly monitored, measured and explicitly incorporated in the firm's strategic planning process.

REFERENCES

Babcock, M. W. and H. W. German, "Forecast of Water Carrier Demand to 1985," *Proceedings of the Transportation Research Forum—1983*, Vol. XXIV, No. 1, pp. 249–57.

_____, "The Impact of Deregulation on Rail TOFC Carloadings," *The Logistics and Transportation Review* Vol. 20, No. 3, 1984, pp. 205–212.

_____, "Impact of Transportation Policy on Intermodal Competition," *Proceedings of the Transportation Research Forum—1986*, Vol. XXVII, No. 1, pp. 281–88.

Baker, G. H., "Strategic Planning for the Transportation Firm," *Proceedings of the Transportation Research Forum—1985*, Vol. XXVI, No. 1, pp. 527–530.

Cunningham, L. F. and R. P. Khandekar, "Airline Managerial Strategy During the Era of Regulation and Regulatory Reform," *Proceedings of the Transportation Research Forum— 1985*, Vol. XXVI, No. 1, pp. 531–539.

German, H. W., "Anti-Locking Brake Systems: The Impact of Public Safety Standards on the Demand for Truck Trailers," *Proceedings of the Transportation Research Forum—1977*, Vol. XVIII, No. 1

German, H. W. and M. W. Babcock, "The Impact of Rail Deregulation on the Movement of Fresh Fruits and Vegetables," *Logistics and Transportation Review*, Vol. 18/4 December 1982, pp. 373–384.

_____, "The Impact of Monetary Policy on Motor Carrier Equipment Demand," *Proceedings of the Transportation Research Forum—1983*, Vol. XXIV, No. 1, pp. 266–72.

_____, "Impact of Interest Rates on Rail Market Shares in the Intercity Freight Markets," *Journal of Economics*, Vol. IX, 1983, pp. 30–35.

Grimm, C. M. and K. C. Smith, "Impact of Deregulation on Railroad Strategies and Performance," *Proceedings of the Transportation Research Forum—1985*, Vol. XXVI, No. 1, pp. 540–544.

Roberts, P. O. and J. S. Mehring, "Transport Management: Strategies for a New Environment," *Proceedings of the Transportation Research Forum—1985*, Vol. XXVI, No. 1, pp. 545–553.

Walters, T. C., "Market Oriented Strategic Management for Motor Carriers," *Proceedings of the Transportation Research Forum—1985*, Vol. XXVI, No. 1, pp. 554–558.

ENDNOTES

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1. Data sources for the variables are as follows:

   RS — Rail tonnage for 1965–80 obtained from Interstate Commerce Commission, FREIGHT COMMODITY STATISTICS OF CLASS I RAILROADS. 1981–86 data published by Association of American Railroads. Industrial production indexes obtained from Board of Governors of the Federal Reserve System, FEDERAL RESERVE BULLETIN.

   PR — Data to determine 1965–1980 rail rates obtained from Interstate Commerce Commission, FREIGHT COMMODITY STATISTICS OF CLASS I RAILROADS. 1981–86 data published by Association of American Railroads. Motor carrier rate index from Transportation Policy Associates, TRANSPORTATION IN AMERICA, various issues. Motor carriers in the index are Class I common carriers of general freight (primiarily LTL carriers).

   I — U.S. Department of Commerce, BUSINESS CONDITIONS DIGEST.

   STAA82 — Motor Vehicle Manufactures Association.

2. Rail rates may be somewhat overstated for the 1981–86 period since the *Freight Commodity Statistics* data does not include rail/shipper contract rates which are confidential and lower than tariff rates.

3. No motor carrier rate data is available on a commodity specific basis. The only time series measure available is revenue per ton mile for all U.S. traffic. This is probably not a serious problem. Motor carriers have a high percentage of variable costs which limits use of differential pricing by commodity.

   Motor carriers in the rate index compiled by Transportation Policy Associates are Class I common carriers of general freight which are primarily LTL carriers. Many of the motor carriers competing with railroads are truckload carriers. Whether this results in a bias in

rates depends on differentials in rate *trends* beween LTL and TL carriers. The correlation coefficient of LTL and TL revenue per ton mile during the 1976-1987 period is .986. TL data is not used because the smaller number observations (relative to LTL) results in a degrees of freedom problem for the regression models in this study. Data to compute the correlation coefficient was obtained from *Transportation in America*, 1988 and *Transportation in America, Historical Compendium 1939–1985*.

4. Of course one can't be certain that the dummy variables exclusively measure the impact of the Motor Carrier Act. They could be measuring other factors. However all factors affecting carrier costs are reflected in the relative modal rate variable. The primary impact of the Staggers Act has been rail rate changes. Interest rates are explicitly in- corporated in the model. By 1980 the interstate highway system was substantially complete, exerting no additional downward pressure (at the margin) on rail traffic. Changes in motor carrier productivity due to increased capacity made possible by STAA82 are explicitly measured by the model. The Motor Carrier Act intensified intramodal and intermodal competition in many ways and was the first fundamental change in federal motor carrier policy since 1935. The model without the dummy variables leaves a great deal of rail tonnage unexplained. A time trend could be used instead of dummy variables. However time trends have the same weakness (i.e. what do they really measure?).
5. Data sources for the variables are as follows:
   USTS — U.S. Department of Commerce, Bureau of the Census *Current Industrial Reports, Truck Trailers*, M37L.
   I^{-1} — U.S. Department of Commerce, *Business Conditions Digest*.
   BFI — U.S. Department of Commerce, *Survey of Current Business*.
6. Data sources for the variables are as follows:
   USVS — see USTS, footnote 2.
   I^{-1} — see footnote 2.
   BFI — U.S. Department of Commerce, Bureau of Economic Analysis, *Business Statistics*, 1986, p. 228.
7. Numbers in parentheses are STCC numbers.
8. U.S. Department of Commerce, Bureau of the Census, *1977 Census of Transportation, Commodity Transportation Survey, Summary, Table 2*.
9. The non-significance of the interest rate is most likely due to multicollinearity with the other independent variables. The interest rate has been found to be highly significant in rail demand models estimated with different independent variables and for different time intervals. For example see Wade German and Michael Babcock, "Impact of Interest Rates on Rail Market Shares in the Intercity Freight Markets," JOURNAL OF ECONOMICS, (Missouri Valley Economics Association) Vol. IX, 1983, p. 30.
10. The 1979 value of relative rates is used since this variable is lagged one year (i.e., 1979 relative rates determine 1980 tonnage).
11. See Harper, D. W. *Transportation in America*, second edition, p. 252.