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DIFFERENTIAL EFFECTS RAIL DEREGULATION IN THE U.S. GRAIN INDUSTRY

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ABSTRACT

The efficiency benefits of U.S. rail industry deregulation are well documented in previous studies of rail productivity and declining rail rates. This research provides new insight regarding the accrual of these benefits within the grain industry. A disaggregate study of corn, wheat, and soybean rates across nine producing regions, shows that in recent years the railroads ability to differentiate markets based on competitive environment has shifted relatively more of the benefit to regions with the most competitive market environments. Regions with less competitive pressure will continue to be relatively more disadvantaged in the rates that are an important determinant in grain market flows and producer profitability if these trends continue.

INTRODUCTION

Railroad deregulation in the United States has been successful in a macroeconomic context. Studies have shown that increased productivity, decreased rates, and increased profitability in the rail industry can be attributed to deregulation (Barnekov and Kleit, 1990; Wilson, 1992; Burton, 1993; Dennis 2000). While evidence suggests that benefits have been shared by shippers, in terms such as rail viability, rate savings, and service, the degree to which these benefits have accrued equitably across shippers and industries has been given sparing consideration. Given the increasing level of competition associated with globalized markets, it may be especially important to understand these differentials, or unintended consequences, in projecting the effects of future investments and policies. The following research investigates how incremental market adjustments, resulting from changes in institutional parameters, can affect relative product valuation over time.

EMPIRICAL MODEL

A time-series cross sectional analysis of grain rail rates is estimated using the Surface

Transportation Board *Annual Rail Waybill Sample, Master File* for the period 1981-2000.[1,2] The following mathematical representation of rail rates defines the model used in the regression analysis performed for this research. The single dependent variable included in all analysis is revenue per ton-mile (also referred to as "rate"). The base model is:

$$\begin{aligned}\ln RPTM = {} & \beta_0 + \beta_1 \ln CARS + \beta_2 \ln SHRT + \beta_3 \ln LOAD + \beta_4 \ln HERF + \beta_5 BDIST + \\ & \beta_6 \ln GPROD + \beta_7 TRANS + \beta_8 TIME + \beta_9 TIMESQ \\ & \beta_{10} \ln TBDIST + \beta_{11} \ln THERF + \beta_{12} NE + \beta_{13} SE + \beta_{14} DE + \\ & \beta_{15} NP + \beta_{16} CP + \beta_{17} SP + \beta_{18} WCB + \beta_{19} PNW + \beta_{20} WEST + \beta_{21} TNE + \\ & \beta_{22} TSE + \beta_{23} TDE + \beta_{24} TNP + \beta_{25} TCP + \beta_{26} TSP + \beta_{27} TWCB + \\ & \beta_{28} TPNW + \beta_{29} TWEST + \beta_{30} MULTI + \beta_{31} UNIT + \beta_{32} SHUTTLE + \\ & \beta_{33} CORN + \beta_{34} SYBN + \beta_{35} TCORN + \beta_{36} TSYBN + \\ & \beta_{37} TSQCORN + \beta_{38} TSQSYBN + \beta_{39} Q2 + \beta_{40} Q3 + \beta_{41} Q4 + \mu + \gamma + \varepsilon\end{aligned}$$

where,

RPTM	=	revenue per ton-mile
CARS	=	number of railcars in the shipment
SHRT	=	length of haul, in short-line miles
LOAD	=	load weight per railcar
HERF	=	rail market concentration index
BDIS	=	distance from nearest barge loading facility
GPROD	=	total U.S. grain production
TRANS	=	transit shipment, identifier for length of haul under 50 miles
TBDIST	=	time and barge distance interaction term
THERF	=	time and rail market concentration interaction term
TIME	=	time trend, year of shipment
TIMESQ	=	squared time trend
NE	=	Northeast Region (Connecticut, Delaware, District of Columbia,

[1]Formally known as the Interstate Commerce Commission (ICC).

[2]Initial attempts were made to extend the scope of the study by including the *Annual Rail Waybill Sample, Master File* from 1972 through 2000. After considering cautionary remarks from the Surface Transportation Board and conducting a review of this data, it was determined that the reliability was not satisfactory in years prior to 1981.

		Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, West Virginia)
SE	=	Southeast Region (Alabama, Florida, Georgia, Kentucky, North Carolina, South Carolina, Tennessee)
DE	=	Delta Region (Arkansas, Louisiana, Mississippi)
NP	=	Northern Plains Region (Montana, North Dakota, South Dakota, Wyoming)
CP	=	Central Plains Region (Colorado, Kansas, and Nebraska)
SP	=	Southern Plain Region (New Mexico, Oklahoma, and Texas)
WCB	=	Western Corn Belt Region (Iowa, Minnesota, Missouri)
PNW	=	Pacific Northwest Region (Idaho, Oregon, Washington)
W	=	West Region (California, Nevada, Utah)
MULTI	=	multi-car train shipment, includes 24 to 49 cars
UNIT	=	unit train shipment, includes 50 to 109 cars
SHUTTLE	=	shuttle train shipment, includes 110 cars or more
CORN	=	commodity identifier for corn shipment
SYBN	=	commodity identifier for soybean shipment
Q2	=	cyclical indicator, 2nd quarter shipment period (April through June)
Q3	=	cyclical indicator, 3rd quarter shipment period (July through September)
Q4	=	cyclical indicator, 4th quarter shipment period (October through December)
TSQCORN	=	time-squared interaction term for corn shipment
TSQSYBN	=	time-squared interaction term for soybean shipment
T#####	=	time interaction term for associated variable A######@, including region and commodity
μ	=	Regional Effects Error Term
γ	=	Time Effects Error Term
ε	=	Normal Effects Error Term

The operating and supply characteristics included in the model are shipment train size (CARS), shipment distance (SHRT), and carload density (LOAD). These factors are indicative of railroad efficiency and productivity gains over time. Measures of intra- and intermodal competition are considered as the influential factors in the relative elasticity of grain rail service demand. Representation of modal competition includes distance barge facility (BDIST) and local rail competition (HERF) as inter- and intramodal measures, respectively. The spatial and time influences on demand elasticity are considered in several terms in the models. Underlying spatial

variability in demand elasticity is accounted for by including regional groupings of rail origins. The regional definition used by USDA Transportation and Marketing defines nine regions, including Central Plains, Delta, Eastern Corn Belt, Northeast, Northern Plains, Pacific Northwest, Southeast, Southern Plains, West, and Western Corn Belt. The regions are based on similarities in agricultural production characteristics. The regions have been used in previous analysis and are useful in commodity- and geographic-based discussions of market phenomena. The underlying time trend is established by TIME, in the year-to-year trend for rail revenue per ton-mile. To better fit the decreasing rate of rate saving in more recent years, the squared time variable (TSQUARE) is included in the model. TIME is expected to be inversely related to revenue per ton-mile, as the rail industry has had greater pricing flexibility in the deregulated environment.

Interaction of time and selected variables allows delineation of differences in change or rates of change across competitive factors, space, and time. Several interaction terms were included to allow an assessment of the differing impacts of deregulation as a result of differing levels of transportation competition over time. The first two interaction terms, THERF and TBDIST, are indicators of a change in the effects of intramodal and intermodal influences on rail rates over time, respectively. THERF is expected to have a positive relationship with rail rates. It is posited that the industry has shifted from the former cost-based regulated structures to market-based differential pricing in a deregulated environment. With market-based pricing, captivity of shippers becomes more important. Therefore, over time regions with lesser degrees of rail competition (more captive) will accrue relatively less of the benefits associated with intraindustry competition.

Regional- and commodity-based time interaction terms are also included to allow for variations in change of rates over time across regions. Nine region/time interactions terms are included as T####, with A####@ referring to regional definition established with the USDA production region variables. TCORN, TSYBN, TSQCORN, and TSQSYBN, are commodity/time interaction terms with the first two variables measuring the effects of commodity differences over time, considering the commodity, and the latter two allowing for a change in the effects of time, considering the commodity, during the two decade time span of the study. The time and time-squared interaction terms may be influenced by factors such as the initial rate, competition levels, and production geography. These interaction terms are discussed in terms of expected signs but do provide important insight in discussing implications for producers of a specific commodity and producers located in a specific region.

An industry demand variable is also included to account for year-to-year variability in the market demand for rail grain transportation. The demand control variable is a measure of U.S. grain production (GPROD). It is defined as the total annual production of seven major agricultural commodities, including wheat, barley, corn, oats, sorghum, rye, and soybeans (National Agricultural Statistics Service, 2002). It is expected that the relationship between revenue per ton-mile and total grain production will be positive and inelastic, signifying that as the demand for rail shipment increases, rail rates will increase. Rail rates will increase as the demand for rail cars increases as determined by an increase in total grain production in the United States.

To measure the seasonal affects of rail rates since deregulation, three quarterly dummy variables indicate the shipment time period. Q2, Q3, and Q4 refer to the second, third, and forth

monthly quarters of the year. The variation is for seasons measured in comparison to the first quarter of the year, as it is the quarter not included in the model. The forth quarter is expected to be positive, indicating that harvest-time and post-harvest shipment volumes put upward pressure on rail service prices. The signs for quarters 2 and 3 are expected to be negative, as there are relatively lower demand levels for rail grain shipments in these quarters considering a quarter-based cycle of annual grain shipments.

Three additional dummy variables are included to delineate rail rate categories. Rail rates are published by the railroads as a single price per car from a train that ranges between a minimum and maximum number of cars. These tariff ranges are generally defined as single car, multiple car (MULTI), unit train (UNIT), and shuttle (SHUTTLE) train shipments. The strict definition of these ranges varies by railroad and commodity. For the purposes of this research, single car rates apply to rail shipments including 1 to 24 cars and multiple car shipments include 25 to 49. These shipments are generally bound for domestic origins, including processors and feedlots. The unit and shuttle shipments, which provide the greatest potential for rail and shipper economies of scale, are generally bound for export destinations. The MULTI, UNIT, and SHUTTLE control variables are included to adjust the intercept for shifts between rate ranges in the rail tariff. The variables may also be used in a general discussion of the rates for shipments destined for the domestic and export markets.

The error terms complete the definition of the empirical model. There are three error components in the model to account for the effects of error associated with normal variation, time variation, and spatial variation.

RESEARCH RESULTS

The result of the log-linear estimation of rail revenue per ton-mile between 1981 and 2000 for corn, soybeans, and wheat is presented in Table 1. Variables included in the model explain approximately 74 percent of the variation in revenue per ton-mile. The model is satisfactory, as most explanatory variables have their expected signs and most are significant at conventional levels.

In examining the parameter estimates for variables expected to influence movement costs, all have their expected signs and are significant at the one percent level. To the extent that demand side variables are accounted for in the estimation, parameter estimates on movement characteristics should reflect the influence of such characteristics on costs. The number of rail cars in a shipment and the commodity weight per car have a negative influence on rate per ton-mile, since unit costs per ton decrease with increased train weight. Similarly, multi-car, unit-train, and shuttle-train dummy variables all have negative influences on rate per ton-mile due to declines in unit costs with increased weight and due to increases in loading and switching efficiency with these larger train sizes. Short-line miles have a negative influence on rate per ton-mile due to the spreading of fixed terminal costs over longer distances.

Variables influencing the elasticity of demand for a particular rail shipment include the Herfindahl-Hirschman Index of railroad competition, the distance of the shipment origin from the

nearest water loading facility, and commodity/regional dummy variables. As expected, the Herfindahl-Hirschman Index and the distance of the shipment origin from the nearest water loading facility both have a positive influence on rate per ton-mile, suggesting a decrease in the elasticity of demand for a particular railroad shipment with less intramodal and intermodal competitive alternatives (Figure 2). Average distance of origin rail points from the nearest barge loading facility, weighted by regional volumes, are longest for wheat at 232 miles. The average distances of origin points from the nearest barge loading facilities are 91 and 92 miles for corn and soybeans, respectively.

Commodity dummy variables for corn and soybeans both have negative and statistically significant parameter estimates, suggesting lower rates for the movement of such products in comparison to wheat. These commodity dummy variables largely reflect differences in geographic and product competition among different commodities. Commodities with more substitutes and that are produced in many regions are likely to realize lower railroad rates. Since corn and soybeans have many substitutes in the feed grain market, with wide spread U.S. production, their negative signs relative to wheat are expected.

Similarly, regional dummy variables reflect differences in geographic and product competition among regions. Regions whose primary grains are also produced in adequate supply elsewhere are more likely to receive favorable rates for their shipments. In this model, all regional dummies are interpreted in relation to the Eastern Corn Belt Region (the region left for the estimation). After controlling for shipment characteristics and other competitive conditions, several regions, such as the Northern Plains, Central Plains, Southern Plains, Western Corn Belt,

and West, experienced higher rates than the Eastern Corn Belt (at least initially).[3] Other regions, such as the North East and the South East, experienced lower rates.

Table 1. Estimation of Revenue per Ton-Mile

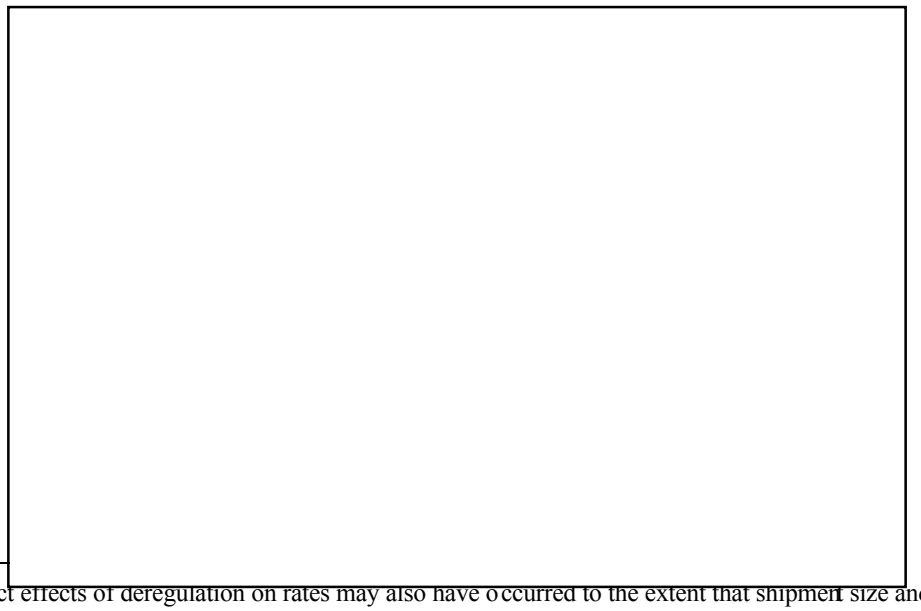
Parameter	Coefficient Estimate	Standard Error	Parameter	Coefficient Estimate	Standard Error
Intercept	2.3301*	-0.0843	South East Dummy	-0.1019*	-0.0061
Number of Rail Cars	-0.0258*	-0.0012	Delta Dummy	0.0696*	-0.0137
Short-Line Miles	-0.5120*	-0.0011	Northern Plains Dummy	0.2871*	-0.0064
Commodity Weight per Car	-0.5173*	-0.0035	Central Plains Dummy	0.2569*	-0.0049
Herfindahl-Hirschman Index	0.0788*	-0.0035	Southern Plains Dummy	0.2540*	-0.0059
Distance from Barge Facil.	0.0212*	-0.0015	Western Corn Belt Dummy	0.1600*	-0.0044
Annual Grain Production	0.0124**	-0.0051	Pacific Northwest Dummy	0.0137***	-0.008
Time	-0.0956*	-0.0011	West Dummy	0.1147*	-0.0116
$Time^2$	0.0035*	-0.00005	Time*North East Dummy	-0.0164*	-0.0012
Time*Dist from Barge Facil.	0.0018*	-0.0002	Time*South East Dummy	0.0130*	-0.0007
Time*Herfindahl-Hirshman Index	-0.0031*	-0.0004	Time*Delta Dummy	-0.0184*	-0.0014
Multi-Car Dummy	-0.0944*	-0.005	Time*Northern Plains Dummy	-0.0019*	-0.0006
Unit-Train Dummy	-0.1046*	-0.0061	Time*Central Plains Dummy	-0.0134*	-0.0005
Shuttle-Train Dummy	-0.5552*	-0.0234	Time*Southern Plains Dummy	-0.0132*	-0.0007
Corn Dummy	-0.1547*	-0.0045	Time*Western Corn Belt Dummy	-0.0151*	-0.0004
Soybean Dummy	-0.2561*	-0.0064	Time*Pacific Northwest Dummy	0.0080*	-0.0009
Time*Corn Dummy	0.0362*	-0.0011	Time*West Dummy	-0.0009	-0.0013
Time*Soybean Dummy	0.0153*	-0.0017	Quarter 2 Dummy	0.0371*	-0.0024
$Time^2$*Corn Dummy	-0.0017*	-0.00006	Quarter 3 Dummy	0.0215*	-0.0023
$Time^2$* Soybean Dummy	-0.0007*	-0.00009	Quarter 4 Dummy	0.0191*	-0.0024
North East Dummy	-0.0338**	-0.014	Short Distance Movement Dummy	0.3124*	-0.0049

Adjusted $R^2 = 0.7368$
F = 16,378; N = 239,854
*significant at the 1 percent level; **significant at the 5 percent level; ***significant at the 10 percent level
All continuous variables (except time) in natural logarithms

[3]The time effects will be discussed subsequently.

Of special interest in this estimation are the changes in rates over time. Since railroad deregulation occurred in 1980, changes in rates since 1981 provide insight into the effects that deregulation has had on rates for various shipment types. Because many variables are interacted with time in the estimation, the total effect of time on rate per ton-mile depends on the commodity shipped, the distance from the nearest water loading facility, the railroad concentration at the origin, and the region where the shipment originated.

Figure 3 shows simulated corn, soybean, and wheat rates per ton-mile when placing all variables at their mean levels for the entire period, except for time. The simulation shows the changes in rates that have occurred solely due to changes in the parameters over time. Thus, it may be thought of as simulating the direct effect of deregulation.[4] As the figure shows, while the rates per ton-mile have come down on all three commodities, their rates have converged somewhat relative to one another.



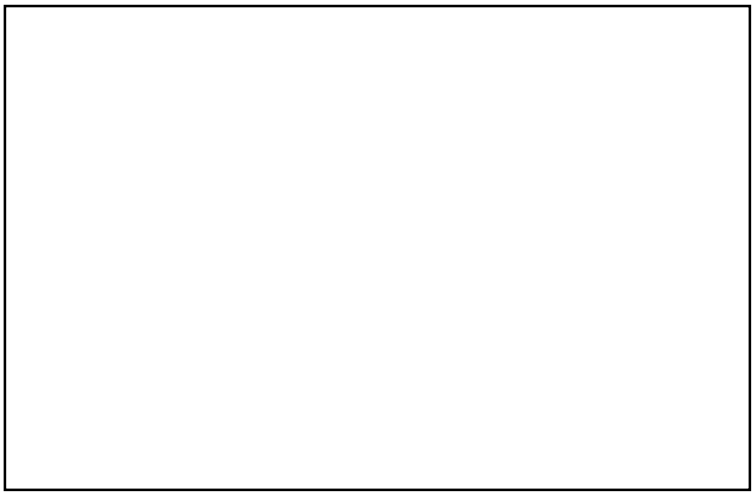
[4]Indirect effects of deregulation on rates may also have occurred to the extent that shipment size and distance changes were the result of deregulation.

As mentioned previously, the change in rates over time depends on a variety of competitive characteristics. The move to deregulation brought about an entirely new philosophy in rate determination. Rates-setting became more market-based. Consequently, an increased importance of demand elasticity variables over time is expected.

Regarding intermodal elasticity between rail and barge, the distance from the nearest barge loading facility shows an increasing importance in our estimation over time. Longer distances to barge loading facilities mean less intermodal competition considering potential truck-barge combinations. Figure 4 simulates the rate savings since 1981 at various distances from the nearest water loading facility for wheat, corn, and soybeans. As the figure shows, rate savings were larger in areas closer to barge facilities. The parameter estimate of 0.0212 suggests that as distance to the nearest water loading facility is increased by 1 percent, the rate per ton-mile increases by 0.02 percent in the initial rate period of 1981. The parameter estimate of .0018 on the time/barge distance interaction term suggests that a one percent increase in distance from the nearest water loading facility leads to a 0.055 percent increase in rate per ton-mile in 2000. Therefore, as expected, the influence of intermodal competition has strengthened during the deregulated environment.

Conversely, the parameter estimate for the time interaction with the Herfindahl Index of origin railroad concentration showed decreasing importance over time. This was not expected since an increased reliance on market factors in rate setting should also lead to increasing importance of intramodal competition. However, one possible explanation for the decreasing importance of this variable over time is truck technology and their increasing ability of trucks to compete over longer distances. If railroads compete over large geographic areas because of the

ability of trucks to haul at low costs for longer distances, the concentration of railroads in a county may be irrelevant. In addition, the role of rail competition may be diminished by increasing local market consumption, including processing, feeding, and dairy, which are often served by trucks.



2. Simulated Intermodal Barge Competition Effects on Rail Rates between 1981 and 2000

The changes in rates over time also varied among regions. Each region has a unique story with regard to the commodities produced, markets served, and transport utilized, and consequently realize different levels of geographic and product competition. Regions are characterized by differences in the availability of terminal markets, the volume and scope of agricultural processing, and movement characteristics. The following sections explore some of the characteristics of the various regions and highlight differences in rate changes that have occurred since 1981.

CONCLUSION

It is important to understand the distribution and incidence of influences associated with deregulation of rail rates. The objective of this research was to provide insight into inter- and intracommodity rail rate differentials observed since rates were deregulated in 1981. A cross-sectional/time-series analysis of U.S. corn, wheat, and soybean shipments was considered in the assessment of rail grain rate differentials. County level rail shipment characteristics for two decades were considered in the analysis. The time period selected, 1981 through 2000, covers two decades of pricing by railroads in the deregulated environment. As expected, result suggest that market-based pricing has become more prevalent in later years. The tendency for railroads to implement more market-based pricing in recent years implies that demand elasticity is becoming an increasing important factor in the relative competitiveness of U.S. grain producers.

The overall benefit of rail deregulation, measured in terms of rail productivity and decreasing in rail rates for shippers, is well established in previous research and consistent with the findings in this research. Important findings in research go beyond the macroeconomic discussion to show that these benefits are not distributed uniformly across or within commodities. Furthermore, as market-based pricing has become more prevalent the variance in distribution of benefits is shown to increasingly favor those grain producers located in regions with higher levels of intermodal competition. In a competitive market environment, trends in relative, as well as overall, rates should be considered in assessing the impacts of policy and investment initiatives. This research will help us to better understand the ultimate consequences

of future policy and investment decisions, in terms of overall and relative competitiveness of grain commodities and U.S. grain producers.

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