IMPACTS OF INTRAMODAL COMPETITION ON 2012 RAILROAD RATES FOR WHEAT

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EXECUTIVE SUMMARY

What is the Issue?

The issue is more fully understanding the relationship of intrarailroad competition and railroad rates for wheat in the largest wheat producing states. The nine largest wheat states are: Idaho, Kansas, Minnesota, Montana, North Dakota, Oklahoma, South Dakota, Texas, and Washington. The overall objective of the research is to investigate railroad pricing behavior for wheat shipments. Specific objectives include: (1) measure the impact of the intensity of intra-railroad competition on railroad wheat rates, (2) develop a model to measure the impacts of railroad costs intra-railroad competition, and intermodal competition on rail wheat rates in the above named nine 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 intra-state variation in railroad wheat rates.

What Did the Study Find?

The distance in rail miles from origin to destination (DIST) and the total shipment weight (TSW) had the expected negative relationships with railroad rates (and were significant at the 1% level). The distance from origin to nearest barge loading location (BARGE) had the expected positive relationship and was also significant at the 1% level: that is, rates went up as distance to the barge loading location increased. The weight of each covered hopper car (CARWT) and the Herfindahl-Hirschman Index (HHI) were both non-significant. HHI is a measure of intra-railroad competition, which indicates that intra-railroad competition during 2012 is not a factor in determining the railroad rate for wheat.

When the number of wheat shipments from the Crop Reporting Districts (CRDs) served by one class railroad is computed, Idaho and North Dakota have the most “single carrier” shipments, while Kansas, Minnesota and Texas have the fewest. Thus the degree of intrarailroad competition would be expected to vary by state.

Previous research has 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 intra-railroad competition varies by state. For example, Idaho has 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.

Moreover, the HHIs indicate substantial variation of intrarailroad competition *within* seven of the nine states, implying variation in intrarailroad competition *within* states. When comparing the high and low HHI of CRDs in each state it was found that Idaho has no variation and Washington’s high and low HHI only differed by 6.2%. Conversely, the other states have a very large percentage differences in HHI ranging from 87.8% (Oklahoma) to 212% (Minnesota). This intra-modal competition *within* states appears to be present in most cases.

Overall, the study found that railroad cost factors (shipment distance, total shipment, weight, etc.), and intermodal competition are important determinants of railroad wheat tariff rates.

How was the Study Conducted?

The following model was estimated with ordinary least squares (OLS) in double-log specification utilizing the 2012 Surface Transportation Board (STB) Confidential Waybill sample and other data:

$RATE = b_0 + b_1\ CARWT + b_2\ TSW + b_3\ DIST + b_4\ BARGE + b_5\ HHI + e_1$

Where:

RATE – Rail revenue per ton mile

CARWT – Weight of each loaded hopper car

TSW – Total shipment weight

DIST – Distance in rail miles between origins and destinations

BARGE – Distance from origin to nearest barge loading location

HHI – Herfindahl-Hirshman Index

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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 Association of American Railroads (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 to 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 ten 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 a have cost effective transportation alternative to railroads since barge loading locations are not directly accessible, and trucks are not competitive for hauling wheat shipments over long distances. Therefore, intra-modal 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.

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 Departments of Transportation

The data in Table 1 indicates 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, and North Dakota 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 intra-modal competition, (2) develop a model to measure the impact of railroad costs, intra-modal competition, and inter-modal 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 intra-modal competition varies within a state with implications for intrastate variation in railroad wheat rates.

WHEAT PRODUCING STATE RAIL SYSTEMS

Tables 2 to 10 contain the railroad route mileage of the nine states by class of railroad (additional tables containing wheat production data by CRD are provided in the appendix). 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 or 41.7% of total Idaho rail miles. [1] However, Idaho has no CRDs 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 data indicates that Minnesota has more Class I rail mileage than non-Class I railroads. UP and BNSF are the dominant Class I railroads but CP (Canadian Pacific) 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 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 6 data 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 constitute 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 that also has 18) and account for 35.1% of the Oklahoma railroad network.

Table 8 data reveals that South Dakota has two Class I railroads with BNSF accounting for about 60% of the Class I miles and CP 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 have 12.8% of the Texas railroad system.

Table 10 displays Washington rail miles which indicates that BNSF is the dominant Class I railroad with 75% of the Class I rail miles, and 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.

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.

A large number of 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) notes 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 crop reporting districts (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 7^{th} lowest rate and North Dakota had the 8^{th} 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, $A_2 \ldots$) 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 includes:

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)

USDA AMS classified the waybill wheat shipment data for the nine states by CRD, which are regions of five to fourteen 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 11 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-Hirshcman 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 12. Variables Ln DIST and Ln TSW have the theoretically expected negative signs and are highly significant (p value of < .001)[2]. 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 13 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 11
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 12
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 13

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.

Table 14
Intrarailroad Competition by State and CRD

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

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 14 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-Hirshman 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 15 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 a very large percentage differences ranging from Oklahoma (87.8%) to Minnesota (212.8%). Thus intrarailroad competition within states appears to be significant.

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.

Table 15

Intrastate Variation in Herfindahl-Hirshman 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%

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 (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-Hirshman Index (HHI) had an unexpected sign but was non-significant, indicating that intra-modal 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 that there is substantial variation of intra-railroad 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 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 intra-railroad competition is present within states.

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ENDNOTES

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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).

2 In statistical analysis, hypothesis tests are used to test the validity of a claim. The hypothesis in question is called the null hypothesis. In this case, the null hypothesis being tested is that the coefficient on DIST is equal to zero (i.e. DIST has no significant impact on RATE). A small p-value (typically < 0.05) indicates strong evidence against the null hypothesis and suggests that there is a relationship between DIST and RATE.

APPENDIX

STATE WHEAT PRODUCTION

Appendix tables 1 to 9 contain wheat production for the 2009-2013 period by Crop Reporting District (CRD) for the nine major wheat production states. This data indicates likely origin areas for rail wheat shipments. For example, Idaho wheat production is concentrated in the North and East CRDs. 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).

Since Kansas is the U.S. leading producer of wheat 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, then rose 38.2% in 2012 and then fell by 16.5% in 2013.

Minnesota spring wheat production is concentrated in the Northwest CRD which on average accounts for 76.5% of the entire state production. Total Minnesota wheat output fell 16% between 2009 and 2011, then increased 8.2% in 2012, and declined 11.5% 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, then 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 that account for 59.2% of Texas output. Total production rose 108.2% in 2010 compared to the depressed production of 2009. Production in 2011 decreased 61.3%, then 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.

Appendix Table 1
Idaho Wheat Production by Crop Reporting District
2009-2013
(Thousands of Bushels)[1]

CRD	2009	2010	2011	2012	2013	Average[2]
North	28,510	31,820	29,572	32,770	32,022	30,939
Southwest	8,010	8,060	9,902	7,205	8,692	8,374
South Central	15,490	16,110	22,216	15,095	17,552	17,293
East	45,500	50,200	53,530	42,130	44,644	47,201
Total	97,510	106,190	115,220	96,440	102,910	103,654

1. Includes winter and spring wheat.
2. The column total doesn't exactly equal the corresponding total row column due to rounding.

Source: U.S. Department of Agriculture, National Agricultural Statistics Service, *Idaho Annual Statistical Bulletin*, various years.

Appendix Table 2
Kansas Wheat Production by Crop Reporting District
2009-2013
(Thousands of Bushels)

CRD	2009	2010	2011	2012	2013	Average[1]
Northwest	50,400	48,127	40,250	45,040	17,190	40,201
West Central	48,800	53,220	23,550	42,700	21,254	37,905
Southwest	62,250	68,028	32,700	51,270	27,531	48,356
North Central	55,200	50,187	46,550	49,120	48,792	49,370
Central	62,100	55,630	51,270	62,615	68,629	60,049
South Central	70,150	74,267	60,650	92,990	86,870	76,985
Northeast	6,115	4,369	4,320	4,720	6,621	5,229
East Central	4,585	1,656	5,330	8,885	14,365	6,964
Southeast	10,000	4,516	11,880	24,860	27,948	15,841
Total	369,600	360,000	276,500	382,200	319,200	341,500

1. The column total doesn't exactly equal the corresponding total row column due to rounding.

Source: (2009-2012) Kansas Department of Agriculture, *Farm Facts*, various issues. (2013) U.S. Department of Agriculture, National Agricultural Statistics Service, *News Release, Kansas Crop Production Report*, 2014.

Appendix Table 3
Minnesota Wheat Production by Crop Reporting District
2009-2013
(Thousands of Bushels)[1]

CRD	2009	2010	2011	2012	2013	Average[2]
Northwest	58,075	62,488	54,366	58,854	54,654	57,687
North Central	999	1,061	1,211	1,219	-	898
West Central	16,568	16,263	10,935	11,884	8,607	12,851
Central	3,330	2,823	1,335	1,441	894	1,965
East Central	632	539	181	15	133	300
Southwest	1,700	1,332	629	697	606	993
South Central	559	547	240	217	191	351
Other	287	197	86	343	1,035	390
Total	82,150	85,250	69,000	74,670	66,120	75,438

1. Includes only spring wheat.
2. The column total doesn't exactly equal the corresponding total row column due to rounding.

Source: Minnesota Department of Agriculture, *Minnesota Agricultural Statistics Service*, various issues.

Appendix Table 4
Montana Wheat Production by Crop Reporting District[1]
2009-2013
(Thousands of Bushels)

CRD	2009	2010	2011	2012	2013	Average[2]
Northwest	2,169	2,736	2,697	2,416	2,615	2,527
North Central	80,762	97,986	88,852	87,501	97,552	90,531
Northeast	51,845	62,732	43,927	67,846	65,678	58,406
Central	19,414	25,255	18,706	19,228	19,521	20,565
Southwest	4,592	4,877	5,045	3,611	2,855	4,196
South Central	9,608	11,381	10,631	8,557	7,753	9,587
Southeast	7,948	7,339	5,112	5,423	6,748	6,514
Other	337	3,054	-	168	288	769
Total	176,675	215,360	174,970	194,750	203,010	192,953

1. Includes spring, winter, 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 Service*, various issues.

Appendix Table 5
North Dakota Wheat Production by Crop Reporting District
2009-2013
(Thousands of Bushels)[1]

CRD	**2009**	**2010**	**2011**	**2012**	**2013**	**Average**
Northwest	75,240	68,133	21,397	74,335	47,429	57,307
North Central	38,190	38,579	22,633	36,363	24,286	32,010
Northeast	66,475	74,045	54,242	69,411	50,879	63,010
West Central	41,400	37,615	20,470	36,755	28,334	32,915
Central	30,540	29,975	17,898	21,843	16,004	23,252
East Central	24,755	27,344	13,920	20,293	17,641	20,791
Southwest	51,290	42,578	22,951	43,320	43,918	40,811
South Central	28,525	24,115	14,708	23,676	20,378	22,280
Southeast	20,145	19,166	11,639	13,215	10,154	14,864
Other	-	-	-	-	14,727	2,945
Total	376,560	361,550	199,858	339,211	273,750	310,186

1. Includes spring, winter, and durum wheat.

Source: U.S. Department of Agriculture, *National Agricultural Statistics Service*, North Dakota Field Office, Fargo North Dakota.

Appendix Table 6

Oklahoma Wheat Production by Crop Reporting District
2009-2013

(Thousands of Bushels)

CRD	2009	2010	2011	2012	2013	Average
Panhandle	16,050	18,150	7,500	16,000	4,000	12,340
West Central	10,100	21,250	9,100	24,400	14,500	15,870
Southwest	8,150	26,200	9,700	35,000	15,800	18,970
North Central	32,650	39,000	32,600	55,900	48,500	41,710
Central	7,225	13,500	8,500	17,650	15,400	12,455
South Central	-	1,200	760	1,350	1,300	922
Northeast	1,200	885	1,280	3,150	4,800	2,263
East Central	420	510	570	-	640	428
Southeast	-	205	390	-	460	211
Other	-	-	-	1,350	-	270
Total	75,795	120,900	70,400	154,800	105,400	105,459

Source: Oklahoma Department of Agriculture, Food and Forestry, O*klahoma Agricultural Statistics*, various issues.

Appendix Table 7

South Dakota Wheat Production by Crop Reporting District[1]

2009-2013

(Thousands of Bushels)

CRD	**2009**	**2010**	**2011**	**2012**	**2013**	**Average[2]**
Northwest	11,609	12,738	10,200	11,215	10,903	11,333
North Central	29,656	26,290	19,310	20,542	17,957	22,751
Northeast	15,497	12,783	8,249	7,380	6,829	10,148
West Central	12,206	13,939	15,401	12,226	7,903	12,335
Central	29,388	32,927	26,772	26,996	16,589	26,534
East Central	5,631	2,784	2,193	685	2,517	2,792
Southwest	2,533	3,731	2,751	2,283	2,371	2,734
South Central	12,572	13,093	12,750	13,294	7,398	11,821
Southeast	9,848	4,815	5,937	4,839	4,923	6,072
Other	-	-	1,037	2,860	-	78
Total	128,940	123,100	104,600	102,320	77,390	107,270

1. Includes winter and spring wheat.
2. The column total doesn't exactly equal the corresponding total row column due to rounding.

Source: U.S. Department of Agriculture, National Agricultural Statistics Service, *South Dakota Annual Statistical Bulletin*, various years.

Appendix Table 8

Texas Wheat Production by Crop Reporting District[1]

2009-2013

(Thousands of Bushels)

CRD	2009	2010	2011	2012	2013	Average[2]
1-N	37,813	54,360	18,265	28,525	12,200	30,233
1-S	4,697	6,900	2,094	3,132	2,375	3,840
2N	4,126	13,400	3,197	9,718	5,904	7,269
2S	3,319	24,500	3,754	14,750	9,386	11,106
3	995	6,520	1,641	4,873	2,443	3,294
4	7,386	9,200	16,759	25,882	27,890	17,423
7	1,240	7,100	1,266	4,095	4,145	3,569
8-N	301	2,300	798	2,465	1,457	1,464
Other	1,229	3,220	1,626	2,740	2,350	2,233
Total	61,250	127,500	49,400	96,000	68,150	80,460

1-N = Northern High Plains
1-S = Southern High Plains
2N = Northern Low Plains
2S = Southern Low Plains
3 = Cross Timbers
4 = Blacklands
7 = Edwards Plateau
8N = South Central

1. Includes only winter wheat.
2. The column total does not exactly equal the corresponding total row column due to rounding.

Source: U.S. Department of Agriculture, National Agricultural Statistics Service, Texas Field Office, various press releases.

Appendix Table 9
Washington Wheat Production by Crop Reporting District[1]
2009-2013
(Thousands of Bushels)

CRD	2009	2010	2011	2012	2013	Average[2]
Western	550	677	440	512	395	515
Central	4,550	8,528	13,135	10,765	10,523	9,500
Northeast	8,943	11,570	6,410	10,018	10,685	9,525
East Central	49,154	62,805	71,987	61,550	61,267	61,353
Southeast	58,560	64,310	72,633	63,500	62,931	64,387
Other	1,327	-	3,275	-	-	920
Total	123,084	147,890	167,880	146,345	146,530	146,200

1. Includes winter and spring wheat.
2. The column total doesn't exactly equal the corresponding total row column due to rounding.

Source: U.S. Department of Agriculture, National Agricultural Statistics Service, *Washington State Annual Statistical Bulletin*, various years.