Transporting the Export-Bound Grain by Rail: A Study of Market Integration

Dragan Miljkovic
Post-Doctoral Fellow
Trade Research Center
Montana State University - Bozeman

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Abstract

This study addresses the issues of market integration in railroad industry analyzing the export-bound grain transportation. A spatial analysis involving four origin states (Illinois, Iowa, Minnesota and Nebraska) and two destinations (Mexican Gulf and Pacific Northwest) is conducted in order to determine if pricing practices by the same or different railroads in different regions are consistent. A system of structural equations is estimated and dynamic regression tests are conducted because of the dynamic nature of interregional trade and arbitrage activities. The results indicate that grain transportation market by rail is not perfectly integrated. This is primarily due to numerous mergers and combining of railroads that took place during the last twenty years.

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I. Introduction

Most agricultural producers in the United States believe that the lack of competition in the railroad industry in recent years has had a major effect on rail rates and service. One of the major issues arising as a product of the lack of competition in the railroad industry in the eyes of agricultural producers is substantial disparities in rail rates across different regions. For example, rates from Montana to the Pacific Northwest port of Portland are 45 percent higher per mile than rates from western and central Nebraska to the same port via the Burlington Northern & Santa Fe Railway (BNSF) (Whiteside). Producers believe that this disparity comes from the fact that BNSF has competition from the Union Pacific Southern Pacific (UPSP) out of its Nebraska origins but not out of its Montana origins.

A brief discussion of how export-bound grain is marketed in most of the United States is appropriate to illustrate how transportation impacts agriculture. Grain is usually sold by growers through local country elevators or grain-sub terminals located nearby and subsequently to merchandisers and exporters. The grain is delivered by a producer to a local elevator. The producer is given some price (*e.g.*, Gulf or Portland Grain Exchange price), less rail transportation charges, less deduction for loading, storage, and margin. Therefore, the producer foots transportation costs of moving the grain to market.

The grain producers' concern regarding the grain transportation rail rates can be summarized through the following statement. "For the producer, the cost of transporting grain can represent as much as one third the overall price received for the grain. The key to understanding the uniqueness of the producer's plight is to understand: they pay the transportation bill. In other words, a grain producer works one year out of three to pay for rail transportation." (Ralph Peck, the Director of the State of Montana Department of Agriculture).

This study addresses the issue of market integration in railroad industry for export-bound grain transportation. A spatial analysis involving four origin states (Illinois, Iowa, Minnesota and Nebraska) and two destinations (Mexican Gulf and Pacific North-West) is conducted in order to determine if pricing practices by the same or different railroads in different regions are consistent.

A number of papers during last 10-15 years dealt with the issue of grain transportation rates (*e.g.*, MacDonald; Wilson, Wilson, and Koo; McMullen, Martin, and Cabeza; Thompson, Hauser, and Coughlin; Fuller, Ruppel, and Bessler; Koo, Tolliver, and Bitzen). This paper differs from previous works because it looks at the market integration issue. In theory, the market integration refers to a measure of degree rather than a specific relationship, so regions may be more or less integrated. At one extreme are perfectly integrated markets and at the other are completely separated markets. In practice, the term market integration is often used to refer to perfect market integration. This practice has become more common as attention of researchers has focused on tests of market integration, which are, more properly, tests of perfect market integration. In the same spirit, tests conducted in this paper are tests of perfect market integration. The discussion of econometric results is complemented with a qualitative analysis targeted at the issues of "imperfect" market integration that cannot be tested econometrically.

The paper is organized as follows. Section II describes the structure of railroad industry in the United States and changes that occurred within the industry during last twenty years. Section III describes the model and data applied in this analysis. Methodology and results are presented in Section IV, while policy implications and conclusions are discussed in Section V.

II. The Railroad Industry in the United States: Background

There have been two distinct phases of railroad activities in the history of the United States: growth (expansion) phase until 1950s and merging (combining) phase after 1950s. The primary growth of railroads occurred on miles of track, expanding from 9,000 miles in 1850 to, at the height of rail plant, nearly 430,000 miles by late 1940s. Notice that the tonnage transported by railroads, interestingly enough, was at the same level in 1988 (1.4 billion tons) as it was in 1929 (Whiteside).

The concentration of the railroad industry started in the 1950s and lasted through the 1990s. It took different forms of combining: mergers, purchases, acquisitions, consolidations etc., to arrive to a point of only five class I carriers in 1997. To understand how dramatic this change was, especially during last 20 years, notice that there were 42 class I carriers in 1980. Table 1 contains major class I combinations from 1980 to 1997.

Table 1. Major Class I Combinations between 1980-1997*

Year	Railroads
1980	CSX Corp. created by merger of Chessie System Inc. and Seaboard Coast Line Industries Inc. Two subsidiaries, Chessie System Railroads and Seaboard Coast Line continued to operate separately.
1980	Burlington Northern + St. Louis-San Francisco Railway
1981	Grand Trunk Western + Detroit and Toledo Shore Line Railroad
1981	Maine Central control acquired by Guilford Transportation
1981	Burlington Northern + Colorado & Southern
1982	Burlington Northern + Fort Worth & Denver
1982	Southern Railway System + Norfolk & Western consolidated by Norfolk Southern Corp.
1982	Union Pacific + Missouri Pacific + Western Pacific [UP and MP subsidiaries operate as one railroad]
1982	CSX Corp. acquired Carolina, Clincfield & Ohio Railway
1982	Seaboard Coast Line + Louisville & Nashville Railroad = Seaboard System Railroad
1983	Grand Trunk Western + Detroit, Toledo & Ironton Railroad [DTI was acquired in 1980]
1983	Boston & Maine control acquired by Guilford Transportation
1984	Delaware & Hudson control acquired by Guilford Transportation
1985	Soo Line + Chicago, Milwaukee, St. Paul & Pacific
1986	Seaboard System Railroad changed name to CSX Transportation

Table 1. continued

Year	Railroads
1987	Chesapeake & Ohio Railway + Baltimore & Ohio Railroad
1987	CSX Transportation + Chesapeake & Ohio
1988	Union Pacific + Missouri-Kansas-Texas [MKT was acquired by Missouri Pacific, a UP Corp. subsidiary]
1991	CSX Transportation + Richmond, Fredericksburg & Potomac
1993	Conrail + Monongahelia Railway [Monongahelia Railway had been acquired in 1990]
1994	Kansas City Southern + MidSouth Rail [Parent company acquired MidSouth Rail in 1993]
1995	Union Pacific + Chicago and North Western Transportation +CNW's western Railroad Properties
1995	Burlington Northern + Atchison, Topeka and Santa Fe Railway = Burlington Northern & Santa Fe Rwy
1995	49% of Texas Mexican Railway purchased by Kansas City Southern Industries
1996	Illinois Central + Chicago, Central & Pacific
1996	Union Pacific + Southern Pacific + SP's SPCSL subsidiary
1996	Mexico's Northeast Railway awarded to partnership 49% owned by Kansas City Southern Industries
1997	Kansas City Southern + Gateway Western Railway

* Includes mergers, purchases, control, acquisition, consolidation, etc. between a Class I railroad and another major freight railroad. Excludes Class I divestitures and transactions in which there are no Class I railroad participants.

Source: Whiteside, T.C. (December 3, 1997). *Rail Freight Transportation in Montana.* Statement before the United States Senate Committee on Commerce, Science and Transportation. Hearing in Great Falls, MT.

The US Congress, concerned with the weakness in the railroad industry, passed a major piece of regulatory relaxation in 1980, entitled the Staggers Rail Act. This re-regulation of the railroad industry was designed to protect the captive shippers that were served by market dominant railroads. The idea was to keep certain protections available to shippers such as farmers from railroad abuses. The Interstate

Commerce Commission during the 1980s, however, chose not to become pro-active in protection of captive shipper issues. Although directed by Congress, under the Staggers Rail Act, it did not ever issue Non-Coal rate guidelines which would have allowed captive agricultural shippers to have a basis for establishing reasonable rates that would be charged by a market dominant railroad. The US Congress finally did away with the Interstate Commerce Commission and formed the Surface Transportation Board with the specific mandate to issue Non-Coal Rate Guidelines within one year.

The railroads also started an effort in the late 1970s continuing through the 1980s to abandoning their plant. Notice that within the railroad industry the term for abandoning the track was "rationalizing" the business. Thus the United States saw the number of track miles shrinking to less than 230,000 miles by 1988.

As a result of the above described developments in the railroad industry, the agricultural producers felt that railroad competitive options to the shippers had decreased with rates and service becoming adversely affected. Also, many shippers became captive with no alternative to shipping their goods.

III. Data and Model

The dynamic nature of interregional trade and arbitrage activities indicates a need for dynamic tests in order to examine spatial price relationships, and therefore market integration. The concern of this paper is to explore the long run tendency of a dynamic (railroad) system, *i.e.*, the convergence of rail rates from different origin-destination combination points to a long-run equilibrium. Cointegration procedures, both bivariate (Engle and Granger) and multivariate (Johansen), are usually used in the studies of long-run market integration. Both procedures require nonstationary series that have linear combinations among them that are stationary. All rail rate series employed in the analysis are stationary in levels. Therefore, cointegration analysis could not be pursued. In addition to that, Barret and McNew and Fackler point out a number of shortcomings associated with using cointegration procedure in testing for market integration. Instead, a system of structural equations is estimated and dynamic regression tests are conducted in order to examine for market integration.

Data on rail movements was provided by the Agricultural Marketing Service, Transportation and Marketing Division. The variables of interest were rail rates ($/ton/mile), tonnage shipped, and the origin and destination points. The data source for these variables is the annual Carload Waybill Sample for 1986-1994. The annual Waybill Sample contains shipment data from a stratified sample of rail waybill submitted by freight railroads to the Interstate Commerce Commission. Each year's data set contains over 100,000 observations, which were sorted by month, commodity type, origin and destination point. The commodities of interest were corn, soybeans, and wheat. The origin points of interest were the Midwestern states of Illinois, Iowa, Minnesota and Nebraska. The selected destination points were the Gulf states and Pacific Northwest states including the Canadian province British Columbia. From this subset of the Waybill data, the following rail rate and tonnage time series were generated: Illinois (IL) to Gulf (GU), Iowa (IA) to Gulf, Minnesota (MN) to Pacific Northwest (PW), and Nebraska (NE) to Pacific Northwest.

Export data was obtained from Grain and Feed Market News, a publication of the U.S. Department of Agriculture. The three variables of interest were the Pacific Northwest-Gulf corn price spread, total exports (in tons) from the Gulf, and total exports (in tons) from the Pacific Northwest, including British Columbia.

The price spread variable was represented by corn rather than the other crops because a significant quantity of corn moved through ports in both regions. The offers were for deliveries at a port elevator, and shipment was to occur within thirty days. The spread between the two cash prices were computed by subtracting the Gulf price from that of Pacific Northwest. The export variables represent exports of wheat, corn, and soybeans from the respective ports to the rest of the world. All export data were reported as weekly shipments, and were subsequently averaged on a monthly basis. These monthly export figures begin in January, 1986 and extend through November, 1994.

Spot barge rates for grain shipments along the Illinois River to the Gulf were obtained from the weekly newsletter entitled "Merchandisers Fact Sheet," published by MID-CO Commodities, Inc. between 1982 and May of 1995. MID-CO Commodities, Inc. is a subsidiary of GROWMARK, Inc. Barge rates are expressed as percent of tariff. The weekly figures given in the newsletter were averaged on a monthly basis. This same publication also provided nearby barge rates for shipments originating at midpoints along the Mississippi River. These rates were quoted for a particular day as opposed to a weekly average. Loadings were expected to take place within thirty days, and the rate applied to all loading points along the river. However, the series was not continuous because portions of the Mississippi were impassible due to river freezing. Since the non-navigability along these sections was an annual occurrence, rates were not published from December to February. As a result, the Illinois River rates were used as a proxy for the Mississippi River during these months. This substitution was thought to be acceptable because changes in barge rates along the Illinois River would reflect the same fluctuations which were felt throughout the entire Mississippi River system. Also, there were no barge rates quoted between July and August of 1987, whereupon estimates were generated.

The time coverage of each variable series was not equal, requiring that some of the observations be discarded. As a result, the set of usable observations was limited to January, 1986 through November, 1994.

The model consists of four pairs of demand and supply equations. The first pair represents the rail demand and supply equations for transporting corn, wheat, and soybeans from Illinois to Gulf. The second pair represents the rail demand and supply equations for the same commodities transported from Iowa to Gulf. The third pair represents rail demand and supply equations for the same commodities transported from Nebraska to the Pacific Northwest. Finally, the fourth pair represents rail demand and supply equations for the same commodities transported from Minnesota to the Pacific Northwest. Note that in addition to these demand and supply equations, each market or demand-supply pair is accompanied by an equilibrium condition equation which equates demand and supply. However, the equations that are estimated econometrically are the four sets of demand and supply equations.

The demand side of the model involves determining those factors which affect rail usage. The most obvious factors are rail rates, with the law of demand implying that there exists an inverse relationship between rates and the demand for rail services, *ceteris paribus*.

Exogenous factors or variables that shift the demand curves are the competing transportation modes. For instance, the rail industry competes with the barge industry for a share of the export-bound grain transportation market. As trip length increases, the rail rate per ton decreases because fixed costs are spread out over greater mileage. It is assumed that as rail rates decrease, grain merchandisers will substitute the cheaper rail transportation for barge service. As a result, less grain is carried by barge, and the demand for barges shifts to the left, thereby reducing barge rates at each level of service.

Export-related variables are also extremely influential in determining rail rates since they represent a measure of foreign demand. The impact of higher export levels depends on the point of origin of ocean freight shipments. For instance, increased movements from the Gulf raise the level of rail demand and shift these curves to the right because more grain is transported by rail to Gulf. The same relationship exists for exports originating from the Pacific Northwest and the rail service to these ports.

Seasonality also plays a role in determining demand. For example, grain shipments (and therefore rail demand) increase during the harvest season and decrease thereafter. As a result, demand and rates go up and then fall back down again after production is complete. Some argue that export volume exhibits seasonal patterns; however, even if this is true, the rate effects caused by these fluctuations are captured by the export variables.

In the case of supply, rail rates are also determined by the level of usage. According to economic theory, there is a direct relationship between the two variables. That is, as rates increase, the quantity of rail-cars supplied will rise.

Other determinants are operational costs, opportunity costs associated with shipping other commodities (e.g., coal, chemicals, and fertilizers), and seasonal effects due to weather and the demand for other commodities. Higher total costs reduce supply and raise rates for each level of service provided because they make it relatively more expensive to supply the same level of service. However, the extent to which rail firms are able to raise rates depends on the degree of intra- and inter-modal competition. A highly competitive environment will significantly limit rate increases and may not allow them to rise at all.

Seasonal effects are expressed through natural occurrences such as floods, droughts, and freezes that limit barge transportation and thus affect rail transportation in an indirect way, and through high demand for other commodities such as coal, chemicals, and fertilizers which use rail services.

The simultaneous system of eight equations is shown below.

$$PILG_t = \alpha_1 + \mu_1 PILG_{t-1} + \mu_2 BRAT_t + \mu_3 ILGT_{t-1} + \mu_4 Spread_{t-2} + \mu_5 GUEX_{t+2} + \delta_i \sum_i Month_t + \varepsilon_1 \quad (1)$$

$$ILGT_t = \alpha_2 + \theta_1 ILGT_{t-1} + \theta_2 PILG_t + \theta_3 GUEX_{t+2} + \delta_i \sum_i Month_t + \varepsilon_2 \quad (2)$$

$$PIAG_t = \alpha_3 + \beta_1 PIAG_{t-1} + \beta_2 BRAT_t + \beta_3 IAGT_{t-1} + \beta_4 Spread_{t-2} + \beta_5 GUEX_{t+2} + \delta_i \sum_i Month_t + \varepsilon_3 \quad (3)$$

$$IAGT_t = \alpha_4 + \gamma_1 IAGT_{t-1} + \gamma_2 PIAG_t + \gamma_3 GUEX_{t+2} + \delta_i \sum_i Month_t + \varepsilon_4 \quad (4)$$

$$PNEP_t = \alpha_5 + \iota_1 PNEP_{t-1} + \iota_2 BRAT_t + \iota_3 NEPT_{t-1} + \iota_4 Spread_{t-2} + \iota_5 PWEX_{t+2} + \delta_i \sum_i Month_t + \varepsilon_5 \quad (5)$$

$$NEPT_t = \alpha_6 + \lambda_1 NEPT_{t-1} + \lambda_2 PNEP_t + \lambda_3 PWEX_{t+2} + \delta_i \sum_i Month_t + \varepsilon_6 \qquad (6)$$

$$PMNP_t = \alpha_7 + \phi_1 PMNP_{t-1} + \phi_2 BRAT_t + \phi_3 MNPT_{t-1} + \phi_4 Spread_{t-2} + \phi_5 PWEX_{t+2} + \delta_i \sum_i Month_t + \varepsilon_7 \qquad (7)$$

$$MNPT_t = \alpha_8 + \lambda_1 MNPT_{t-1} + \lambda_2 PMNP_t + \lambda_3 PWEX_{t+2} + \delta_i \sum_i Month_t + \varepsilon_8 \qquad (8)$$

Variables are defined as follows. BRAT represents the spot barge rate (% of tariff); PILG is Illinois to Gulf rail rate (all rail rates are in $/ton/mile); PIAG is Iowa to Gulf rail rate; PNEP is Nebraska to Pacific Northwest rail rate; PMNP is Minnesota to Pacific Northwest rail rate; ILGT is Illinois to Gulf grain shipments by rail (tons); IAGT is Iowa to Gulf grain shipments by rail; NEPT represents Nebraska to Pacific Northwest grain shipments by rail; MNPT represents Minnesota to Pacific Northwest grain shipments by rail; Spread is Pacific Northwest to Gulf corn price spread (in cents/bushel); GUEX represents total grain exports from the Gulf (tons); PWEX is total grain exports from the Pacific Northwest (tons); and, Month stands for dummy variables for the month of the year. All non-dummy variables are transformed into logs. Equations (1), (3), (5), and (7) represent the demand for rail transportation of grains from Illinois to Gulf, Iowa to Gulf, Nebraska to Pacific Northwest, and Minnesota to Pacific Northwest, respectively. Equations (2), (4), (6), and (8) represent corresponding supply equations. The number of lags for the variables is determined based on empirical observations rather than statistical tests. For instance, it is intuitive that rail and barge rate need an adjustment period to respond to changes in grain export prices. Also, most grain shipments delivered to export ports are not necessarily promptly loaded on the ocean ships.

To test for perfect market integration, the lagged rail rate coefficients across different pairs of origin-destination points are then tested for equality. In an identified simultaneous-equations model, these coefficients represent the long-run or equilibrium multipliers (Greene). The null hypothesis tested are:

H_0: $PILG_{t-1} = PIAG_{t-1}$,

H_0: $PNEP_{t-1} = PMNP_{t-1}$, and

H_0: $PILG_{t-1} = PIAG_{t-1} = PNEP_{t-1} = PMNP_{t-1}$.

Adopting the null hypothesis indicates perfect integration within the Mid-West to Mexican Gulf market in the first case, within the Mid-West to Pacific Northwest market in the second case, and between the two markets in the third case.

IV. Methodology and Results

Three-stage least squares (3 SLS) is used to estimate the previously defined system of eight equations (Judge et al.; Greene). After the theoretical considerations are made to justify the specification of the model, the econometric diagnostic analysis is conducted to confirm the validity of the theoretical arguments (Myers). Note that the estimation of the model using 3 SLS requires the econometrician to be fairly certain of the model specification because parameter estimates are asymptotically efficient if and only if the model is correctly specified. The likelihood ratio statistic that is asymptotically distributed as chi-squared (Greene, p. 639) suggests that the model specification is appropriate. The dynamic homoskedasticity test (ARCH test which is asymptotically distributed as chi-squared with one degree of freedom [Engle]) does not suggest the presence of heteroskedasticity. Finally, the Durbin h-statistic is used in testing for autocorrelation due to the presence of dependent lagged variables in the equations. The standard DW statistic is biased toward rejecting the presence of autocorrelation in such cases and therefore should not be used. The regression results do not provide any evidence of autocorrelation in any of the equations.

The regression results, with the estimated coefficients and corresponding t-values, are found in Table 2. The results reported in Table 2 include the estimated coefficients of the seasonal variables (monthly dummies). Originally, all seasonal variables were included in the model. Only statistically significant seasonal variables are reported. The results of the model are summarized below.

Table 2. Estimated Results from the Simultaneous Equation Model

			Dependent Variables (Eq. #)					
Variables	$PILG_t$ (1)	$ILGT_t$ (2)	$PIAG_t$ (3)	$IAGT_t$ (4)	$PNEP_t$ (5)	$NEPT_t$ (6)	$PMNP_t$ (7)	$MNPT_t$ (8)
α_1	2.0945 (1.769)							
α_2		-2.6746 (-0.5203)						
α_3			3.3071 (4.286)					
α_4				-9.3404 (-3.616)				
α_5					3.1933 (2.099)			
α_6						-6.2545 (-0.9626)		
α_7							2.8926 (2.990)	
α_8								-7.2296 (-2.268)
$PILG_{t-1}$	0.7012 (2.047)							
$BRAT_t$	0.2789 (3.118)		0.4715 (3.970)		0.7154 (9.201)		0.7558 (7.665)	
$ILGT_{t-1}$	-0.0467 (-0.776)	0.1051 (0.959)						
$Spread_{t-2}$	-0.0558 (-0.978)		-0.0204 (-0.323)		0.1704 (2.698)		0.1852 (2.246)	

Table 2 continued

	Dependent Variables (Eq. #)							
Variables	$PILG_t$ (1)	$ILGT_t$ (2)	$PIAG_t$ (3)	$IAGT_t$ (4)	$PNEP_t$ (5)	$NEPT_t$ (6)	$PMNP_t$ (7)	$MNPT_t$ (8)
$GUEX_{t+2}$	-0.1562 (-1.613)	0.1957 (0.472)	-0.2536 (-2.070)	0.6218 (1.216)				
$PILG_t$		4.4374 (6.280)						
$PIAG_{t-1}$			0.7199 (3.921)					
$IAGT_{t-1}$			-0.1275 (-1.846)	0.4758 (3.932)				
$PIAG_t$				1.6336 (2.588)				
$PNEP_{t-1}$					0.2809 (1.494)			
$NEPT_{t-1}$					-0.1244 (-3.381)	0.3075 (3.561)		
$PWEX_{t+2}$					-0.3091 (-4.401)	0.7650 (3.483)	-0.2788 (-3.145)	0.8095 (2.881)
$PNEP_t$						2.4282 (5.613)		
$PMNP_{t-1}$							-0.2554 (-0.948)	
$MNPT_{t-1}$							-0.0099 (-0.218)	0.2049 (1.471)
$PMNP_t$								2.4043 (4.054)

Table 2 continued

	Dependent Variables (Eq. #)							
Variables	$PILG_t$ (1)	$ILGT_t$ (2)	$PIAG_t$ (3)	$IAGT_t$ (4)	$PNEP_t$ (5)	$NEPT_t$ (6)	$PMNP_t$ (7)	$MNPT_t$ (8)
August		-0.5819 (-1.731)						
September				-0.5953 (-1.746)	0.0931 (1.732)	-0.5898 (-2.332)		
October	-0.2420 (-3.280)	0.5756 (1.723)	-0.2676 (-2.545)		-0.1492 (-2.524)	-0.5297 (-2.040)	-0.1494 (-2.229)	
November			-0.2990 (-3.064)	0.6150 (1.769)	-0.3359 (-5.550)		-0.3096 (-4.017)	

Note: Critical Values for *t*-test at 10 and 5 percent are 1.645 and 1.960 respectively.

First, the estimated coefficient of demand equations are analyzed. The expected negative relationship between rail rate and quantity of grain shipped by rail is evident in all four demand equations. It is statistically significant in the cases Iowa to Gulf and Nebraska to Pacific Northwest. All four rail demand equations are positively influenced by the barge rate. This result implies that as barge rates increase, merchandisers will substitute rail for barge, shifting the demand curve for rail service outward and increasing the rail rate at all levels of service. There is an apparent relationship between rail demand and the Pacific Northwest to Gulf corn price spread. These coefficients are negative, as expected, for Illinois to Gulf and Iowa to Gulf cases, and positive for Nebraska to Pacific Northwest and Minnesota to Pacific Northwest cases. They are statistically significant (and larger in size) only in the latter two cases indicating that the corn price spread has a minimum influence for shipments from Illinois and Iowa to Gulf because no grain from these states is transported to Pacific Northwest. On the other hand, the corn price spread is a very important factor for merchandisers in Nebraska and Minnesota because they face choice of shipping grain to either location, *i.e.*, Gulf or Pacific Northwest. Similarly, the coefficients on remaining two export related variables, GUEX and PWEX, have the expected negative signs indicating that as exports from Gulf and Pacific Northwest ports increase, demand for rail service increases and the rail rate decreases. Finally, the coefficient on the lagged dependent variable, the rail rate, has a positive sign and is significant in cases of shipments to Gulf, while such relationship does not exist in cases of shipments to Pacific Northwest. More about this particular finding will be discussed as we discuss the market integration test results.

The expected positive relationship between price and quantity in the supply equations appears and is statistically significant in all four cases. Notice that these coefficients represent price flexibility rather than elasticity because of the way the model is set up. The inverse of the flexibility represents the upper limit on the elasticity measure. The coefficients on export variables, GUEX and PWEX, are all positive as expected. Intuitively, an increase in exports from these ports will increase the amount of grain shipped by rail to the ports. Finally, the coefficients on the lagged dependent variable, the grain quantity shipped by rail, are all positive.

Tests for perfect market integration yield some interesting results (Table 3). The first hypotheses tested is that the lagged rail rate coefficients for grain transported from Illinois and Iowa to Gulf are equal. The Wald test statistic with *chi-squared* distribution and 1 d.f. indicates that the null hypotheses can be accepted at 5 percent significance level. This result is somewhat expected. Both states almost exclusively ship their grains to Mexican Gulf ports (primarily New Orleans and Galveston). The major railroads serving both states during the period under consideration, *i.e.*, 1986-1994, were Union Pacific, Southern Pacific and Burlington Northern. Both states face similar distance from major Gulf ports. Also, the Mississippi River represents the border between the two states indicating similar opportunities to ship the grains by barge to Gulf. Thus, it seems unlikely that even mergers between Union Pacific and Southern Pacific, and Burlington Northern and Atchison, Topeka and Santa Fe Railway in 1995 (see Table 1) might have affected this “long run equilibrium” significantly. As we said in the introduction, the market integration refers to a measure of degree rather than a specific relationship; this test confirms the existence of perfect market integration in the long run, and any changes in the period following the analyzed period are unlikely to disturb significantly the high level of integration within this region.

The second hypotheses tested is that the lagged rail rate coefficients for grain transported from Nebraska and Minnesota to Pacific Northwest are equal. The Wald test statistic with *chi-squared* distribution and 1 d.f. indicates that the null hypotheses cannot be accepted at any significance level usually considered in empirical work. Thus perfect market integration does not exist between these Mid-Western states in shipping grains by rail to Pacific Northwest export ports. It seems that a logical explanation for this outcome is lack of competition among railroads in Minnesota for shipping grains to Pacific Northwest. Burlington Northern is the only railroad transporting grains from this state to Pacific Northwest ports. Alternative route to ship grains from Minnesota to Pacific Northwest via Union Pacific is much longer (through Omaha, Nebraska) and highly unlikely to occur. On the other hand, the alternative routs from Nebraska to Pacific Northwest (via Union Pacific or Burlington Northern) give more options and flexibility to merchandisers in Nebraska and put the pressure on railroads to establish more competitive rates. Otherwise, these two states face similar options in shipping their grains to Gulf by rail or barge and different explanation for the lack of perfect market integration is not obvious.

Table 3. **Tests for Market Integration**

Hypotheses Tested	Wald Test Statistic (Chi-Squared distributed)		p-value	Inference
H_0: $PILG_{t-1} = PIAG_{t-1}$	0.002464	(1 d.f.)	0.96041	Accept H_0
H_0: $PNEP_{t-1} = PMNP_{t-1}$	5.359687	(1 d.f.)	0.02061	Reject H_0
H_0: $PILG_{t-1} = PIAG_{t-1} = PNEP_{t-1} = PMNP_{t-1}$	9.776981	(4 d.f.)	0.02056	Reject H_0

Finally, the hypotheses that there is perfect integration of grain transportation by rail from four different origin states in Mid-West to two different destination regions, Gulf and Pacific Northwest, is strongly rejected. This hypotheses was expectedly rejected in the light of rejection of previously tested hypotheses, *i.e.*, Nebraska and Minnesota to Pacific Northwest. We also conducted tests (not reported in the table) on perfect integration between Illinois to Gulf and Nebraska to Pacific Northwest as well as from Iowa to Gulf and Minnesota to Pacific Northwest. All test statistics suggested rejecting the null hypotheses of perfect integration.

V. Implications and Conclusions

All of the above results indicate that grain transportation market by rail is far from perfect and integrated. In some instances perfect integration occurs mostly due to similar structure of the industry in the region and similar set of opportunities to merchandisers for grain transport by rail or other modes of transportation. Even this study of limited scope combining only four origin and two destination regions strongly suggests that railroad industry in the United States goes through the phase of operating as an imperfectly competitive market making agricultural producers very vulnerable to these market conditions.

The trend of merging and combining continued throughout the years after the analyzed period (1986-1994). A major merger that occurred after 1994 affecting the region under consideration in this analysis as well as many states west of the Mississippi River was between the Union Pacific Railroad and Southern Pacific Railroad. Southern Pacific owned a railroad from Chicago to Galveston and New Orleans, and was a competitor with Union Pacific and Burlington Northern. Now only two companies, UPSP and BNSF, control almost all of the railroads originating in the largest grain producing states and ending in export ports of Gulf and Pacific Northwest.

It seems that the agricultural producer's concerns regarding rail rates and service are very legitimate. The advocates of agricultural interests make suggestions along the following lines to the U.S. government. "The issue of fairness in rates and service for captive shippers must be addressed now, before it gets out of hand. We need competition, not more concentration. We need effective protection for captive shippers and a cap on rates to protect captive shippers from monopolistic abuse until and when a truly competitive access plan becomes reality." (Whiteside)

Finally, it is important to note that the rail rates may converge in different regions even when imperfect or monopolistic market structure dominates. That would, however, most likely be an inefficient equilibrium achieved possibly through some kind of implicit collusive agreement among a few remaining railroads that dominate markets in certain regions. In all likelihood, uniformly distributed high rail rates would not resolve this very important problem, but would further threaten numerous agricultural producers.

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