State Variation in Railroad Wheat Rates

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Wheat shippers in the Central Plains states have no cost effective transportation alternative to railroads. Wheat produced in these areas moves long distances to domestic processing and consumption locations or to ports for export. Wheat shippers in the Great Plains don't have direct access to barge loading locations and trucks provide no intermodal competition for these movements. Wheat shippers in Montana and North Dakota are highly dependent on rail transport because they are distant from barge loading locations and intra-railroad competition is limited. In North Dakota, the BNSF controls 78% of the Class I rail mileage, and in Montana, the BNSF controls 94%. Montana ships nearly 100% of its wheat by rail.

Unlike Montana and North Dakota, the BNSF and UP have roughly equal track mileage in Kansas. The BNSF has 44% of the Class I rail mileage and the UP, 55%. Also, both railroads serve the major Kansas grain storage and market centers.

A 2010 USDA study found that in 1988, Montana and North Dakota had the highest rail grain revenue per ton-mile of the 10 major grain producing states. By 2007 this was no longer the case. The overall objective of the paper is to investigate railroad pricing behavior for the shipment of North Dakota, Kansas, and Montana wheat. Specific objectives include (1) develop a model to measure the impacts of railroad costs and competition on rail wheat rates for North Dakota, Kansas, and Montana, (2) identify and measure the major cost determinants of rail wheat prices, and (3) measure intermodal competition by comparing rail wheat rates in captive markets (Montana and North Dakota) to one with more intermodal competition (Kansas).

The results indicate that there is little difference in average Montana and Kansas rail wheat rates per ton-mile. However, North Dakota average railroad wheat prices per-ton mile are higher than average Kansas rates per ton-mile.

INTRODUCTION

Railroads were the most heavily regulated transportation mode prior to passage of the Staggers Rail Act in 1980. Deregulation gave the railroads a great deal of pricing flexibility that was previously unavailable. Prices between variable cost and 180% of variable cost were not subject to regulatory jurisdiction and 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 branch lines that lost money. Mergers reduced the number of Class I railroads from 40 in 1980 to seven today.

Deregulation has benefited both the railroads and the shippers. For the rail 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 (AAR, various years). The average railroad rate of return on the 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).

According to Winston and Grimm (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 lines sold or leased to short line railroads (Prater 2010).

Railroads are important for transporting agricultural commodities from producing regions to domestic processing locations and export ports. These shipments involve large scale movement of low value, bulk commodities over long distances, and thus rail service is virtually the only cost effective shipping alternative available.

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 movements of grain to export ports. Wheat shippers in the Great Plains states have no cost effective transportation alternative to railroads. Wheat produced in these areas moves long distances to domestic processing and consumption locations or to ports for export. Wheat shippers in the Great Plains don't have direct access to barge loading locations and trucks provide no intermodal competition for these movements.

Wheat shippers in Montana and North Dakota are highly dependent on rail transport because they are distant from barge loading locations and trucks are not cost effective for long distance shipments of wheat. Cutler et al. (2009), found that Montana ships nearly 100% of its wheat by rail.

Intrarailroad competition is limited in both North Dakota and Montana. In North Dakota, the Burlington Northern Santa Fe (BNSF) controls 78% of the Class I rail mileage (Table 1). The only other Class I railroad in North Dakota is the SOO Line Railroad Company, controlled by the Canadian Pacific Railroad. The regional and local railroads are bridge carriers for the Class I railroads and thus provide little direct intrarailroad competition. However, depending on the railroad network, non-Class I railroads may contribute to intrarailroad competition. For example, in North Dakota, the Dakota, Missouri Valley and Western (DMVW) is an affiliate of the Canadian Pacific (CP) but it serves areas of the state that the BNSF does also, but not in the CP. Thus DMVW competes with BNSF for these shipments. Also in North Dakota, the Red River Valley and Western (RRVW) is an affiliate of BNSF but serves many areas of the state where there is a strong CP presence. Thus RRVW competes with CP for these shipments. So in essence the regional and local railroads may compete on behalf of the Class I railroads.

In Montana, the BNSF controls 94% of the Class I railroad mileage (Table 2). The only other Class I railroad is the Union Pacific (UP) with only 125 miles of track. Regional operators include Montana Rail Link (MRL) with 937 miles of track and Dakota, Missouri Valley and Western Railroad (DMVWR). The regional classification of DMVWR is somewhat misleading as the railroad only operates 51 miles of track in Montana. While MRL operates a large amount of track, it serves as a bridge carrier of BNSF and thus doesn't provide intramodal competition. The MRL operates and maintains the track, but BNSF still owns the mainline. The DMVWR is affiliated with the CP and links into CP lines in central North Dakota. The local railroads are linked to one or the other Class I railroads, and thus provide generally little intramodal competition.

Table 1: North Dakota Railroad Mileage 2011*

Class I	Miles
Burlington Northern Santa Fe	1,714
SOO Line Railroad Company (CP)	482
Subtotal	2,196
Regional Railroads	
Dakota, Missouri Valley and Western	475
Red River Valley and Western Railroad	540
Subtotal	1,015
Local Railroads	
Dakota Northern Railroad	50
Northern Plains Railroad	297
Yellowstone Valley	9
Subtotal	356
Grand Total	3,567

*Figures include trackage rights.
Source: North Dakota Department of Transportation. *North Dakota Transportation Handbook*, 2012, p 23.

Table 2: Railroads Operating in Montana, 2011

Class I	Miles
Burlington Northern Santa Fe	2,003 (157 inactive)
Union Pacific	125
Regional Railroads	
Montana Rail Link	937
Dakota, Missouri Valley and Western	57
Local Railroads	
Central Montana Rail Inc	84
Mission Mountain Railroad	42
RARUS Railway Company	63
Yellowstone Valley	137
Total	3,448

Source: Montana Department of Transportation

Table 3: Kansas Railroad Miles Operated 2011

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

Source: Kansas Department of Transportation. *2011 Kansas Statewide Rail Plan*, pp 38 and 52.

Unlike Montana and North Dakota, the BNSF and UP have roughly equal track mileage in Kansas (Table 3). The BNSF system is 1,237 miles, or 44%, of the Class I rail mileage while the UP system is 1,535 miles, or 55%, of the Kansas Class I miles. Also, both railroads serve the major Kansas grain storage and marketing centers (Kansas City, Abilene, Salina, Wichita, Topeka, and Hutchinson). Kansas has one regional railroad, the Kansas and Oklahoma, operating 753 miles in central and western Kansas. Kansas has 10 local railroads that collectively operate 1,143 track miles, or about 25% of the total Kansas rail system. The major local railroads are the Kyle (417 miles) serving north central and northwest Kansas, and the South Kansas and Oklahoma Railroad (305 miles) serving southeast Kansas. The local railroads don't compete with UP or BNSF.

Tables 4 through 6 display wheat production for the 2008 to 2012 period by Crop Reporting District (CRP) for Montana, North Dakota, and Kansas, respectively. Between 2008 and 2010, total Montana wheat production increased from 164.7 million bushels to 215.4 million in 2010, a gain of about 30%. In 2011, wheat production plummeted to 175 million bushels, an 18.8% decline from 2010, before recovering to 194.8 million bushels in 2012. The north central and northeast CRDs are the primary wheat growing areas, collectively accounting for an average of 75.7% of Montana wheat production from 2008-2012.

Table 4: Montana Wheat Production by Crop Reporting District (CRD)[1], 2008-2012 (Thousands of Bushels)

CRD	2008	2009	2010	2011	2012	Average[2]
Northwest	2,460	2,169	2,736	2,697	2,416	2,496
North Central	82,665	80,762	97,986	88,852	87,501	87,553
Northeast	37,500	51,845	62,732	43,927	67,846	52,770
Central	20,250	19,414	25,255	18,706	19,228	20,571
Southwest	4,375	4,592	4,877	5,045	3,611	4,500
South Central	10,289	9,608	11,381	10,631	8,557	10,093
Southeast	6,921	7,948	7,339	5,112	5,423	6,549
Other	-	337	3,054	-	168	1,186
Total	164,730	176,675	215,369	174,970	194,750	185,297

[1] Includes spring wheat, winter wheat, and durum wheat.
[2] The column total doesn't exactly equal the corresponding total row column due to rounding.
Source: Montana Department of Agriculture, *Montana Agricultural Statistics*, various issues.

Table 5: North Dakota Wheat Production by Crop Reporting District (CRD)[1], 2008-2012 (Thousands of Bushels)

CRD	2008	2009	2010	2011	2012	Average
Northwest	61,330	75,240	68,133	21,397	74,335	60,087
North Central	32,290	38,190	38,579	22,633	36,363	33,611
Northeast	81,630	66,475	74,045	54,242	69,411	69,161
West Central	14,305	41,400	37,615	20,470	36,755	30,109
Central	30,685	30,540	29,975	17,898	21,843	26,188
East Central	31,535	24,755	27,344	13,920	20,293	23,569
Southwest	15,670	51,290	42,578	22,951	43,320	35,162
South Central	18,730	28,525	24,115	14,708	23,676	21,951
Southeast	25,025	20,145	19,166	11,639	13,215	17,838
Total	311,200	376,560	361,550	199,858	339,211	317,676

[1]Figures include spring, durum, and winter wheat.
Source: USDA; NASS, North Dakota Field Office, Fargo, ND.

Table 6: Kansas Wheat Production by Crop Reporting District (CRD), 2008-2012 (Thousands of Bushels)

CRD	2008	2009	2010	2011	2012	Average
Northwest	37,485	50,400	48,127	40,250	45,040	44,260
West Central	34,475	48,800	53,220	23,550	42,700	40,549
Southwest	45,250	62,250	68,028	32,700	51,270	51,900
North Central	56,215	55,200	50,187	46,550	49,120	51,454
Central	67,360	62,100	55,630	51,270	62,615	59,795
South Central	85,250	70,150	74,267	60,650	92,990	76,661
Northeast	5,860	6,115	4,368.8	4,320	4,720	5,077
East Central	6,480	4,585	1,655.9	5,330	8,885	5,387
Southeast	17,625	10,000	,516.3	11,880	24,860	13,776
Total	356,000	369,600	360,000	276,500	382,200	348,860

Source: Kansas Department of Agriculture, *Farm Facts*, various issues

Table 5 data indicates that North Dakota wheat production rose from 311.2 million bushels to 361.6 million in 2010, an increase of 16.2%. In 2011, wheat production dropped 44.7% relative to 2010 production before recovering to 339.2 million bushels in 2012, an increase of nearly 70% relative to 2011. The northwest and the northeast are the major wheat production regions, collectively accounting for nearly 41% of total North Dakota wheat production during the five most recent years for which data are available.

Table 6 contains Kansas wheat production, which remained relatively steady in the 2008-2010 period, averaging 361.9 million bushels. As was the case for all three states, production plunged to only 276.5 million bushels in 2011, a 23.6% decrease relative to the 2008-2010 average. In 2012, wheat production was 382.2 million bushels, the highest total annual production in the 2008-2012 period and 38.2% higher than 2011 production. The largest wheat producing CRDs are the southwest, north central, central, and south central, that collectively accounted for 68.7% of the average total production during the 2008-2012 period.

The overall objective of the paper is to investigate railroad pricing behavior for the shipment of North Dakota, Kansas, and Montana wheat. Specific objectives include (1) develop a model to measure the impacts of railroad costs and competition on rail wheat rates for North Dakota, Kansas, and Montana, (2) identify and measure the major cost determinants of rail wheat prices, and (3) measure intramodal competition by comparing rail wheat rates in captive markets (Montana and North Dakota) to one with more intramodal competition (Kansas).

Prater (2010) found that in 1988, Montana and North Dakota had the highest rail grain revenue per ton-mile of the 10 major grain producing states. By 2007 this was no longer the case. While there have been many studies of railroad pricing of grain there have been few recent studies comparing variation of regional grain rail rates and the possible causes of the variation. Specifically, there has been no study of rail pricing behavior in the captive rail markets of Montana and North Dakota in the last six years.

LITERATURE REVIEW

Numerous studies discuss railroad industry competition and pricing, providing various degrees of competition within the agricultural industry. Much of the previous analysis investigated the impact of deregulation after the Staggers Rail Act of 1980. However, research interest in the rail industry and competition in the agricultural markets continued up to the present. A significant amount of the literature is regional in scope motivated by the fact that regional rail transport networks vary, resulting in regional variation in intramodal and intermodal completion.

A large number of studies analyzed changes in agricultural markets 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 Mac Donald (1987), (1989a), and 1989 (b). In general, these studies found that wheat rates declined in all corridors in the 1981-1985 period. Grain rates on movements from the eastern Corn Belt (Indiana, Michigan, and Ohio) increased while rates on movements 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 have occurred as a result of deregulation in the 1972-1995 period. They use a nonlinear regulatory adjustment mechanism to represent the effects of deregulation over time with the largest effects occurring shortly after deregulation. Over time, the total effects of deregulation continue to reduce rail rates but at a slower rate.

The authors found that in 1981, the effect on rates of Staggers 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 longer term percent reduction in 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 rates but eventually converge to larger longer term effects.

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

The author concludes that a movement from a monopoly to a duopoly causes corn rates to decline by 23.1% at 25 miles from water, 16% at 50 miles away, and 9.6% at 100 miles from water. 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 5.7% at 100 miles.

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 1981. The study found that the benefits of rail deregulation are not distributed uniformly 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 rates. Distance, volume, and weight per car all have significant effects on North Dakota rail rates. They also discovered that North Dakota's primary commodities (wheat and barley) experience higher rates than corn and soybeans. They said this is the case since wheat and barley are not heavily produced in water competitive regions.

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, 100% of Montana wheat is shipped by rail to the PNW (Pacific Northwest).

The authors found that in 2006, Montana wheat shippers paid higher average rail rates on a per car basis and a per ton basis than wheat shippers in other nearby states. The same was true for North Dakota. They also found that the average R/VC ratio for Montana wheat shipments to the PNW was 253% in 2006, well above the averages for all other states with significant rail wheat shipments.

However, recent data are inconclusive on whether Montana and North Dakota wheat rail rates are higher than other states. 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 oilseeds (soybeans) generally decreased in the 1988-2007 period. Also revenue to variable cost ratios (R/VC) increased in most crop reporting districts (CRD) and the ratios were related to the number of railroads competing in the CRD.

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, South Dakota, and Kansas 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 during the 1988-2007 period.

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

The USDA (2013) provided average grain and oilseed tariff rates per ton-mile by state, 2006-2010. The study calculated the rates for 36 states. Rates ranged from 2.5 cents (South Dakota) to 9.8 (Michigan). Montana and North Dakota had rates of 3.3 cents and 3.4 cents, respectively. Montana had the 7th lowest rate and North Dakota had the 8th lowest rate. In contrast, Kansas had the 14th lowest rate at 3.7 cents. However, rates are not provided separately for wheat.

MODEL AND DATA

The model is a variant of the model published in Koo et al. (1993). Equilibrium prices of rail transport of agricultural products are determined by the demand for and supply of rail service. 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) $Q_d = (P_1, P_2, P_3\ldots, A_1, A_2, S)$.

The supply of a railroad's service is a function of the price of the railroad's service (P_1), the price of other modes transport (A_1, A_2…) and cost factors such as distance (d) and 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) $P_1 = f(\text{iac}, \text{ioc}, d, v, S, C)$

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 North Dakota and Montana wheat. Most of the shipments are long distance movements to Portland, making truck competition ineffective. The average distance from Montana origins to barge loading locations is 522 miles and from North Dakota origins is 421 miles, rendering barge competition to be non-existent. The BNSF dominates the rail industry in Montana and North Dakota, so intramodal competition is non-existent as well. Thus, the empirical model is as follows:

(5) $RATE = B_0 + B_1CARWT + B_2DIST + B_3GVW + B_4BARGE + B_5DUMMY + \varepsilon i$

RATE - Rail rate in dollars per ton-mile for the shipment
CARWT- Weight (lbs) of each loaded covered hopper rail car in a shipment
DIST - Distance in rail miles between origins and export port
GVW - Total shipment weight in pounds (tons)
BARGE - Distance of origin to barge loading facilities
DUMMY - Dummy variable to represent either a Montana or Kansas location, or a North Dakota or Kansas location. Montana or North Dakota are assigned 1 and Kansas 0
ε - random error term

The dependent variable (RATE) is the rail rate per ton-mile and can be obtained by dividing total revenue of the shipment by weight and distance. Calculation is further demonstrated in Table 7. Variation in total revenues of the shipment is obtained by varying the number of cars in the train, and variation in the distance is obtained by varying the origin of the shipment. The total shipment weight (GVW) is obtained by varying the number of carloads in the train and multiplying by the weight per car (CARWT). The distance variable (DIST) is the distance from various origins in Montana and North Dakota to Portland, Oregon, and from various origins in Kansas to Houston, Texas. The distance of the origin to barge loading facilities (BARGE) is the distance from Montana origins to Lewiston, Idaho, the distance from North Dakota origins to Minneapolis, and the distance from Kansas origins to Kansas City, Missouri. Variation in CARWT is introduced by assuming various car sizes, i.e., 268,000-pound cars vs. 286,000-pound cars.

Table 7: Method for Calculation for BNSF Rates Per Ton-Mile

(1)	Total Revenue of Shipment = Number of cars in the shipment x rate per car.
(2)	Weight of the Shipment = Number of cars in the shipment x weight per car.
(3)	Divide (2) by 2,000 to get tons per shipment.
(4)	Divide (1) by (3) to get revenue per ton.
(5)	Divide (4) by distance of the shipment and multiply the result by 100 to get revenue per ton-mile, expressed as an integer.

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

The GVW variable reflects (a) the number of cars in the shipment and (b) the weight per car. Since the empirical model includes the commodity CARWT, the volume variable 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. Thus, the change in rail rates per ton-mile are expected to decrease at a decreasing rate as volume increases.

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 is positive since the greater the distance to water ports the greater the pricing power of railroads.

CARWT is expected to have a negative relationship to the change in rail rates per ton-mile. Because operating costs such as switching costs per car, labor costs, clerical costs, and various other costs are fixed per car, these costs per car decrease as car weight increases. Thus the change in rail rates per ton-mile falls as car weight rises.

The empirical model is estimated for Montana, North Dakota, and Kansas. For Montana and North Dakota, the shipments in the empirical model are from Montana and North Dakota wheat origins to Portland, Oregon, for export. For Kansas, the modeled wheat shipments are from Kansas origins to the export ports at Houston. Like Montana, intermodal competition is limited in the Kansas wheat transport market. The distance to Houston makes truck competition nonexistent, and historically only negligible amounts of Kansas wheat have been shipped on the Missouri and Arkansas Rivers. However, unlike Montana and North Dakota, Kansas is served by both the BNSF and UP. The lines of the two railroads are in close physical proximity in many cases, and they have roughly the same number of Kansas track miles (1,237 miles for BNSF and 1,535 miles for UP). Then intramodal competition is introduced by pooling the data of the three states and inserting a dummy variable in the equation for all Montana or North Dakota observations.

The model is estimated using BNSF rates for wheat movements in Montana and North Dakota to Portland and Kansas to Houston. These are believed to be the best data available as it represents accurate BNSF shipping charges as of August 2013. The rates were provided by BNSF personnel for each respective car type and train size. The BNSF personnel also supplied the rail shipping miles from each origin to the port destination.

As Table 8 indicates, the distance from Montana origins to Lewiston, Idaho, range from a low of 410 miles (Collins) to a high of 786 miles (Glendive) with an average distance of 519 miles for the 11 Montana origins. The distance from Kansas origins to Kansas City, Missouri, range from a low of 66 miles (Topeka) to a high of 455 miles (Coolidge) with an average distance for the 10 Kansas origins of 245 miles. The distance from North Dakota origins to Minneapolis, Minnesota, range from a low of 253 (Casselton) to a high of 624 miles (Williston) with an average distance for the 16 North Dakota origins of 437 miles. Thus, Kansas origins are significantly closer to barge loading locations than Montana and North Dakota.

Table 8: Montana, North Dakota, and Kansas Truck Miles to Nearest Barge Facility

Truck Mileage to nearest barge facility – Montana origins to Lewiston, ID			
Glendive	786	Kintyre	678
Harlem	452	Moccasin	463
Collins	410		
Pompeys Pillar	597	Average	
Shelby	449	519	
Carter	413.5		
Rudyard	511		
Grove	467		
Chester	486		

Truck Mileage to nearest barge facility – Kansas origins to Kansas City, MO		
Wichita	197	
Wellington	233	
Salina	183	Average
Hutchinson	223	245
Garden City	387	
Dodge City	345	
Concordia	206	
Abilene	156	
Coolidge	455	
Topeka	66	

Truck Mileage to nearest barge facility – North Dakota origins to Minneapolis			
Grand Forks	313	Scranton	587
Langdon	436	Bernard	352
Casselton	253	Hensler	468
Jamestown	326	Rugby	465
Minot	497	Drayton	357
Bismarck	426	Arvilla	331
Williston	624	Bisbee	459
Bowman	600	Average	
Bottineau	501	437	

EMPIRICAL RESULTS

Table 9 displays the mean, standard deviation, minimum, and maximum values. For the Kansas-Montana model, the mean RATE (revenue per ton-mile * 100) is about 3.5. The mean CARWT is 276,727 with a minimum of 268,066 and a maximum of 286,000 pounds. The mean distance from Kansas origins and Montana origins to Houston and Portland, respectively, (DIST) was about 876 miles with a minimum of 641 and a maximum of 1,214 miles. The mean of GVW (weight of the train) was 19,768,980 pounds with a minimum of 6,164,000 and a maximum of 34,320,000 pounds. The mean of BARGE for truck miles from Montana origins to Lewiston, Idaho, and from Kansas origins to Kansas City, Missouri, was about 435 miles with a minimum of 66 and a maximum 786 miles. The mean of the Montana dummy variable was 0.636.

Table 9 also contains the variable statistics for the Kansas-North Dakota model. The mean of RATE was 3.21 and 275,714 for CARWT. The mean of DIST for wheat shipments from North Dakota origins to Portland and from Kansas origins to Houston was 1,171 miles, with a minimum of 641 and a maximum of 1,602 miles. The mean of GVW was 19,429,930 pounds with a minimum of 6,164,000 and a maximum of 34,320,000 pounds. The mean of BARGE for truck miles from North Dakota origins to Minneapolis and from Kansas origins to Houston was 373 miles with a minimum of 66 and a maximum of 624. The mean of the North Dakota dummy variable was 0.608.

The empirical model was estimated using OLS (robust standard errors) and double log specifications. Equations were estimated for the Kansas-Montana data, the Kansas-North Dakota data, and the Kansas-Montana and North Dakota data for both estimation methods.

For the OLS estimation (see Table 10) of the Kansas-Montana model, CARWT had a positive sign but was non-significant. DIST and GVW had the expected negative signs and were significant at the 1% level. BARGE had the expected positive sign and was significant at the 5% level. The dummy variable was negative and significant at the 1% level, indicating that average Montana wheat rail rates per ton-mile are less than average Kansas wheat rates per ton-mile.

Table 9: Variable Statistics

Montana-Kansas Model Data				
Variable	Mean	Standard Deviation	Minimum	Maximum
RATE	3.498	.0527	2.36	4.8
CARWT	276,727.3	9,012.953	268,000	286,000
DIST	875,765	134,459	641	1,214
GVW	19,768.98	11,350.69	6,164	34,320
BARGE	434.598	167.013	66	7.86
DUMMY	0.636	0.481	0	1
North Dakota-Kansas Model Data				
Variable	Mean	Standard Deviation	Minimum	Maximum
RATE	3.210	0.579	2.36	4.8
CARWT	275,714.3	8,925.925	268,000	286,000
DIST	1,171.216	332.083	641	1,602
GVW	19,429.93	11,741.45	6,164	34,320
BARGE	372.751	135.788	66	624
DUMMY	0.608	0.489	0	1

Table 10: Kansas-Montana Model Results
OLS (robust standard error) Method

Variable	Coefficient	t statistic	p value
CARWT	1.70(e-06)	0.90	0.369
DIST	-.0026422	-8.97**	0.000
CVW	-.0000335	-25.54**	0.00
BARGE	.0005784	2.01*	0.045
DUMMY	-0.18895	-3.3588	0.0011
Constant	5.872175	10.87**	0.000
Observations 264			
F statistic 162.46			
R^2 0.74			
Root MSE 0.269			

**Statistically significant at .01 level.
*Statistically significant at .05 level.

OLS estimation of the Kansas-North Dakota model (see Table 11) found that CARWT had an unexpected positive sign and was statistically significant. As was the case with the Kansas-Montana model, both DIST and GVW had the expected negative signs and were significant at the 1% level. BARGE had an unexpected negative sign and was significant at the 1% level. The dummy variable was positive and significant at the 1% level, indicating that average North Dakota wheat rates per ton-mile are higher than average Kansas wheat rates per ton-mile.

The results of the OLS estimation of the model utilizing the data from all three states are displayed in Table 12. CARWT had the unexpected positive sign but was not significant. DIST and GVW had expected negative signs and the coefficients were highly significant. BARGE had an unexpected negative sign and was significant at the 5% level. The Montana dummy variable was negative but not significant. In contrast, the North Dakota dummy variable was positive and significant at the 1% level.

Table 11: Kansas-North Dakota Model Results
OLS (robust standard errors) Method

Variable	Coefficient	t statistic	p value
CARWT	3.63(e-06)	2.21*	0.028
DIST	-0.0023879	-14.71**	0.000
GVW	-0.0000274	-23.21**	0.000
BARGE	-0.0008152	-5.36**	0.000
DUMMY	0.756382	5.71**	0.000
Constant	5.382395	10.98**	0.000
Observations 245			
F statistic 322.59			
R^2 0.86			
Root MSE 0.2207			

**Statistically significant at .01 level.
*Statistically significant at .05 level.

Table 12: Kansas, Montana, and North Dakota Model Results
OLS (robust standard error) Method

Variable	Coefficient	t statistic	p value
CARWT	2.57(e-06)	1.84	0.067
DIST	-0.0018819	-19.67**	0.000
GVW	-0.0000273	-27.58**	0.000
BARGE	-0.000190	-2.02*	0.045
Montana	-0.07775	-1.59	0.113
North Dakota	0.32917	4.48**	0.000
Constant	5.108501	12.87**	0.000
Observations 245			
F statistic 287.24			
R^2 0.79			
Root MSE 0.24869			

**Statistically significant at .01 level.
*Statistically significant at .05 level.

The empirical results of the double log specification are similar to that of OLS method. The results for the Kansas-Montana dataset are displayed in Table 13. The log of CARWT has a positive sign but is non-significant. Both the log of DIST and GVW have the expected negative sign and are significant at the .01 level. Log of BARGE has an unexpected negative sign but is not significant. The Montana dummy variable has a positive sign but is not significant, indicating there is no difference in average Montana rail wheat rates per ton-mile and average Kansas rates per ton-mile.

Table 14 displays the coefficients and statistical results for the double log specification of the Kansas-North Dakota dataset. Log CARWT has an unexpected positive sign but is non-significant. Both log DIST and log GVW have the expected negative sign are statistically significant at the .01 level. Log BARGE has an unexpected negative sign and is significant at the .05 level. The North Dakota dummy variable has a positive sign and is significant at the .01 level, indicating that North Dakota average rail wheat rates per ton-mile are higher than Kansas average rates per ton-mile.

Table 13: Kansas-Montana Model Results
Double-Log Method

Variable	Coefficient	t statistic	p value
L CARWT	0.116116	0.73	0.464
L DIST	-0.55545	-11.77**	0.000
L GVW	-0.154434	-24.34**	0.000
L BARGE	-0.020705	-1.08	0.279
L DUMMY	0.003313	0.19	0.847
Constant	5.1618	2.57*	0.011
Observations 264			
F statistic 200.94			
R^2 0.72			
Root MSE 0.080			

**Statistically significant at .01 level.

*Statistically significant at .05 level.

Table 14: Kansas-North Dakota Model Results
Double Log Method

Variable	Coefficient	t statistic	p value
L CARWT	0.252022	1.74	0.083
L DIST	-0.7512066	-14.65**	0.000
L GVW	-0.1332539	-24.08**	0.000
L BARGE	-0.276614	-2.03*	0.043
L DUMMY	0.2064771	5.23**	0.000
Constant	4.59084	2.42*	0.016
Observations 245			
F statistic 543.94			
R^2 0.84			
Root MSE 0.070			

**Statistically significant at .01 level.
*Statistically significant at .05 level.

The statistical results for the double log specification of the Kansas-Montana-North Dakota dataset are in Table 15. Log CARWT and Log BARGE both have unexpected signs but neither is statistically significant. In contrast, both log DIST and log GVW have the expected negative signs and are statistically significant. The Montana dummy variable is positive but not statistically significant, indicating no difference in average Kansas rail wheat rates per ton-mile and average Montana rates per ton-mile. However, the dummy variable for North Dakota has a positive sign and is significant at the .01 level. Thus, North Dakota average rail wheat rates per ton-mile are higher than average Kansas rates per ton-mile.

Table 15: Kansas, Montana, North Dakota Model Results
Double Log Method

Variable	Coefficient	t statistic	p value
L CARWT	0.200978	1.72	0.086
L DIST	-0.612514	-18.88**	0.000
L GVW	-0.134345	-28.97**	0.000
L BARGE	-0.004035	-0.32	0.751
MT DUMMY	0.0067543	0.41	0.685
ND DUMMY	0.109476	4.47**	0.000
Constant	4.188548	2.79**	0.006
Observations 413			
F statistic 484.48			
R^2 0.78			
Root MSE 0.074			

**Statistically significant at .01 level.
*Statistically significant at .05 level.

In summary, the results for DIST and GVW were very robust across all six models with the expected negative sign and statistically significant at the 1% level. In contrast, CARWT had the unexpected positive sign in all models but was non-significant in five of the six models. This could be due to a lack of variation in CARWT since the models contained only two car weights (268,000 and 286,000 pounds). Also, CARWT could be correlated with GVW. The empirical results for BARGE were puzzling. It had the expected positive sign and was statistically significant at the .01 level only in the Kansas-Montana OLS equation. In the other five equations, BARGE had the unexpected negative sign and was statistically significant in three cases, and was non-significant in the other two equations.

CONCLUSION

The hypothesis of the paper is that the greater intramodal competition in Kansas compared with the lack of intra-rail competition in Montana and North Dakota would result in higher railroad wheat prices in North Dakota and Montana than Kansas. The empirical results for Montana don't confirm the hypothesis. In the four equations involving Montana data, the dummy variable for Montana is positive but non-significant in two of the four equations and negative but non-significant in another case. In one case, the Montana dummy variable is actually negative and significant, indicating that Montana average wheat rates per ton-mile are lower than those of Kansas.

The empirical results for North Dakota are consistent with the expectation that railroad average wheat rates per ton-mile are higher than average Kansas wheat rates due to greater intramodal competition in Kansas relative to North Dakota. The dummy variable for North Dakota is positive and significant at the .01 level in all four equations involving North Dakota data, indicating higher average rail wheat rates in North Dakota.

The inconsistent results for the BARGE variable permit no conclusion on the impact of intermodal competition on railroad wheat rates per ton-mile in the three states.

Additional research in this area would explore the hypothesis that intramodal competition varies within a particular state. This can be done by measuring intramodal competition by origin county or by origin Crop Reporting Districts (CRD), which are regional groups of five to 14 counties. The Herfindahl Hirschman Index (sum of squared market shares of each railroad in the CRD) would be used to measure rail vs. rail competition. The higher the index the greater the 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 relatively equal size.

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