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Intrarailroad and Intermodal Competition Impacts on Railroad Wheat Rates

by Michael W. Babcock and Bebonchu Atems

The issue addressed in this paper is more fully understanding the relationship of intrarailroad competition and rail rates for wheat in the largest wheat producing states, which are Idaho, Kansas, Minnesota, Montana, North Dakota, Oklahoma, South Dakota, Texas, and Washington. The overall objective of the study is to investigate railroad pricing behavior for wheat shipments. The rate model was estimated with OLS in double-log specification utilizing the 2012 STB Confidential Waybill sample and other data.

The research found that the distance from origin to destination and the total shipment weight had the expected negative relationships with railroad wheat rates and were statistically significant. The distance from origin to the nearest barge loading location had the expected positive relationship to railroad wheat rates and was also significant. The weight of each covered hopper car and the Herfindahl-Hirschman Index were both non-significant. However, the study used other data to determine that intrarailroad competition for wheat shipments within states appears to be present in most states.

INTRODUCTION

Railroads were the most heavily regulated transportation mode prior to passage of the Staggers Rail Act in 1980. Deregulation gave the railroads price flexibility that was previously unavailable. Prices between variable cost and 180% of variable cost were not subject to regulatory review. The Staggers Act set time limits for ICC decisions regarding abandonments and mergers. Thus, Class I railroads were able to quickly abandon or sell unprofitable branch lines. Mergers reduced the number of Class I railroads from 40 in 1980 to seven today.

Generally, deregulation has benefited both the railroads and the shippers. For the railroad industry, the average rate of return on investment increased from less than 3% in the 1970s to 4.4% for the 1980s, 7.64% in the 1990s, and 8.21% in the 2000s (Association of American Railroads [AAR], various years). For the 2010 to 2013 period, the rate of return on investment averaged 12.09% (AAR 2014). The average railroad rate of return on shareholders' equity rose from 2.44% in the 1970s to 7.37% in the 1980s, 9.51% in the 1990s, and 9.38% in the 2000s (AAR, various years). For the 2010-2013 period, the rate of return on shareholders' equity averaged 13.94% (AAR 2014).

Gallamore (1999) analyzed the relationship between deregulation and innovation in the rail industry. Using a before-and-after analysis, he pointed out that railroads stagnated under the final decades of ICC regulation but have significantly recovered as indicated above by the improved financial performance after 1980.

According to Grimm and Winston (2000), the net annual benefits to shippers were more than $12 billion (in 1999 dollars) in the first decade following passage of the Staggers Act. Shippers have benefited from 20 years of declining rail rates (inflation adjusted revenue per ton-mile) as well as the preservation of rural area branch lines sold or leased to short line railroads (Prater 2010).

Railroads are important for transporting agricultural commodities to domestic processing locations and export ports. These shipments involve large scale movements of low value, bulk commodities over long distances. Compared with other major grains (and soybeans), railroads are a particularly valuable mode for transporting wheat, moving 51% of all wheat shipments in 2013

(Sparger and Marathon 2015). According to Prater (2010), nine of the top 10 wheat producing states are more than 150 miles from barge transportation on the Mississippi River, which provides the most significant intermodal competition to railroads for long distance shipments of grain to export ports. Wheat shippers in the Great Plains states do not have a cost effective transportation alternative to railroads since barge loading locations are not directly accessible, and trucks are not competitive for hauling shipments over long distances. Therefore, intramodal competition for wheat shipments is expected to be a significant factor in rail rates. Table 1 contains Class I railroad route mileage for the nine major wheat producing states in 2013.

The data in Table 1 indicate the railroad mileage of some states is dominated by a single Class I railroad. For example, 88.1% of the rail miles in Idaho are UP miles. The BNSF has 94.1% of the Montana rail miles, 78.1% of the North Dakota miles, and 75.4% of the Washington miles. These states all have regional and local railroads that act as bridge carriers for the Class I railroads and, as such, they provide little direct intrarailroad competition. However, depending on the state railroad network, non-Class I railroads may contribute to intrarailroad competition.

Unlike Idaho, Montana, North Dakota, and other states are characterized by a Class I duopoly of roughly equal size firms. For example, in Kansas the BNSF has 44.3% of the Class I rail miles and the UP has 55%. In Minnesota the BNSF has 36.4% and the CP (Canadian Pacific) has 38.9% of the state's rail miles. In Oklahoma the BNSF and UP have 43.9% and 49.7% of the Class I rail miles, respectively. The BNSF and UP have respective shares of 40.5% and 52% of Texas Class I miles. This group of states would be expected to have lower rail wheat rates than the previous group due to greater intrarailroad competition. The degree of intrarailroad competition varies among states as should the level of railroad wheat prices. Potentially, intrarailroad competition could vary within states as well.

The overall objective of this research is to investigate 2012 railroad pricing behavior for the shipment of wheat. Specific objectives include: (1) measure the impact on railroad wheat rates of the intensity of intramodal competition, (2) develop a model to measure the impact of railroad costs, intramodal competition, and intermodal competition on rail wheat rates in the nine major wheat production states, (3) identify and measure the major cost determinates of railroad wheat rates, and (4) examine the hypothesis that railroad intramodal competition varies within a state with implications for intrastate variation in railroad wheat rates.

WHEAT PRODUCING STATE RAIL SYSTEMS

Tables 2-10 contain the railroad route mileage of nine states by class of railroad. Idaho has two Class I railroads, but the UP has 88.1% of the Class I miles. Idaho also has 10 Class III railroads, which collectively account for 714 miles for 41.7% of total Idaho rail miles.[1] However, Idaho has no CRDs (Crop Reporting Districts) for wheat that are served by at least two Class I railroads.

Table 3 contains Kansas rail mileage, with BNSF and UP accounting for the great majority of Class I miles. Kansas has 11 Class II and III railroads, which as a group account for 40.5% of Kansas railroad mileage.

Table 4 indicates that Minnesota has more Class I rail mileage than non-Class I. CP and BNSF are the dominant Class I railroads, but UP and CN (Canadian National) have significant track mileage as well. Minnesota has 10 Class II and III railroads, which account for only 17% of the total Minnesota rail system.

As indicated by the data in Table 5, the BNSF is the dominant railroad in Montana, accounting for 63.2% of the Montana rail network. Montana has two Class II and three Class III railroads that as a group account for 36.8% of total Montana rail miles.

Table 1: Class I Railroad Mileage by State, 2013

State	BNSF	% of Total	UP	% of Total	KCS	% of Total	CN	% of Total	CP	% of Total	Total
Idaho	118	11.9%	877	88.1%	-	-	-	-	-	-	995
Kansas	1,237	44.3	1,535	55.0	18	0.6	-	-	-	-	2,790
Minnesota	1,686	36.4	665	14.4	-	-	479	10.3	1,804	38.9	4,634
Montana	2,003	94.1	125	5.9	-	-	-	-	-	-	2,128
North Dakota	1,714	78.1	-	-	-	-	-	-	482	21.9	2,196
Oklahoma	1,037	43.9	1,173	49.7	150	6.4	-	-	-	-	2,360
South Dakota	889	59.8	-	-	-	-	-	-	598	40.2	1,487
Texas	4,929	40.5	6,336	52.0	908	7.5	-	-	-	-	12,173
Washington	1,633	75.4	532	24.6	-	-	-	-	-	-	2,165
Total	15,246	49.3	11,243	36.4	1,076	3.5	479	1.5	2,884	9.3	30,928

Source: State Department of Transportation

BNSF – Burlington Northern Santa Fe; UP – Union Pacific; KCS – Kansas City Southern; CN – Canadian National; CP – Canadian Pacific

Table 6 reveals that BNSF is the dominant Class I railroad in North Dakota, but CP has about 500 miles as well. North Dakota has two Class II and two Class III railroads that collectively constitutes 35.4% of the North Dakota rail system.

Table 7 indicates that Oklahoma has two Class I railroads (BNSF and UP) of roughly equal size. Oklahoma has more (18) Class III railroads than any of the other eight states (except Washington, which also has 18) and account for 35.1% of the Oklahoma railroad network.

Table 8 reveals that South Dakota has two Class I railroads, with BNSF accounting for about 60% of the Class I miles and UP the other 40% of the South Dakota rail system. South Dakota has seven Class III railroads, which account for 19.5% of the South Dakota railroad network.

Texas has significantly more rail miles than any of the other eight states (Table 9). UP has 52% of the Class I rail miles, followed by BNSF (40.5%) and KCS (7.5%). Texas has two Class II railroads and eight Class III railroads that together accounty for 12.8% of the Texas railroad system.

Table 10 displays Washington rail miles, which indicate that the BNSF is the dominant Class I railroad in Washington with 75% of the rail miles; UP accounting for the remaining 25%. Washington has 18 Class III railroads, accounting for 35.9% of the Washington railroad network.

Table 2: Idaho Railroad Mileage by Class of Railroad, 2013

Class I	**Miles**
Burlington Northern Santa Fe (BNSF)	118
Union Pacific (UP)	877
Subtotal	995
Local Railroads (Class III)	
Montana Rail Link	33.5
Bountiful Grain and Craig Mountain	126.6
St Maries River	72.3
Boise Valley	42.1
Eastern Idaho	264.5
Great Northwest	4.3
Idaho Northern Pacific	101.3
Pend Oreille Valley	25.7
Washington and Idaho	19.1
U.G. Government	24.3
Subtotal	714
Grand Total	1709

Source: *2013 Idaho Statewide Rail Plan*. Idaho Department of Transportation.

Table 3: Kansas Railroad Mileage by Class of Railroad, 2013

Class I	**Miles**
Burlington Northern Santa Fe (BNSF)	1,237
Union Pacific (UP)	1,535
Kansas City Southern (KCS)	18
Subtotal	2,790
Regional Railroads (Class II)	
Kansas and Oklahoma Railroad	753
Local Railroads (Class III)	
South Kansas and Oklahoma Railroad	305
KYLE Railroad	417
Cimarron Valley Railroad	183
Nebraska, Kansas, and Colorado Railroad	122
Garden City Western Railroad	45
V&S Railway	25
Blackwell Northern Gateway Railroad	18
Blue Rapids Railroad	10
Boothill and Western Railroad	10
Missouri and Northern Arkansas Railroad	8
Subtotal	1,143
Grand Total	4,686

Source: *2011 Kansas Statewide Rail Plan*. Kansas Department of Transportation, pp. 40 and 52.

Table 4: Minnesota Railroad Mileage by Class of Railroad, 2013

Class I	**Miles**
Burlington Northern Santa Fe (BNSF)	1,686
Union Pacific (UP)	665
Canadian National (CN)	479
Canadian Pacific (CP)	1804
Subtotal	4,634
Regional & Local Railroads (Class II & Class III)	
Minnesota Northern Railroad	257
Twin Cities and Western Railroad	234
Progressive Rail Inc.	97
Minnesota Prairie Line	94
Otter Tail Valley Railroad	72
St Croix Valley Railroad	66
Northern Plains Railroad	51
Minnesota Southern Railroad	42
Red River Valley and Western	32
Minnesota, Dakota and Western	6
Subtotal	951
Grand Total	5,585

Source: *2014 Minnesota Statewide Rail Plan,* Minnesota Department of Transportation, 2014.

Table 5: Montana Railroad Mileage by Class of Railroad, 2013

Class I	**Miles**
Burlington Northern Santa Fe (BNSF)	1,939
Union Pacific (UP)	125
Subtotal	2,064
Regional Railroads (Class II)	
Montana Rail Link	475
Dakota, Missouri Valley and Western	540
Subtotal	1,015
Local Railroads (Class III)	
Central Montana Rail Line	84
Mission Mountain Railroad	42
Butte, Anaconda and Pacific Railroad	63
Subtotal	189
Grand Total	3,268

Source: Montana State Department of Transportation, 2014.

Table 6: North Dakota Railroad Mileage by Class of Railroad, 2013

Class I	**Miles**
Burlington Northern Santa Fe (BNSF)	1,700
Canadian Pacific (CP)	484
Subtotal	2,184
Regional Railroads (Class II)	
Dakota, Missouri Valley and Western Railroad	424
Red River Valley and Western Railroad	427
Subtotal	851
Local Railroads (Class III)	
Northern Plains Railroad	297
Dakota Northern Railroad	48
Subtotal	345
Grand Total	3,380

Source: North Dakota Public Service Commission, *2013 Annual Report*.

Table 7: Oklahoma Railroad Mileage by Class of Railroad, 2013

Class I	**Miles**
Burlington Northern Santa Fe (BNSF)	1,037
Union Pacific (UP)	1,173
Kansas City Southern (KCS)	150
Subtotal	2,360
Local Railroads (Class III)	
South Kansas and Oklahoma Railroad	275
Grainbelt Corportation	176
Kiamichi Corportation	158
Arkansas-Oklahoma Railroad	118
Farmrail Corporation	161
Wichita, Tillman and Jackson Railroad	85
South Kansas and Oklahoma Railroad	67
Arkansas, Todd and Ladd Railroad	47
Texas, Oklahoma, and Eastern	41
Blackwell Northern Gateway Railroad	18
Cimarron Valley Railroad	35
Tulsa-Supulpa Union Railroad	23
Sand Springs Railroad	20
Tulsa Port of Catoosa	16
Western Farmers Electric Coop Railway	14
Public Service of Oklahoma Railroad	10
Northwestern Oklahoma Railroad	5
Port of Muscoge Railroad	5
Subtotal	1,274
Grand Total	3,634

Source: *Oklahoma Statewide Freight and Passenger Rail Plan*, Oklahoma Department of Transportation, 2014.

Table 8: South Dakota Railroad Mileage by Class of Railroad, 2013

Class I	Miles
Burlington Northern Santa Fe (BNSF)	889
Canadian Pacific (CP)	598
Subtotal	1,487
Local Railroads (Class III)	
D&I Railroad	54.2
Dakota, Missouri Valley, Western Railroad	56.4
Dakota Southern Railroad	168.5
Sisseton Milbank Railroad	37.1
Sunflour Railroad	19.4
Ellis and Eastern Railroad	14.3
Twin Cities and Western Railroad	10.7
Subtotal	361
Grand Total	1,848

Source: *2014 South Dakota Statewide Railroad Plan,* South Dakota Department of Transportation.

Table 9: Texas Railroad Mileage by Class of Railroad, 2013

Class I	Miles
Burlington Northern Santa Fe (BNSF)	4,929
Union Pacific (UP)	6,336
Kansas City Southern (KCS)	908
Subtotal	12,173
Regional Railroads (Class II)	
Texas Northeastern Railroad	665
Texas Pacifico Transportation	391
Subtotal	1,056
Local Railroads (Class III)	
Fort Worth and Western Railroad	276
West Texas and Lubbock Railroad	107
Texas Northeastern Railroad	104
Blacklands Railroad	66
Farmrail Corp. Railroad	59
Brownsville and Rio Grande Railroad	42
Kiamichi Railroad	40
Georgetown Railroad	30
Subtotal	724
Grand Total	13,953

Source: Texas Department of Transportation.

Table 10: Washington Railroad Mileage by Class of Railroad, 2013

Class I	**Miles**
Burlington Northern Santa Fe (BNSF)	1,633
Union Pacific (UP)	532
Subtotal	2,165
Local Railroads (Class III)	
Palouse River and Coulee City Railroad	169
Cascade and Columbia River Railroad	148
Kettle Falls International Railroad	142
Eastern Washington Gateway Railroad	108
Puget Sound and Pacific Railroad	108
Washington and Idaho Railroad	87
Columbia Basin Railroad	86
Central Washington Railroad	80
Great Northwest Railroad	69
Port of Pend Oreille Railroad	61
Portland, Vancouver, Junction Railroad	33
Patriot Woods Railroad	29
Royal Slope Line	26
Yakima Central Railroad	21
Western Washington Railroad	18
Port of Seattle Railroad	11
Port of Chehalis Railroad	10
Columbia and Cowlitz Railroad	9
Subtotal	1,215
Grand Total	3,380

Source: Washington Department of Transportation.

STATE WHEAT PRODUCTION

Table 11 contains average annual wheat production for each of the nine states during the 2009-2013 period. Kansas, North Dakota, Montana, and Washington had the largest production with 341.5, 310.2, 193, and 146.2 million bushels, respectively. Collectively, the nine states averaged 1,463.3 million bushels of wheat per year.

Table 11: Total Average Wheat Production, 2009-2013 (Thousands of Bushels)

State	Average Production	Production Rank
Idaho	103,654	7
Kansas	341,500	1
Minnesota	75,438	9
Montana	192,953	3
North Dakota	310,186	2
Oklahoma	105,459	6
South Dakota	107,270	5
Texas	80,460	8
Washington	146,200	4
Total	1,463,310	

Source: US Department of Agriculture, National Agricultural Statistics Service

Wheat production data indicate likely origin areas for rail wheat shipments. Total annual wheat production varies greatly in all nine states. For example, total Idaho wheat production increased by 18.2% between 2009 and 2011, before plunging 16.3% in 2012 (relative to 2011) and then recovering by 6.7% in 2013 (relative to 2012). Idaho wheat production is concentrated in the North and East CRDs.

Since Kansas is the leading producer of wheat in the U.S., it has significant production throughout the western two-thirds of the state. However, the Central and South Central CRDs have the largest wheat production in the state. Total Kansas wheat output fell 25.2% between 2009 and 2011, rose 38.2% in 2012, and then fell by 16.5% in 2013.

Montana wheat production is concentrated in the North Central and Northeast CRDs, accounting for, on average, 77.2% of total state output. Total Montana wheat production displayed an "up, then down" pattern. Production rose 21.9% from 2009 to 2010, then fell 18.8% in 2011, followed by an 11.3% gain in 2012 and a 4.2% increase in 2013.

North Dakota has wheat production in all nine of its CRDs. However, the Northwest plus the Northeast districts, on average, account for 38.7% of the state's wheat production. Total North Dakota wheat output plummeted 46.9% between 2009 and 2011, soared 69.7% in 2012, but then in 2013 declined 19.2% to its lowest level of the five-year period.

Oklahoma wheat production is concentrated in the West Central, Southwest, and North Central CRDs, which account for 72.6% of average Oklahoma wheat output. Total Oklahoma wheat production increased 59.5% in 2010 (relative to 2009), then dropped by 41.8% in 2011. Production in 2012 more than doubled the 2011 production, increasing by 119.9%, but declined in 2013 by 31.9%.

Average wheat production in South Dakota is concentrated in the Central and North Central CRDs, accounting for about 46% of total output. Total production declined 18.9% between 2009 and 2011, and fell another 26% between 2011 and 2013. Wheat production in 2013 was only 60% of the 2009 output.

Texas wheat production, on average, is concentrated in the Northern High Plains and the Blacklands CRDs, which account for 59.2% of Texas output. Total production rose 108.2% in 2010 compared with the depressed production of 2009. Production in 2011 decreased 61.3%, rose 94.3% in 2012, and then declined by 29% in 2013.

Washington wheat production is located almost entirely in the East Central and Southeast CRDs, which together constitute 86% of average wheat output. Total production increased 36.4% between 2009 and 2011 and then declined by about 13% in both 2012 and 2013.

LITERATURE REVIEW

Numerous studies have examined the relationship of railroad industry competition and rail pricing in agricultural markets. Many of the previous studies investigated the impact of deregulation after the passage of the Staggers Rail Act of 1980. A significant amount of the literature is regional in scope motivated by the fact that regional railroad networks vary, resulting in regional variation in intrarailroad and intermodal competition.

Several studies analyzed changes in intramodal competition and rail prices in grain transport following passage of the Staggers Act of 1980. These include Adam and Anderson (1985), Babcock et al. (1985), Chow (1986), Fuller et al. (1987), and MacDonald (1987) (1989a) and (1989b). In general, these studies found that rail wheat rates declined in nearly all corridors in the 1981-1985 period. Grain rates on movements by rail to the Great Lakes, Gulf of Mexico, and the Pacific Coast declined by large percentages.

Wilson and Wilson (2001) documented the rail rate changes that occurred as a result of deregulation in the 1972-1995 period. They use a nonlinear regulatory adjustment mechanism to represent the annual effects of deregulation over time and saw that the largest effects occurred shortly after deregulation. Over time, the total effects of deregulation continue to reduce rail rates but at a slower rate.

Wilson and Wilson found that in 1981, the effect on rail rates of the Staggers Act was a decrease of 10.6%, 9.9%, 1.8%, 13.7%, and 8.4% for barley, corn, sorghum, wheat, and soybeans, respectively. These initial effects grew over time at a decreasing rate. By 1995, the long-term percent reduction in rail rates resulting from deregulation was 52%, 46%, 55%, 52%, and 42% for barley, corn, sorghum, wheat, and soybeans, respectively. Thus, rail deregulation had relatively small initial effects on rail rates but eventually developed into larger long-term effects.

Harbor (2008) took a comprehensive look at competition within the U.S. railroad industry. She found that the further a shipment originates from water competition, the higher the rail rates. For instance, corn shippers located 100 miles from a barge loading point pay 18.5% higher rates than those located 50 miles from water. Soybean shippers located 100 miles from water have rail rates 13.4% higher than shipments originating 50 miles from barge loading points.

Harbor (2008) concludes that a movement from a monopoly to a duopoly causes corn rail rates to decline by 23.1% at 25 miles from water, 16% at 50 miles away, and 9.6% at 100 miles from water. She also found that a movement from a duopoly to a triopoly causes rail rates for corn to decline an additional 14.2% at 25 miles from water, an additional 10.1% at 50 miles away, and an additional 15.7% at 100 miles from water.

Some studies have focused on the issue of railroad wheat rates in the northern Great Plains states, especially Montana and North Dakota. Bitzan et al. (2003) provided insight into inter- and intra-commodity rail rate differentials observed since rates were deregulated in 1980. The study found that the benefits of railroad deregulation were not distributed evenly across or within commodities, favoring grain producers in regions with higher levels of intermodal competition.

The study concluded that as the number of railroads serving a market decreases or that distance to the nearest water competition rises, rail rates increase. Thus, states dominated by a single railroad and also distant from water competition will have relatively high rail rates. The authors found that the northern, southern, and Central Plains states had higher rail rates than the Eastern Corn Belt.

Koo et al. (1993) examined railroad pricing behavior in shipping grain from North Dakota to domestic and export destinations by using an econometric technique with cross sectional data from 1984 to 1989. The authors found that cost factors play an important role in the variation of rail rates; distance, volume, and weight per car all have significant effects on North Dakota rail rates. They also observed that North Dakota's primary grain commodities (wheat and barley) experience higher rates than corn and soybeans because wheat and barley are not heavily produced in water competitive regions.

Kwon et al. (1994) investigated the ability of railroads to practice differential pricing in a competitive and unregulated transportation market. They also measured the determinants of rail differential pricing in the Kansas wheat transportation market. Using data from the second half of the 1980s the authors found that railroads practice differential pricing in the unregulated Kansas wheat transportation market. This is the case for both the intra-Kansas and Kansas export wheat transportation markets, although the determinants of railroad differential prices are different in the two markets.

In 2007, Montana lawmakers appropriated $3 million for research into rail issues facing Montana, including rates and service. Cutler et al. (2009) note that Montana is distant from ports and population centers and, combined with the bulk nature of the commodities, means that motor carrier intermodal competition is ineffective. Thus, nearly 100% of Montana wheat is shipped by rail to the PNW (Pacific Northwest).

Cutler et al. (2009) found that in 2006, Montana and North Dakota wheat shippers paid higher average rail rates on a per-car basis and a per-ton basis than wheat shippers in other nearby states. They also found that the average revenue to variable cost ratio (R/VC) for Montana wheat shipments to the PNW was 253% in 2006, well above the averages for all other states with significant railroad wheat shipments.

Marvin Prater et al. (2010) examined the sufficiency of rail rate competition in rural areas and the impact of intramodal competition on rail rates. They found that rail competition for grain and oilseed shipments generally decreased in the 1988-2007 period. Also, revenue to variable cost ratios (R/VC) increased in most CRDs and the ratios were related to the number of railroads competing in the CRD.

Recent data are inconclusive on whether North Dakota and Montana wheat rail rates are higher than other states. In the 1988-2007 period, Prater et al. (2010) found that in the case of revenue per ton, Montana and North Dakota had the smallest increases of the 10 states evaluated. Iowa, Nebraska, Kansas, and South Dakota had the largest increases.

For revenue per ton-mile, Colorado, Kansas, Indiana, and Missouri had the largest increases, while Montana, North Dakota, and Illinois had the smallest increases. In fact, North Dakota revenue per ton-mile actually decreased in the 1988-2007 period.

For R/VC ratios, the states with the largest increases were Kansas, Missouri, Colorado, and Nebraska. Montana's R/VC ratio remained virtually unchanged. North Dakota and Indiana had the least increase in R/VC ratios in the 1988-2007 era.

USDA (2013) provided average grain and oilseed tariff rates per ton-mile by state for the 2006-2010 period for 36 states. The rates ranged from 2.5 cents (South Dakota) to 9.8 cents (Michigan) per ton-mile. Montana and North Dakota had rates of 3.3 and 3.4 cents, respectively. Montana had the 7th lowest rate and North Dakota had the 8th lowest rate. The study didn't supply rates for wheat separately.

Babcock et al. (2014) estimated an empirical model of intrarailroad competition involving Montana, North Dakota, and Kansas using OLS (robust standard errors) and double log specifications.

Equations were estimated for Kansas-Montana data, North Dakota-Kansas data, and the Kansas, Montana, and North Dakota data for both estimation methods.

For the Kansas-Montana estimation, the total shipment weight and the distance from Montana wheat origins to Portland were the most significant. Average Montana wheat rail rates were about the same as Kansas. For the Kansas-North Dakota estimation, the total shipment weight and the distance to Portland from North Dakota wheat origins were the most significant factors. North Dakota average rail wheat rates were higher than Kansas average rail wheat rates.

The hypothesis of the study was that the greater intrarail competition in Kansas relative to Montana and North Dakota would result in higher railroad wheat prices in Montana and North Dakota than Kansas. The hypothesis was confirmed for North Dakota but not for Montana.

MODEL

The model in this study is a variant of the model published in Koo et al. (1993) where equilibrium prices of rail transport of agricultural products are determined by the demand for and supply of rail service. The demand for an individual railroad's service (Q_d) is a function of the price of the railroad's service (P_1), the price of other railroads' transport service (P_2, P_3…), the prices of other modes of transport (A_1, A_2…), and other factors affecting the demand for rail transport (S). Thus, the demand function is equation (1).

(1) $Q_d = f(P_1, P_2, P_3 \ldots A_1, A_2, S)$

The supply of a railroad's service (Q_s) is a function of the price of the railroad's service (P_1), the price of other modes of transport (A_1, A_2…), and cost factors such as distance (d), shipment volume (v), and other variables that affect the cost of rail transport (C). Thus, the supply function is equation (2).

(2) $Q_s = f(P_1 \ldots A_1, A_2, d, v, C)$

In equilibrium $Q_d = Q_s$ so equations (1) and (2) can be combined to form the equilibrium condition. Thus, the equilibrium price equation for railroad (1) is as follows:

(3) $P_1 = f(P_2, P_3 \ldots, A_1, A_2, d, v, S, C)$

If the prices of other railroads (P_2, P_3) are defined as intramodal competition (iac) and the prices of other modes (A_1, A_2…) are defined as intermodal competition (ioc), then equation (3) can be rewritten as follows:

(4) $P_1 = f(iac, ioc, d, v, S, C)$

The empirical model for this study is based on equation (4). As discussed above, intermodal competition is likely to be minimal for rail shipments of wheat since the shipments are long distance movements to domestic processing centers and export ports making truck competition ineffective. The average distances from Great Plains origins to barge loading locations is 364.6 miles (Montana), 381.9 miles (North Dakota), 219.9 miles (Kansas), 276.7 miles (Texas), 214.8 miles (South Dakota), and 186.4 miles (Oklahoma). These distances render barge competition to be minimal to nonexistent.

The only significant source of competition is intrarailroad competition. Thus, the empirical model is as follows:

(5) $RATE = b_0 + b_1 CARWT + b_2 DIST + b_3 TSW + B_4 BARGE + b_5 HHI + e_1$

RATE – Railroad rate in dollars per ton-mile for the shipment
CARWT – Weight of covered hopper (pounds)
DIST – Distance in rail miles between origins and destinations
TSW – Total shipment weight (tons)
BARGE – Distance from origins to barge loading locations
HHI – Herfindahl-Hirschman Index

In terms of hypothesis testing, CARWT, the weight of the rail car, is expected to have a negative relationship with the change in rail rates per ton-mile (RATE). This is because operating costs such as switching cost per car, labor costs, clerical costs, and various other costs are fixed per car, so the costs per car decrease as car weight increases. Thus, the change in rail rates per ton-mile falls as car weight increases.

The expected sign of the distance between origins and destinations (DIST) is negative. A large amount of railroad costs are fixed with respect to distance such as loading and clerical costs, insurance, interest, taxes, and managerial overhead. As these fixed costs are spread over more miles, the costs per mile decrease at a decreasing rate, so the change in rail rate per ton-mile falls as distance increases.

The variable for total shipment weight TSW reflects (a) the number of cars in the shipment and (b) the tons in the shipment. Since the empirical model includes the commodity CARWT, the weight of the shipment reflects the impact on rail rates of increased cars in the shipment. Because a large share of rail costs are fixed with respect to weight, railroads also realize economies of weight. Therefore, the change in rail rates per ton-mile are expected to decrease at a decreasing rate as weight per shipment increases.

Next, intermodal competition is proxied by highway miles to barge loading locations. Longer distances to water access points reduce the feasibility of truck-barge competition for rail wheat shipments. Thus, the theoretically expected sign of BARGE, the distance from origins to barge loading locations, is positive since greater distances to water ports are likely to give greater pricing power to the railroads.

Finally, the Herfindahl-Hirschman Index (sum of squared market shares of each railroad in the CRD) is used to measure intrarailroad competition. The higher the index the greater the rail market concentration in the CRD. The maximum value of the index is 10,000 when one firm has a monopoly in the market. The index approaches zero when a market consists of a large number of firms of about equal size. The theoretically expected sign of the HHI is positive. As the index increases rail market concentration increases, leading to less intrarailroad competition and higher railroad wheat transport prices.

DATA

The principal data source for this study is the 2012 Confidential Waybill Sample compiled annually by the Surface Transportation Board (STB). The sample contains shipment data from a stratified sample of waybills submitted by freight railroads to the STB. Data obtained from the Confidential Waybill Sample include:

1. Revenue per ton and revenue per ton-mile
2. Rail car code, i.e., C113 is a 268,000-pound loaded covered hopper car, and C114 is a 286,000-pound fully loaded covered hopper car

3. Distance in rail miles from origin to destination
4. Origin and destination state
5. Originating and termination railroad
6. Total shipment weight (obtained by multiplying the cars in the shipment by the tons shipped)

U.S.D.A. AMS (Agricultural Marketing Service) classified the waybill wheat shipment data for the nine states by CRD, which are regions of five to 14 counties. The number of CRDs for the nine wheat producing states are as follows:

Idaho	4
Kansas	7
Minnesota	6
Montana	7
North Dakota	9
Oklahoma	5
South Dakota	7
Texas	7
Washington	5
Total	57

USDA AMS personnel also calculated the shortest distance from the center of each CRD to the closest barge loading location using GPS.

EMPIRICAL RESULTS

Table 12 displays the mean, standard deviation, maximum, and minimum values of the variables. The mean car weight is 279,694 pounds with a minimum value of 268,000 and a maximum of 286,000 pounds. The mean distance of the shipment from origin to destination is 853 miles with the minimum and maximum values of 29 and 2,719 miles, respectively. The mean weight of the shipment is 385,021 tons with a minimum of 62 tons and a maximum of 1,533,753. For distance of origin CRD to the nearest barge loading location, the mean, minimum, and maximum values are 302, 7, and 552 miles, respectively. The mean of the Herfindahl-Hirschman Index was 7,347 with minimum and maximum values of 3,197 and 10,000.

The empirical model was estimated in double log specification (denoted as Ln) and the results are displayed in Table 13. Variables Ln DIST and Ln TSW have the theoretically expected negative signs and are highly significant (p value of $< .001$). Ln BARGE has the expected positive sign and is statistically significant (p value of $<.001$). The results for Ln CARWT had an unexpected positive sign, but the coefficient was non-significant. This could be due to a lack of variation in CARWT since the model contained only two car weights (268,000 and 286,000 pounds), the only car sizes and types for rail wheat shipments.

The results for Ln HHI were surprising since it had an unexpected sign, but the coefficient was non-significant. The non-significance of HHI is likely not due to multicollinearity since the partial correlation coefficients with the other explanatory variables are quite low. The correlation between Ln HHI and Ln CARWT, Ln TSW, Ln DIST, and Ln BARGE are 0.179, 0.09, 0.02, and 0.09, respectively. The lack of variation in HHI may have contributed to the lack of significance since nearly 40% of the 57 CRDs in the analysis were served by only one railroad.

There is the possibility that intrarailroad competition may no longer be a factor determining the level of railroad rates for wheat. The analysis is cross-sectional using data for 2012. It is possible that the underlying effect of HHI will be better captured using panel data analysis. This should be investigated for the years 2011, 2013, and 2014. In addition, further research should investigate the importance of intrarailroad competition in determining railroad rates for corn and soybeans for the years 2011 through 2014.

Table 14 lists the number of "single carrier" shipments; that is, CRDs served by one Class I railroad. Idaho and North Dakota have the most "single carrier" shipments while Kansas, Minnesota, and Texas have the fewest. As indicated previously, the UP has 88.1% of the Idaho Class I rail mileage while the BNSF has 78.1% of the North Dakota mileage. In contrast, the UP and BNSF have roughly equal shares of the Class I rail miles in Kansas and Texas. Minnesota is served by four Class I railroads and no single railroad has more than 39% of the state rail mileage.

Table 12: Variable Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
RATE	5.764	4.322	0.0323	57.029
CARWT	279,694	8,589	268,000	286,000
DIST	853	443	29	2,719
TSW	385,021	558,852	62	1,533,753
BARGE	302	124	7	552
HHI	7,347	1,997	3,197	10,000

RATE - Revenue per ton mile x100, measured in cents per ton-mile
CARWT - measure in pounds
DIST - measured in miles
TSW - measured in tons
BARGE - measured in miles
HHI – index number, sum of rail squared market shares in a CRD

Table 13: Model Results

Variable	Coefficient	t-statistic	p-value
Ln CARWT	0.002157	0.08	0.936
Ln DIST	-0.0422	-30.52*	0.000
Ln TSW	-0.00223	-7.67*	0.000
Ln BARGE	0.00666	4.35*	0.000
Ln HHI	0.00327	-1.18	0.238
Constant	0.324074	0.98	0.328
Observations	2001		
F-statistic	243.15		
R^2	0.38		
Root MSE	0.03411		

*statistically significant at .01 level

Table 14: Number of Shipments from CRDs That Have One Class I Railroad

State	Number of Monopoly Shipments	Rank of States*
Idaho	128	9
Kansas	0	1
Minnesota	10	2
Montana	21	4
North Dakota	103	8
Oklahoma	36	5
South Dakota	47	6
Texas	11	3
Washington	64	7

*The lower the rank number the greater the intrarailroad competition. Fewer CRDs served by only one railroad.

Previous studies have indicated that the presence of two railroads in a grain transportation market results in lower rail transportation rates than a monopoly (MacDonald (1987, 1989a, and 1989b) and Harbor (2008). Table 15 indicates that a majority of the CRDs are served by at least two Class I railroads. More specifically, none of the four Idaho CRDs are served by more than one Class I railroad but all seven Kansas CRDs are served by at least two Class I railroads. Four of the six Minnesota CRDs have at least two Class I railroads, but only three of the seven Montana CRDs have more than one Class I railroad. Seven of the nine North Dakota CRDs are served by two to three Class I railroads, but only three of the five Oklahoma CRDs have this characteristic. Next, five of seven South Dakota CRDs have two to three Class I railroads, and five of the six Texas CRDs also have more than one Class I railroad. Four of the five Washington CRDs are served by a single carrier, leaving only one that is served by more than one railroad.

The Herfindahl-Hirschman Index values (HHI) indicate substantial variation in intrarailroad competition within states, although it may no longer be a factor determining rail tariff rates for wheat during 2012. Table 16 contains the high and low HHI values of CRDs in each state and a percentage difference between them. Idaho has no variation and Washington only 6.2%. However, the other seven states have very large percentage differences ranging from Oklahoma (87.8%) to Minnesota (212.8%). Thus intrarailroad competition within states appears to be significant.

Table 15: Intrarailroad Competition by State and CRD

State	CRD	Competing Railroads
Kansas	2010	UP, BNSF, Kyle
Kansas	2020	UP, BNSF
Kansas	2030	BNSF, UP
Kansas	2040	UP, BNSF
Kansas	2050	UP, BNSF
Kansas	2060	BNSF, UP
Kansas	2080	UP, BNSF
Minnesota	2710	BNSF, UP
Minnesota	2740	BNSF, UP, TCWR
Minnesota	2750	CPUS, UP
Minnesota	2760	CPUS, BNSF, UP
Montana	3020	BNSF, CP
Montana	3030	BNSF, CP
Montana	3070	BNSF, UP
North Dakota	3810	BNSF, CPUS
North Dakota	3820	BNSF, CPUS
North Dakota	3830	BNSF, CPUS
North Dakota	3840	BNSF, CPUS
North Dakota	3850	BNSF, CPUS, RRVW
North Dakota	3860	BNSF, CPUS
North Dakota	3890	BNSF, CPUS
Oklahoma	4010	BNSF, UP, ATLT
Oklahoma	4020	UP (ATLT), BNSF
Oklahoma	4030	UP, BNSF
South Dakota	4610	BNSF, CPUS
South Dakota	4620	BNSF, CPUS
South Dakota	4630	BNSF, TCWR, CPUS
South Dakota	4650	BNSF, CPUS
South Dakota	4660	BNSF, CPUS
Texas	4811	BNSF, UP
Texas	4821	BNSF, UP
Texas	4822	BNSF, UP
Texas	4840	BNSF, UP, KCS
Texas	4870	BNSF, KCS
Washington	5330	BNSF, UP

BNSF - Burlington Northern Santa Fe
UP - Union Pacific Railroad
Kyle - Kyle Railroad
TCWR - Twin Cities and Western Railroad
CPUS - Canadian Pacific (US)
RRVW - Red River Valley and Western Railroad
ATLT - AT&L Railroad
KCS - Kansas City Southern Railroad

Table 16: Intrastate Variation in Herfindahl-Hirschman Indexes of Crop Reporting Districts (CRD)

State	Low	High	High-Low % Difference
Idaho	10,000	10,000	0
Kansas	4,839	9,279	91.80%
Minnesota	3,197	10,000	212.80%
Montana	5,008	10,000	99.70%
North Dakota	5,001	10,000	100%
Oklahoma	5,326	10,000	87.80%
South Dakota	3,834	10,000	160.80%
Texas	4,643	10,000	115.40%
Washington	9,417	10,000	6.20%

CONCLUSION

This study examined 2012 rail transportation of wheat in the nine major wheat producing states. Potential competition in this market is intramodal (railroad vs railroad) and intermodal (railroad vs truck-barge). Truck competition is not effective in this market since the shipments involve relatively low value, large shipment sizes, and are shipped over long distances. The rail networks (and thus potential intramodal competition) vary among the nine states. For example, the railroad network in Idaho, Washington, Montana, and North Dakota are largely dominated by a single Class I railroad. However, the rail networks of Kansas, Minnesota, Oklahoma, and Texas are characterized by a Class I duopoly or triopoly of roughly equal size rail firms. The latter group of states would be expected to have lower railroad wheat rates than the former group of states due to greater intrarailroad competition. Also, potentially intrarailroad competition could vary within states as well.

Intermodal competition could also vary among the nine states since the distance to the nearest barge loading location varies by state. For example, Minnesota wheat shippers are closer to barge loading locations than Montana shippers. Thus, the overall objective of the study was to investigate railroad pricing behavior for the shipment of wheat. Specific goals were to (1) measure the impact on railroad wheat rates of the intensity of intramodal competition, (2) develop a model to measure the impact of railroad costs, intrarailroad competition, and intermodal competition on wheat rates in the major wheat production states, (3) identify and measure the major cost determinants of railroad wheat rates, and (4) examine the hypothesis that railroad intramodal competition varies within a state with implications for intrastate variation in railroad wheat rates.

The model was estimated in double log specification. The distance of the shipment from origin to destination (DIST) and the total shipment weight (TSW) have the expected negative sign and were highly significant. This indicates that rail cost variables have an impact on rail wheat rates, which are lower for long distance shipments and total shipment weights (more cars in the train). Distance to barge loading locations (BARGE) had the expected positive sign and was highly significant. Thus, despite the relatively long distances of most of the nine states from barge loading locations, intermodal competition in the form of truck-barge combinations can influence railroad rates.

The Herfindahl-Hirschman Index (HHI) had an unexpected sign but was non-significant, indicating that intramodal competition was no longer significant in the determination of rail tariff rates for wheat during 2012. When the number of shipments from CRDs served by one Class I railroad is compared, Idaho and North Dakota have the most "single carrier" shipments while Kansas, Minnesota, and Texas have the fewest. Thus, the degree of intrarailroad competition varies by state.

Previous studies have found that the presence of two railroads of roughly equal size in a grain transportation market results in lower rail rates. For wheat, a total of 35 CRDs (61% of the total CRDs) are served by at least two Class I railroads. The presence of intrarailroad competition varies by state. For example, Idaho had no CRDs served by at least two Class I railroads while all seven of the Kansas CRDs were served by at least two Class I railroads.

Not only varying among states, the HHIs indicate there is substantial variation of intrarailroad competition within states. For example, when comparing the high and low HHI of CRDs in each state, it was found that Idaho has no variation and Washington has only a 6.2% difference between the high and low HHI. However, the other seven states have a very large percentage difference in HHI ranging from 87.8% (Oklahoma) to 212% (Minnesota). These differences imply that intrarailroad competition is present within states.

Overall, the study found that railroad cost factors, such as distance shipped and total shipment weight, and intermodal competition are important determinants of 2012 railroad wheat rates. The HHIs were not significant, but other evidence implies that intrarailroad competition is present within states.

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Endnotes

1. The Surface Transportation Board (STB) defines Class II railroads as those with operating revenue of $37.4 million or more and less than the Class I threshold of $467.1 million. Class III railroads are those with operating revenue less than $37.4 million. These thresholds are adjusted annually for inflation (AAR, Railroad Facts, 2014, p. 3).

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Disclaimer

The opinions and conclusions expressed do not necessarily represent the views of USDA or AMS.

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